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Enhancing Pre-Service Teachers' Understanding of Science Teaching through STEM Activities Integrated Inquiry Learning with Thai Context

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Abstract

The objectives of this research were: 1) To develop and examine a learning model using STEM activities for pre-service science teachers, and 2) To study the condition and develop a learning model using STEM activities in science teaching integrated with Thai local context using schools and communities as bases. The target group of the research was 81 pre-service science teachers from 240 1st-4th years, obtained by purposive sampling, they are volunteer ones, who are interested in improving their teaching. The tools used in the research were lesson plans, questionnaires, field notes, and journal writing. The lesson plans included three STEM activities integrated into local settings that could be applied in science classrooms. The results were as follows: 1) The developed STEM learning model can be used as a guideline for teaching and learning with promising results; 2) The target group of pre-service science teachers had a significant improvement in their level of understanding of the science learning process in STEM activities. In the beginning, they received an average score of 17.28 on a scale of 50 and a standard deviation (SD) of 3.13 on STEM Learning Management Understanding Link-local context using schools and the community is the base, which could

be interpreted as a low level. After teaching using these developed STEM activities, their average score was raised to 41.93 with the SD being 3.71, which could be interpreted as a high level. It could be concluded that the learning approach from this research is one approach that can improve teaching and learning management for pre-service science teachers.

Keywords: Local contexts, Teaching process, Science teaching, STEM Education

1. Introduction

Entering an era when the tide of educational reforms and instructional changes is happening all the time requires much exertion from both students and instructors. Just in seven years, from 2008 to 2014, Organization for Economic Cooperation and Development (OECD) nations embraced no less than 450 instruction changes (OECD, 2015). In terms of both approach and practice, there is an energetic exertion to move to instruct and learning towards students' capacity improvement in which STEM instruction is considered one of the key solutions. STEM stands for Science, Technology, Engineering, and Mathematics. It is an instructing and learning approach in which Science, Technology, Engineering, and Mathematics are integrated as a whole instead of being learned separately as the real-world problems are complicated and complex that can be only solved most effectively by combining all your knowledge, skills and even suitable attitude. The concept of STEM was first introduced in 2001 by the scientific administrators at the U.S. National Science Foundation as reviewed by Kelley and Knowles (2016). Most nations around the world esteem STEM instruction and empower all levels of instruction, which is also a challenge as each setting requires a different and diverse way to apply STEM. Therefore, it is worth studying STEM as an integrated model that can connect local contexts with science, technology, engineering, and mathematics.

Considering the fast-paced financial, social, and political development in the last decades, endeavors for progress and up-to-date instruction frameworks to drive the long-haul development is necessary. There was little evidence of whether education reforms have a significant impact since instructive impacts are challenging to measure and survey, and were rarely evaluated. For example, the fast change in school equipment, the popularity of social networks and online information, and the new scientific findings. Those make education need to be date and not meet the requirement of society.

Similarly, there's small information approximately the real forms that produce, or are assumed to create the required results. These forms "between the foundation of an approach and its impacts within the world of action" (O'Toole, 2000) are commonly alluded to as arrangement usage, indeed on the off chance that there's no agreement on the definition.

Among the many specific goals in education, the completion of academic skills constitutes an important goal for universities (Elliott & Shin, 2002) because this closely combines with the retention and enrollment of students in STEM fields after they graduate (Douglas et al., 2006; Whole et al., 2010; Tengteng et al., 2019). Progresses in science, technology, engineering, and mathematics are projected to be the driving constrain of the long-run economic and in

general well-being, not only for the progressed economies such as the United States (US), whereas the request for STEM experts in the US was anticipated to increase by 17 % between 2008 and 2018 (Langdon et al., 2011), but also for the developing economies around the world. These were not predictions anymore but the reality when the need for STEM experts in the workplace was advancing these years and more and more countries considered STEM education as one of their main teachings and learning approaches in their renew curricula, such as in the case of Thailand (please provide a reference here) or Vietnam (Vietnam Ministry of Education and Training, 2018). Within the 21st century, the field of technology and engineering has been changing and rising quickly. A result of these changes was reflected in educational instructions, which STEM ended up an indispensable portion of instruction in most countries. STEM makes students learn science, mathematics, engineering, and technology together in solidarity rather than learning each subject independently and losing the all-encompassing point of view. Moreover, it empowers students to apply what has been learned to real-life applications. These days science classrooms got to engage students with more real-world problem-solving exercises instead of learning a bund of information (Dejarnette, 2012). To achieve this objective, it is basic to get teachers ready for instructing STEM subjects through coordinated approaches (Honey et al., 2014). This circumstance increments the requirement for reconsidering the STEM instruction approach for each context, in a rapidly developing world. Educators are faced with the need to plan and provide viable instruction programs for teachers to prepare them to accommodate this shift of STEM instruction in their work and to embrace STEM instruction through collaborative approaches in their classrooms (Corlu et al., 2014; Stubbs & Myers, 2016). Coordinates STEM instructing approaches improved science substance information (Becker & Stop, 2011). Moreover, despite their solid convictions around STEM integration, preservice teachers detailed an expanded feeling of trouble in actualizing STEM integration units after completion of an instructor planning program (Berlin & White, 2012).

STEM in Thailand has been receiving the consideration of all stakeholders since the Thai Ministry of Education called for coordinated STEM instruction approaches in which students learn how to solve issues by interfacing substance and hones of different STEM areas. The Thai government is advancing instruction in STEM at all instructive levels to extend the number of students in STEM and to make strides in Thai students' capacity in common. STEM instruction is considered essential to get ready Thai students for a comprehensive society that requires everybody to have the individual and social aptitudes to work. STEM instruction ventures are being advanced in schools and colleges all through Thailand with the bolster of the National STEM Instruction Center and the Territorial STEM Instruction Center which are acting as instructor improvement centers to get ready excellent STEM to bolster fabric and conduct instructor preparation (The Institute for the Promotion of Teaching Science and Technology [IPST], 2017). The learning activities in this STEM strategy course were pointed to encourage pre-service teachers' development of their STEM instructive understanding by collaboratively working with others and partaking with specialists in taking a STEM instructing course as part models for STEM instructing (Pimthong & Williams, 2021). As expected, students of the Bachelor of Science Program in General Science, who are studying in the 2019 Revision Program, a four-year program at the Faculty of Education,

Sakon Nakhon Rajabhat University, must have an in-depth understanding of the science and must have the ability to design science learning activities to connect local context concepts. A self-contained society where students are in an environmental context is conducive to greatly advantageous learning. Compared to other institutions in other regions, the new dimension focuses on learning outcomes as graduates of qualified teachers based on teacher professional standards, a high profession with the ability to manage, learn and develop learners to be good people. Focus on developing graduates to have the potential to perform teaching and learning from basics (Bachelor of Education Program, 4-Year Renovation Program, 2019), this research developed a learning model using STEM activities for teachers to develop an in-depth understanding of science teaching and learning that connect local contexts using schools and communities as a base for the pre-service teachers. As mentioned above, STEM education focuses on 21st-century skills such as critical thinking, creativity, problem-solving, etc. Morrison (2006) described the students who took STEM education as 'inventors' because they became aware of the needs of the world, and found and implemented creative solutions. In addition, not only creativity but all other 21st-century skills are considered very important for pre-service teachers because they are the ones who will improve the country further. From this point of view, this study aimed to create and examine a learning model using STEM activities for pre-service science teachers and to study the condition and develop a learning model using STEM activities in teaching science with in-depth integration linking the Thai local context using schools and communities as bases.

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1.1 Research Framework

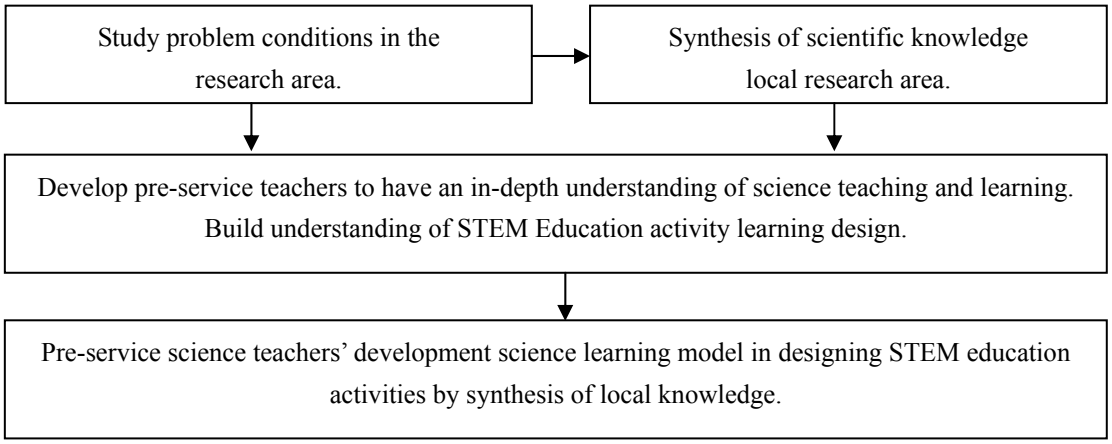

Figure 1. A conceptual framework of the research

2. Method

2.1 Participant

The participants of the research consisted of 81 students, including 58 first-year and 23 in the fourth year, studying in science education, Bachelor of Education, Faculty of Education, Sakon Nakhon Rajabhat University, Northeast of Thailand in the academic year 2020. The research was purposive sampling. They were taking this STEM lesson for the first time and they were selected among of students. When choosing pre-service science teachers, priority

was given to pre-service science teachers who meet the condition pre-determined by the researcher. These conditions are: 1) Enroll in Teaching science and Biology for teacher course; 2) Attending classes in science education, working after class for about 2-3 hours per week. The students' age was between 19 to 21 years old. The first-year students were coded as S1-1 to S1-58 and the fourth-year students were coded as S4-59 to S4-81. Participants as pre-service science teachers could withdraw at any point in the course of the study. They had studied curriculum, teaching methods, creation and use of technology, and assessment in prior years before entering the 1-year professional training in their 4th year of study. There are 4 middle school teachers and 2 high school teachers who joined the research. They are observes the teaching of the pre-service science teachers and feedback are provided by one teacher per science class.

2.2 Sampling Procedures

In the classroom where the researchers are conducting the research, many STEM learning activities have been made in the 'Science' course before implementing STEM learning activities. From this point of view, the applied group was accustomed to being taught STEM-focused activities. In this STEM learning process, the pre-service teachers of the class participated as an audience. Thus, an environment was tried to be created for students to feel safer and more comfortable.

2.2.1 Qualitative Methodology

To obtain in-depth insights into pre-service science teachers' understanding, the researchers collected qualitative data from two-hour meetings after the course with the participants, one with pre-service science teachers (n = 81, group 1), one with middle school teachers (n = 4, group 2), and one with high school teachers (n = 2, group 3). The researchers asked pre-service science teachers from the first group to answer two open-ended questions: "What are the successes with the implementation process?", and "What are the challenges/uncertainties with the implementation process?" then let them write notes about successes and challenges or issues of concern. Groups 2 and 3 answer open-ended questions: ''How about your student in class before and after the course?" and "What do you think when you observe pre-service science teachers teaching STEM lessons in class?'' The researchers collected groups' notes at the end of each meeting. Groups' discussions and notes were documented and analyzed for the identification of themes. This research, therefore, wants to develop the learning process using STEM activities for pre-service science teachers to develop an in-depth understanding of science teaching and learning connect local contexts using schools and communities as a base.

2.3 Research Tools

This research model was mixed methods research. The following research tools include lesson plans, questionnaires, observations, field notes, and journal writing. These data collection instruments were developed by the researchers. Information regarding the development of these tools is listed below.

2.4 Data Collection

The researchers divided the data collection into three phases as follows: Phase 1: Consolidation of field data for research; Phase 2: Understanding and Designing Activities; and Phase 3: Bringing learning activities into school. Data collection is done by observation engagingly from December 2019 to February 2020, researchers and target groups developed research frameworks, observation, and interview methods. For the reliability of the interpretation of this research, it is important to take into account the long time spent in the context of the area group to get acquainted with and be a part of what is being studied until the information can be interpreted correctly. This was to get the information that the researcher truly needed (Lincoln & Guba, 1985).

2.5 Data Analysis

Analyze the data obtained from the field record and informal interviews, and participant observation of community activities. Here are the steps:

(1) Initial data analysis: is an analysis of data performed during data collection, namely the recording of the informant's concepts and behavior during interviews and engaging observations. At this stage, it is considered a recording of what the investigators initially interpreted.

(2) Grouping data: reduces data into categories based on features, which includes the process of grouping data.

(3) Linking relationships between data: is an analysis to find pattern categories to describe the studied phenomena.

(4) Find the average of the understanding questionnaire responses, organize learning activities using STEM events connect to local contexts, use schools and communities as the base of the target group, and then apply the average score value against the criteria. The scales are as follows: 4.51-5.00 as "Excellent"; 3.51-4.50 as "Good"; 2.51-3.50 as "Average"; 1.51-2.50 as "Little"; and 1.00-1.50 as "Very little.

2.5.1 Statistics Used and Presentation of Data

Statistics used and presentation of basic statistical data analysis data include a percentage and standard deviation (SD).

The credibility of the analytical process is achieved by reviewing the results of peer debriefing since the interpretation is based on each subjective.

2.6 Research Design

Implementation of the research was as followed: The study lasted for 4 weeks with 3 hours per week in which two weeks were spent on the assessment of pre-post design STEM activities, and two weeks were spent on implementation. The total implementation period was 12 hours. The pre-service science teachers in the study group were taught according to the instruction. In the classes with the study group, the concepts of science in the lesson were

shown to the students. The pre-service science teachers spoke on the related concepts of science, and they discussed them together. At the end of the classes, the pre-service science teachers were given the printed concepts of science, and they were asked to answer the activity questions regarding science in Thai context. The pre-service science teachers who responded incorrectly were corrected and were given correct feedback. Then, they designed three sample STEM activities that integrated with the local context and culture of Sakon Nakhon, Thailand. The last step was implementing these STEM activities in their microteaching classes.

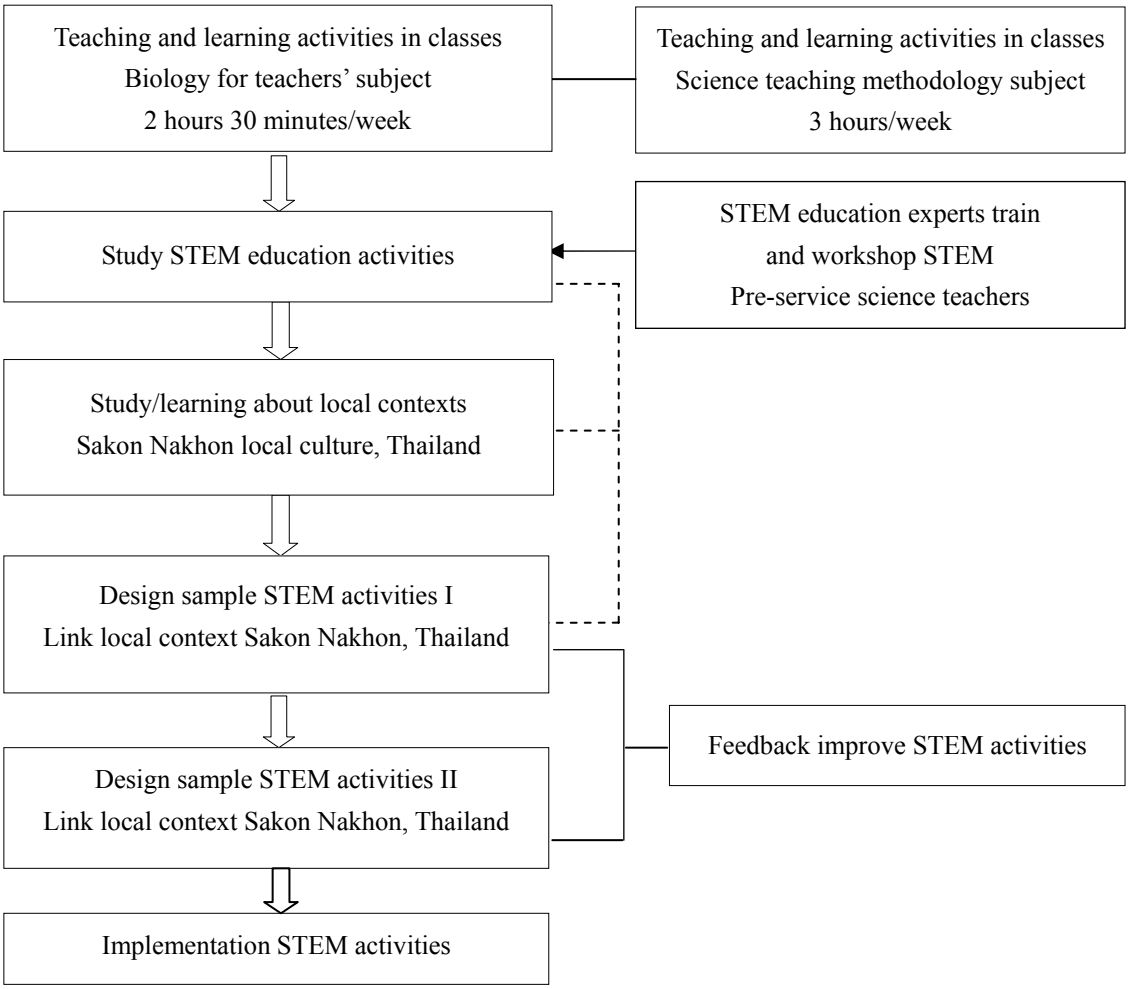

Figure 2. Model of improving pre-service teachers' understanding of science teaching in STEM activities integrated with Thai context

3. Results

(1) The findings to create and examine a learning model using STEM activities for pre-service science teachers to develop an in-depth understanding of science teaching and learning connected to local contexts, using schools and communities as a base could be found

in the learning model in Figure 3.

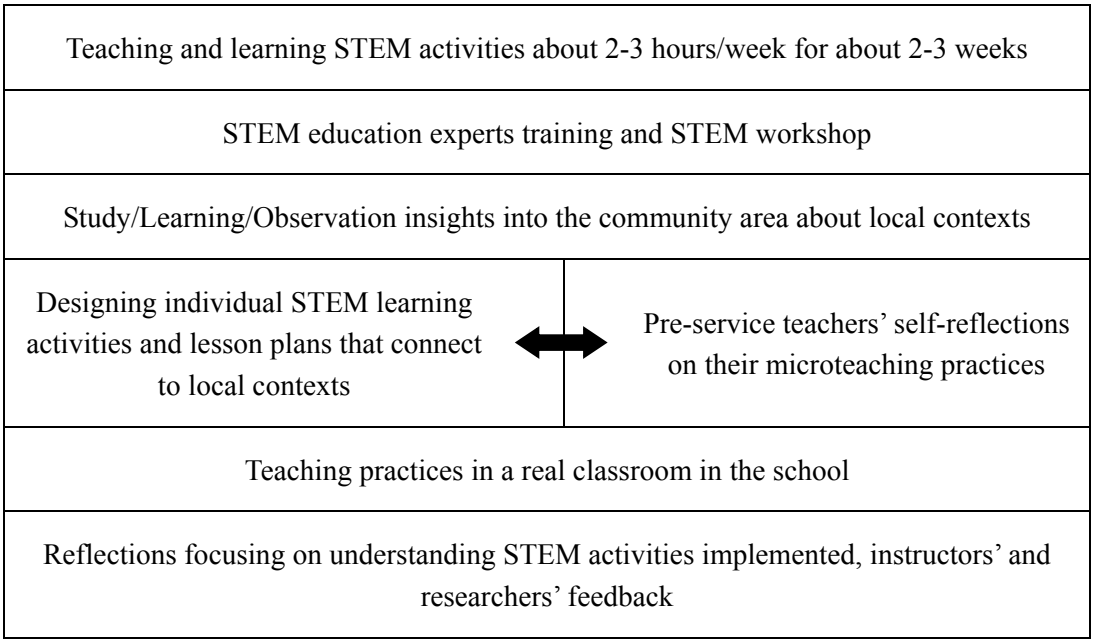

Figure 3. Model of learning about "STEM teaching" of pre-service science teachers

In the first stage, the researchers interviewed the pre-service teachers about their need to learn about their general learning activity design. Here are some examples of the responses from the first-year students:

> "*…If you want to design a learning activity for your teaching by yourself, you can't do it well. If there is an activity that helps you train yourself, I think it will be good...*" (S.1-19)

> "*...It would be fun to try to design a lesson plan for yourself, but I think sometimes it's hard. I'm not sure yet. I do want to find out as much as I can. I fell into STEM education...*" (S.1-12)

Researchers interviewed about the need to learn about their learning management design. Here are some examples of interviews with fourth-year students: "*...STEM learning design is very interesting. Students will also learn and use it during coaching…*" (S.4-51)

> "*...If you learn to design STEM activities in conjunction with local knowledge, I think that it will make learners more interested in studying…*" (S.4-70)

Table 1. Activity-based learning pattern assessment results for students and teachers to develop an in-depth understanding of STEM teaching and learning Associate local contexts using schools and communities as a base from experts (n = 3)

Condition	Assessment Results		
	$\bar{x}$	S.D.	Assessment Results
1. Suitability of activity-based learning style STEM for students and teachers	4.00	.000	Good
2. The possibility of applying this format in real-world situations.	3.66	.577	Good
3. The usefulness of activity-based learning patterns STEM for students and teachers	4.66	.577	Very good
Average	4.40	.058	Very good

Development results trial learning style using STEM activities in teaching science in depth, integrating, linking with local contexts using schools and communities as a base. Analyzed data from the responses were shown in Table 2.

Table 2. Results of STEM learning understanding analysis link-local context using schools and the community is the base of the 81 targeted pre-service teachers 81

Consideration Issues	Pretest		Quality Level	Posttest		Quality Level
	$\bar{x}$	SD		$\bar{x}$	SD	
1. Cognition on managing STEM Learning linked with local context by schools and communities as the base.	13.32	3.20	Low	42.27	2.93	More
2. Management Design Learn STEM	13.54	2.03	Low	42.72	2.99	More
3. Implementation of STEM activities to use in classrooms	25.00	4.18	Middle	40.82	5.23	More
Average	17.28	3.13	Low	41.93	3.71	More

From Table 2, the understanding of first and fourth-year pre-service teachers about cognition, designing, and implementing STEM learning activities linked to local contexts using schools and communities as a base was shown. A total of 81 pre-service teachers completed the questionnaires on their understanding of STEM learning linking local contexts using schools and communities as a base. The questionnaires are 3 consideration Issues; 10 questions per 1

consideration issue; a total of 30 questions with 5 levels of understanding (from a minimum of 1 to a maximum of 5; 1-Very little; 2-Little; 3-Average; 4-Good; 5-Excellent). Total 50 score; quality level < 16.67 score-low; 16.67-33.32 score-middle; > 33.32 score-more.

Data analysis showed that all the three components, including 1) Cognition on managing STEM Learning linked with local context by schools and communities as the base; 2) STEM learning design; 3) Implementation of STEM activities to use in classrooms had improved after the course. Before training, the average scores respectively were 13.32, 13.54, and 25.00 standard deviations of 3.20, 2.03, and 4.18, respectively, which may be interpreted as low levels to moderately. After studying, the targeted pre-service teachers scored comprehension average scores of 42.27, 42.72, and 40.82, standard deviations of 2.93, 2.99, and 5.23 respectively, which translates all aspects to more level. And the overall picture before the student, the targeted pre-service teacher scored the understanding score. An average score of 17.28 standard deviation of 3.13, translates to a low level. After studying, the targeted pre-service teachers scored understanding points. The average score was 41.93 standard deviations of 3.71, which translated to more levels.

2. Results on analysis of STEM lesson plans and learning integrated activities integrated with local context show these three ideas: 1) Growing Vegetable in Containers: reflects the community context where farming is the major economy and food security is a huge concern nowadays. People in the community grow vegetables at home and make their "kitchen gardens" as a way to improve their family diet. This STEM activity was designed by the participants and can be used for 5th graders. The participants also learned the teaching methods and the design of STEM activities in class through this activity; 2) Create a Mak Ben: reflect the social, and cultural traditions of the Buddhist community in Thailand. Mak Ben is a small tower of flowers and leaves (mainly banana leaves) that is used as a shrine to worship in temples and Buddhist rituals, which is one of the major traditions of the Northeast. This activity was designed for grade 4 students; 3) Create a cobweb: Cobweb (or spider web) made from Thai silk or colorful threads is a traditional decoration ornament. These colorful cobwebs were used in everyday life and spiritual life, involving using them at temples as a way to show respect to the spirits. The pre-service teachers designed science content integration activities for 8th graders in form of a situational activity.

The pre-service teachers demonstrated their ideas for designing activities, linking community traditions, and linking scientific content. According to the data collected by researchers and teacher-observers, all the three STEM learning activities linked the local knowledge of Sakon Nakhon province, Sawangdan Din District, Tha Rae District, where most people are in the farming community and have local cultural ties: temple visits, merits at festivals, so students in the school are very close to the local environmental context of agriculture and festival culture of the Northeast. This makes the lessons and activities truly fun and effective.

Table 3. Analysis of lesson plan, learning management, integrated activities STEM link-local context

Lesson plan STEM activities	Characteristics of STEM activities	Class students
1. Growing Vegetable in Containers	Pre-service teachers design STEM activities as follows: Situation reflects the community context where farming is the major economy and food security is a huge concern nowadays. People in the community grow vegetables at home and make their "kitchen gardens" as a way to improve their family diet. STEM activities are used to organize classroom instruction. Science: plant structure, plant growth Mathematics: measurement Technology and engineering: shape design, balance design	Students Grade 5
2. Create a Khan Mak Ben	Pre-service teachers design STEM activities as follows: The situation reflects the social, and cultural traditions of the Buddhist community in Thailand. Mak Ben is a small tower of flowers and banana leaves that is used as a shrine to worship in temples and Buddhist rituals, which is one of the major traditions of the Northeast. Science: characteristics of plant leaves, structure of the leaves, banana leaves Mathematics: geometry, triangle, cone Technology and engineering: shape design, balance design	Students Grade 4
3. Create a cobweb	Pre-service teachers design STEM activities as follows: Situation: Colorful cobweb is a traditional decoration ornament and were used in everyday life and spiritual life, involving using them at temples as a way to show respect to the spirits. Science: tension in the rope line Mathematics: geometry Technology and engineering: shape design, balance design	Students Grade 8

Figure 4. Students designed and made growing-vegetable containers STEM Activity

4. Conclusion and Discussion

4.1 Summary of creating and examining a learning model using STEM activities for pre-service science teachers in order to develop an in-depth understanding of science teaching and learning, connect local contexts, using schools and communities as a base.

4.1.1 Summary of the creation and examine a learning model using STEM activities for pre-service science teachers. Science Teaching Methodology and Biology for teacher course described in this study was designed for a typical 8-week semester. To enhance pre-service teachers' teaching practices that promote students' thinking about STEM, inquiry experiences, and reflection on action served as a basis for developing learning STEM activities in the methods course. During the first class period of the course, to provide pre-service teachers' understanding of the features of inquiry, a STEM activity was used to get them involved. The STEM activity started with an engagement activity which led participants to formulate a series of questions on how roller coasters work that they were to follow in the investigation. After that, they were asked to design, build and analyze STEM activities and lesson plans. Their preliminary explanations based on evidence were generated and evaluated to draw conclusions. After that, a series of STEM-based activities were used as model lessons to introduce pre-service teachers to the definition and inclusion in the inquiry process. The focus as shown in Figure 3: The first step, asking questions and encouraging

pre-service teachers to apply creative thinking to formulate scientific questions for figuring out a scientific problem. The second step, hypothesis generation, includes the formulation of relations between variables and problems of the study. The pre-service science teachers use reasoning skills to generate hypotheses for making logical inferences to the best possible explanation. The third step, hypothesis testing, pre-service teachers collect data to test hypotheses that they formulated. They use creative thinking to design investigations or models to test their ideas and use reasoning skills to construct explanatory hypotheses. Critical thinking uses as a basis in the fourth-five step, pre-service teachers analyze and interpret data to make empirical claims and arguments, and then they will evaluate scientific claims, weigh evidence, and assess alternative explanations. A crime scene investigation activity, for example, is used as a STEM model lesson to present the emphasis on critical thinking skills in the fourth-five phase of STEM.

When pre-service teachers are given the responsibility of analyzing the cause, they formulate and select relevant and promising hypotheses, test hypotheses by collecting evidence such as black boxes, and cargo truck conclusions validly, and judge the validity of references. Another key activity for the course was pre-service teachers' self-reflections on their own thinking processes that guided their investigations. Pre-service teachers reflected weekly on inquiry features and thinking skills they had used while engaged in STEM activities. Finally, each pre-service teacher created a lesson plan to engage students' STEM. Next, the teachers engaged in microteaching with their peers, after which they conducted self-reflections focusing on inquiry features and thinking skills they had implemented, and instructor feedback was provided.

Science Teaching Methodology and Biology for teacher course shifted pre-service teachers' inquiry teaching practices from placing emphasis on a process to be learned about that primarily represented only the evidence and explain features to the inclusion of the additional features of question, connect, and communicate.

The results of the design of STEM learning activities from phase 2 of the learning management model using STEM activities for students and teachers by providing STEM knowledge from experts showed that students and teachers were able to segment STEM activity into four sub-activities. It showed that the results of the design of STEM learning activities from stage 2 of the learning management model using STEM activities for students and teachers by providing expert STEM knowledge showed that students and teachers were able to segment stem activity in a total of 4 sub-activities. 1) Waste problem; 2) Covid-19 mask storage box; 3) biodiesel production; and 4) natural color dyeing, which will see STEM activities that students design a range of expert training. It is not a STEM activity that students and teachers use to manage STEM learning on the school ground. The researchers estimated that what teachers do is just a training exercise so that teachers can get the right approach to designing STEM learning activities in line with Catine and Belta (Cetin & Balta, 2017). Design activities to identify students' understanding of STEM supplies In a context consisting of 42 science teachers enrolled in teaching technology and materials science courses, enrolled in the course. In elementary school, Siriz University is divided into five parts: a car driven by balloons. The mouse, the water bottle rocket, bridge, found that female

students were interested in using the media so that they could be used for teaching in the future, and most students believe that the materials can facilitate and ensure their teaching. However, there are still students. Some those believe that preparing media, materials, and equipment is difficult and spends too much time does not suit the level of the learner. You can see that the students and teachers targeted this research. The concept of designing a variety of STEM activities, as well as studies from other research, shows that targeted students and teachers have a fairly basic understanding of STEM learning management.

4.1.2 Summary of quality inspection of science learning activity models with STEM activities linking local context, researchers with teacher students created and had experts monitor the quality of learning patterns using activities. STEM for students and teachers to develop an in-depth understanding of science teaching and learning, linking local contexts using schools and communities as a base. Summary of the assessment of the suitability of the draft activity learning management plan STEM found that the average ranged from 4.60-5.00 and the standard deviation was from 0.00-0.55, indicating that all elements were the most appropriate, with the following details: 1) The concept and nature of the learning management plan are clear; 2) The aim of the event is appropriate and suitable for the age of the student the goal of the event; 3) Curriculum learning standards are clear, suitable for problem conditions, and have practical possibilities; 4) Learning material and expected learning outcomes, it covers learning standards and has practical possibilities. Learning covers the expected learning outcomes. The division of learning units covers the learning material; 5) Sorting activities encourage learners to have continuous thought. Activities in the learning unit are possibly used in teaching and learning. Activities reflect the stem learning of the learner. Activities are convenient for continuous use and time spent organizing STEM teaching activities; 6) Materials and equipment used in learning management are suitable for STEM learning activities and are possible to be used in STEM teaching and learning. Measurement and evaluation methods are consistent with activity. Stem learning assessments are suitable for learners, and the time spent measuring and evaluating is appropriate. In line with Lai (2018), it has studied the use of the Inquiry-Based teaching model to promote STEM learning for learners to investigate whether pursuit learning methods are effective in improving STEM learners' learning by using both quantitative and qualitative data collection. The sample is students who will answer the question of the course satisfaction survey, measured 5 levels, level 1 is the least satisfied up to level 5, namely the highest satisfaction. In addition, qualitative data reflects the learner's learning and the teaching of the teacher. Feedback and analysis of data have been collected, which shows that the quality monitoring of teaching models suggested educators have diversified the guidelines.

4.2 Summary of study the condition and develop a learning model using STEM activities in teaching science in-depth integration linking the local context using schools and communities as bases.

4.2.1 Summary of the Analysis of Stem Activity Management Plan

Link-local context it found that 1) Vegetable container situation activities are activities that reflect the professional community context of the community. People in the community grow

vegetables and kitchen gardens. STEM activities designed by the target audience can be used to organize classroom instruction. For 5th grade students, teachers learn in the form of teaching methods and design stem activities in class; 2) Situation activities create a Mak Ben Activities reflect the community context. Social, cultural, Buddhist community connections Cultural society involves temples and Buddhist rituals, according to the Heath of The Northeast. Students design activities to integrate science content for 4th and 3rd graders.) The situation activities created a vibe in everyday life, and the effect of the force on objects, which students learned and designed, received the idea of designing STEM activities in social and cultural areas related to temples. People in the community make a tung to take it to the temple. Students have the idea of designing activities to connect community trajectories, linking scientific content. For second-graders, according to data collected by researchers and teachers, it found that all three STEM learning activities linked the local knowledge of Sakon Nakhon province, Sawangdan Din District, Tha Rae District, mainly people in the farming community, and local cultural ties: temple visits, merits festivals. It is very close to the local environmental context of agriculture and cultural traditions of the Northeast. This makes lessons and activities truly fun and learned in line with Alebiosu (2006). Local scientific wisdom used by women in Geria in everyday life Use a female audience questionnaire 320 in Yoruba County Ogan State, Nigeria The research showed that 13 subjects were used to conduct teaching activities to teach in secondary school classes with 85 science, chemistry, biology, physics, agriculture teachers, who came from 15 schools, to use them as class activities, and then to use questionnaires. Ask students about their relevance in scientific knowledge? The research showed that there were two contents: 1) childcare; and 2) childcare. A way to prevent food from rotting using what is in nature is ashes, and Nigerian women are found to use local wisdom in everyday life related to science. This research has a research perspective that is consistent with research studies in different areas, indicating that the model of the study integrates activity. STEM connects local contexts as a useful guide and can use information in a community context to design learning activities in class.

4.2.2 Summary of Community Area Conditions Study School before Learning

Activities learn STEM using activity-based learning patterns STEM in providing in-depth science teaching, integrating, and linking local contexts using schools and communities as a base. It found that the target group who provided information in studying the contextual conditions of the school community, the teachers went out to interview people in the community near the school. 12 people with an average age of 45-74 years of age, 4th to bachelor's degree, most occupations in farming and petting, in the area of 10 to 40 years, and Tha Rae district area, 9 people, average age between 37-68 years old, graduated from 6th to bachelor's degree, most occupations farmed, gardened and served in the area of 11 to 25 years. Interviewer (Student, Teacher) ask for questions based on interview questions by informing the interviewee (person in the community area). Note that the information is obtained. It does not affect the interviewee, only designs science teaching activities for students. Permission to take photos during interviews and record interviews, semi-structured interviews are asking people who are in the community area to explain social-cultural activities that may be linked to the conscience or knowledge behind the social culture. Data

can be collected on purpose. Some of the teachers are local and well-acquainted with the culture and understand the community context. Studying community conditions School before managing STEM learning activities using activity-based learning patterns STEM in providing in-depth science teaching, integrating, linking local contexts using schools and communities as a base. Found that the community area of Yangngam School (Sakhon Khet Udom) has issues with community data analysis. As follows: 1) Making a Mak Beng; 2) Growing rice farming; and 3) Growing vegetables in the kitchen farming, community areas of Ban Wai school, community data analysis issues as follows: 1) Growing rice farming; and 2) Growing vegetables in the kitchen economic farming school community area Tha Rae Wittaya community data analysis issues as follows: 1) Growing rice farming; 2) Growing vegetables, growing corn, growing peppers, and 3) Making silk threads in link with Bellcour (2005), studying local wisdom related to ecosystems from local sages on North America's Turtle Island and integrating local wisdom into science in the relevant science teaching course between content and practicality by exploring beliefs that can prove to be quantifiable in terms of concrete. By using interview methods and observations, then interpreting and analyzing. It found that local wisdom of the integrated ecosystem can be applied in the current curriculum that provides teaching and learning. Results of this research link to logistic regression analyses examine academic and social engagements' impact on STEM field persistence in postsecondary education, net of individual and institutional factors. Analysis by ethnicity, initial major, and engagement demonstrates that underrepresented minorities have different engagement patterns, but these engagement behaviors do not contribute significantly to staying in the STEM fields (Daniel, 2016).

4.2.3 Summary of STEM learning understanding analysis connects local contexts using schools and communities as a base of first and fourth-year teachers. A total of 81 people completed STEM learning management understanding questionnaires linking local contexts using schools and communities as a base. There are 30 items of STEM learning understanding, the data analysis showed that 1) Cognitive STEM learning management linked local contexts by schools and communities as a base; 2) Desing, managing STEM learning; 3) Utilizing STEM activities in the school area, overall before studying, targeted teachers scored comprehension average score of 17.28, standard deviation of 3.13, which translates to a low level. After studying, the targeted teachers scored understanding points. The average score of 41.93 standard deviations of 3.71, which translated to a considerable level, corresponded to Venice, Den Bork, and Tarconis (2017). STEM in secondary school explore and compare student learning. This is a collaboration between schools and external agencies to drive learning with activities. Learner STEM the researchers characterized the activities, which explained the diversity of learner perceptions, in which a total of 12 activities collected data from the United States and the Netherlands. Use questionnaires with a level of scoring linking each STEM activity, such as what's going on in class, constructivist-based environmental surveys (CLES), classroom evaluations, and learning questionnaires. Teachers' perception of perspective tends to be more positive than most levels of learners. Long-lasting activities that focus on problems as a base, the perception of new perspectives in science, and the perspectives of scientists focused on a positive learning environment. In addition, access to the learning environment can create opportunities to

increase students' motivation to learn. STEM and in line with Songsak Phusri-on's research. In other words, lack of planning and evaluation. Students give students only practices, where they practice but cannot assess what each student has learned. What effect does it have, which is found to be an activity? STEM in the class must be done continuously and over a long period, making it a regular instruction in the class. It shows the effect of developing learning patterns using activities STEM for students and teachers to develop an in-depth understanding of science teaching and learning Connect local contexts using schools and communities as a base this time, it is a guide to providing one of the teaching and learning. For teachers, that can provide students with an understanding of the learning management process in the classroom and design learning activities that integrate local knowledge to teach science courses using schools and communities as a base. Results showed that most of the thesis focuses on action research due to the school contexts. Teaching strategies or innovations employed are problem-based learning, inquiry-based learning, STEM education, and other trending approaches. All informants or samples are studying at the high school level. Overall of quality of the thesis can be considered at a good level and the scenario-based STEM project design process caused a positive change in the STEM attitude and science, engineering and technology, mathematics, and 21st-century skills, which are sub-factors of the STEM attitudes of pre-service science teachers (Nuangchalerm & Prachagool, 2021; Huriye, 2020).

5. Suggestion

(1) Research should be conducted on the development of learning patterns using activities. STEM for students and teachers to develop an in-depth understanding of science teaching and learning. Connect local contexts using schools and communities as a base, focusing on community areas near schools, and universities.

(2) Local connections and contexts should be studied with diverse students, and teachers in the community, residents who will get preliminary information before the actual landing.

(3) Designing learning style activities using activities STEM for students, teachers, required time besides a fair amount of teaching time. And the equipment box must be provided to the teacher's student for use in the actual class during continuous professional experience training and studying the results of events.

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