



Perceptions of pre-service science teachers toward teaching STEM from suburb University in Thailand

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Abstract

To improve the quality of education, it is important to understand teachers' perceptions about STEM teaching. In this study, the goal is to explore the perception of STEM from pre-service science teachers who are studying in suburban areas. All the information from teachers will be primarily needed for preparation to enhance teaching STEM. Data were collected from the five pre-service science teachers as case studies. The pre-service science teachers' perceptions were captured through group discussion, semi-interview and questionnaire. Content analysis was used to analyze open-ended responses from these five case studies. The findings showed that all participants had barely heard about STEM education and had few experiences with teaching STEM. However, they think the STEM teaching approach is very challenging and important. Three prominent themes emerged from the data that showed they had a positive perception as they viewed STEM education as follows: (1) STEM education is a way of teaching to make a classroom exciting and a challenging activity to motivate students; (2) STEM education is integrated with four-disciplines; and (3) STEM education is a science teaching method that leads students to have 21st century skills, especially problem solving skills. A strong perception of STEM is a good starting point for learning and practicing teaching STEM. Moreover, they also have a self-learning capability by searching and studying STEM by themselves through the internet, and through other experiences. We can assume it is not a problem learning STEM in the suburbs because of advances in high-technology nowadays.

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Introduction

STEM education is an on-going trend in education. It is an integrated approach to learning with the goal of instilling creative problem-solving techniques and the creation of future innovators in students (Roberts et al., 2012). In Thailand, the National Science and Technology and Innovation Policy Office has developed a policy to promote the strength of STEM education to increase workforce productivity and innovation (the National Science and Technology and Innovation Policy Office

To educate students for the 21st century, several countries' educational institutions have accepted and enforced a stronger concentration on STEM education in schools (Honey et al., 2014). As teachers, it is important that they know the demands on their students, about learners in the 21st century, that are required to exhibit understanding and skills that are related to STEM education. This is true especially for the pre-service science teachers, who not only must acquire science content knowledge, and understand the nature of science, but have scientific attitudes and positive attitudes towards science (Vitale, 1992). Pre-service science teachers also need to have several types of pedagogical knowledge to teach their students in the classroom (Nilsson, 2008).

Teachers' specialized knowledge, referred to as Pedagogical Content Knowledge (PCK), is critical to teaching quality. The ability of a teacher to make a specific subject understandable for individual students by combining content and pedagogical expertise is referred to as PCK (Shulman, 1986). Teachers' perceptions about teaching are perceived to be one essential issues of PCK, and they have a strong influence on their practice (Beijaard et al., 2000). So, as a starting point for change, the first step in improving teachers' PCK to teach STEM is to learn more about how they think about STEM. According to Park and Oliver (2008), a teacher's orientation serves as a conceptual map for making judgments about the other PCK components because it is influenced by their beliefs and perceptions about learning and teaching. Similarly, Gess-Newsome (2015) claims that a teacher's beliefs and perceptions can act as a lens for their teaching. This is why we must concentrate on investigating and changing teachers' perceptions. A detailed grasp of teachers' perceptions of STEM can serve as a significant basis for building a more comprehensive and high-quality STEM professional training over time. It is very important to know how

teachers think inside because perceptions will have a direct impact on both their desire to embrace STEM and their ability to do so effectively in their own classroom. If educators know about the perception of STEM teaching, then we can prepare the plan for enhancing STEM teaching efficiency for teachers (Margot & Kettler, 2019).

Moreover, as we know, many pre-service science students who live in the suburbs still do not have good opportunities to access the information on STEM learning due to a lack of specific professional training and special learning courses. So, it would be advantageous if we knew their needs and their perception to prepare them to be effective STEM teachers. So, we need to take the first step in preparing pre-service science teachers in the suburbs to learn to be STEM teachers. Then, the researchers have to know what pre-service science students really think about STEM teaching. The next step is focusing on how to implement STEM teaching to match with their suburb area resources.

Previously, research using a survey of STEM perceptions from in-service science teachers in Thailand, and reporting about teachers' belief in STEM education (Srikoom et al., 2017) was conducted, but there have been no reports of STEM perceptions from pre-service science teachers, in particular, groups from the suburbs. So, it would be really beneficial to do research that covers both urban and suburban areas and understand perceptions about STEM including with pre-service and in-service science teachers. However, in this research, a survey of STEM perceptions from all pre-service science teachers was not conducted because of a time limitation. Therefore, the researcher started small scale by using case studies as a preliminary study for gathering data and using such in the next step for the large scale after.

Additionally, to complete educational issues and enhance pre-service science teachers' competences for being STEM teacher in the future, the purpose of this study was to explore perception of STEM from pre-service science teachers in suburbs including understanding of STEM definition. The research question guiding this study was "What is pre-service science teachers' perceptions about STEM education?"

Teachers' Perception of STEM Education

Perception is whenever we perceive or gain knowledge that comes from observing or learning about it. We can say it is a concept—something that has been given to the senses or it is an idea of something—something presented to the senses (Graham, 1869).

To examine pre-service science teacher perceptions of STEM learning, we used theoretical perspectives theory to study perceptions of STEM learning, and attitudes toward STEM (Guzey et al., 2016). The theoretical lens allows it to be explored in the context of what are pre-service science teacher perceptions about STEM learning and experience STEM learning.

Margot and Kettler (2019) mentioned that perception is important for STEM talent development for teachers. Teachers' age, gender, and STEM experiences may all influence their views on STEM education. Also, STEM prior views and experiences will influence their STEM instruction, and if the educators understand what teachers' perceptions of STEM education are, then we can provide best practices and support for teachers.

Similarly, Stubbs and Myers (2016) mentioned that teachers' perceptions of the STEM approach are crucial because they can affect teachers' decisions and teacher perceptions which were influenced by the history of their educational experiences, as shown in interesting findings in many researches.

In Thailand, little research on STEM perceptions has been done. One of them is work from Srikoom et al. (2017) that surveyed science teacher's perception about STEM from schools and teachers around 85.5 percent had never knew of STEM education, but only 19 percent could define it. Teachers think STEM education is important, but many are confused about engineering. Another piece of research from Saptarani et al. (2019) supported that teachers had a positive perception of STEM and found that a majority of teachers said STEM was useful.

Research from Pitiporntapin et al. (2018) also mentioned about Thai in-service teachers' perceptions of STEM education, that they struggled to link STEM disciplines and they lacked confidence in their ability to do it even if they were interested in implementing the STEM educational approach.

In Korea, Park et al. (2016) surveyed beliefs and perceptions toward STEM teachers in South Korea and found that the majority of teachers viewed STEM education positively. However, they identified obstacles to its successful implementation, including time, increased workload, and a lack of financial and administrative assistance.

In Indonesia, STEM perceptions and implementation abilities in prospective teachers, along with STEM activities, are critical in developing prospective teachers' characteristics in supporting their students as citizens of the twenty-first century generation (Rusydiyah et al., 2021).

As we know, students' learning is also influenced by their teachers' teaching methods (Trigwell et al., 1999). In terms of STEM education, teachers claim that people begin to form perceptions and knowledge of STEM before and during elementary school, emphasizing the importance of teaching STEM at the primary levels. Teachers who have bad attitudes regarding STEM (which is a part of their perspective) are more likely to avoid teaching it (Appleton, 2003). Teachers may establish and enhance negative attitudes toward STEM since their attitudes are frequently conveyed to their students (Deemer, 2004). So, in establishing strong teacher expertise for teaching STEM, Teachers' perspectives on the STEM should be considered.

In another study, the perspectives of teachers who received STEM training were studied. The teachers had a good attitude in STEM education, which increased their awareness and viewpoint in STEM teaching (Kan & Murat, 2018).

Teachers' perception can differ depending on their position, region, and teaching style. This might be perplexing for teachers attempting to integrate STEM-focused plan into classrooms. Bybee (2013) also mentioned that developing STEM education is fraught with difficulties. When people turn up with differing perceptions, they may also emerge with differing outcomes.

As a result, identifying teachers' STEM perceptions became one of the most key things that science educators and other STEM-education decision - makers must keep in mind (Bybee, 2010). Perceptions of STEM will have a direct impact on both their desire to embrace STEM and their ability to do so effectively in their own classroom. Hence, if educators are concerned about the opinion of STEM education, they may devise a strategy for improving teachers' STEM teaching efficiency (Margot & Kettler, 2019).

Methodology

Research Design

The research used qualitative design, which is a case study approach (Cobern & Adams, 2020), to analyze perceptions of STEM learning and identify pre-service science teachers' perceptions of STEM education. A case study was used for representing and explaining the depth of thinking in each participant. Data were collected throughout the STEM methods course program from focus group discussions, questionnaires, and

semi-interviews. The STEM questionnaire, which was designed by STEM experts, was developed and applied. It comprises open-ended questions to investigate pre-service science teachers' perceptions of STEM education regarding the definition of STEM education, the STEM integration, and implementation of STEM education in their classroom. Individual semi-structured interviews were conducted to get to know the backgrounds and experience of STEM teaching in each participant. The interviews with participants were audio taped and transcribed.

Participants

Five Thai pre-service science teachers, who were studying science education majors from a suburban university in Thailand, were invited. Background information of participants is shown in Table 1. They enrolled in a sixteen-week STEM method course program instructed by the first author.

Data Analysis

To analyze perceptions involving the participants' own definitions and perspective points were desired. Open-ended responses from these five different cases were analyzed using content analysis. Iterative coding, memo writing, focused coding, and integrative memo writing were used (Emerson et al., 1995). The research team, including my advisor and co-adviser, double-checked all coded themes from the analysis. In the first level of analysis, the open-ended question was examined. The data were coded and rearranged into categories by the research team in the second-level analysis. We organized the answers of pre-service science teachers to the definition of STEM education into a worksheet and stated differences and overlaps in order to group teachers' responses (following in Table 2).

Results

This part informs the pre-service science teachers' opinion of the importance of STEM education and their interest regarding STEM education by using the open-ended questions. The findings show all participants (5 pre-service science teachers) see the importance and value of STEM education. The responses and the opinions from participants are shown in Table 2.

According to the findings of this study, they all believe that a STEM teaching is very valuable, challenging, and important for Thai education. The researcher classified the responses from pre-service science teachers' perceptions into three prominent themes that emerged from the data. Three themes following this are in Figure 1.

The first theme: *STEM education is a way of teaching to make a classroom exciting* in that STEM provides challenging activities to motivate students to learn as we see the words: enjoy, fun, excited and challenging" in quotes from participants, For example, "*STEM makes students alert and feel excited to learn science more or STEM is a challenging approach that opens students to have a chance to design activities by themselves.*"

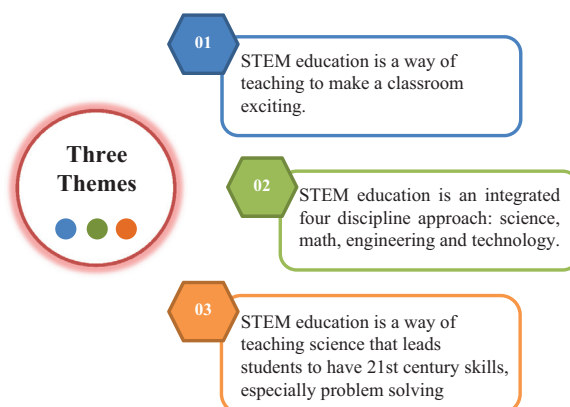


Figure 1 Three prominent themes of STEM perception from pre-service science teachers.

Table 1 The background of student participant demographics, age, gender, resources to learn STEM

Student name	Gender	Age	Hometown region	Resources to learn STEM
Pimchanok (Student A)	Female	21	Northern region of Thailand	Internet
Supansa (Student B)	Female	21	Northern region of Thailand	Sci-Camp, workshop and Internet
Sirinat (Student C)	Female	21	Western region of Thailand	Internet
Sudtikan (Student D)	Female	21	Eastern region of Thailand	Internet
Tararad (Student E)	Female	21	Eastern region of Thailand	Internet and workshop

Table 2 Codes and categories emerging from pre-service science teachers' responses about the opinion of importance of STEM education and interest regarding STEM education

Quotations	Code	Themes
“I think STEM is a new way of education that not only provides knowledge but also makes students enjoy the classroom and be excited in STEM activities”	Enjoy the classroom, excited in STEM activity, challenge teacher, challenge subject, motivate student learning, challenging for student to create, excited to learn science, have more fun and be interesting, feel excited to learn science and challenge and learning.	STEM education is a way of teaching to create classroom excitement and provide a challenging activity to motivate students to learn
“I think STEM is very important nowadays because it is a very challenging subject that opens students to have a chance to design activities by themselves, and it also challenges the teacher on how to design STEM activities to motivate student learning”		
“STEM is a new teaching approach for me, that made students have fun through the activity, where students can design an experiment by themselves. It is quite challenging for students to create their own activity that makes them alert and feel excited to learn science more”		
“STEM is important for both the science teacher and science student. STEM classroom has more fun and looks interesting for students because they can have a challenge and learn by doing by themselves through STEM activity”		
“STEM not only helps a student to have knowledge in science, mathematics, engineering and technology, but STEM also helps a student to have many skills such as teamwork skill, thinking skill, designing skill and solving problem skill, very necessary skills for students in 21st century life.”	Knowledge in science, mathematics, engineering and technology, and use four disciplines in their activity.	STEM education is an integrated four discipline: science, math, engineering and technology approach
“I think STEM really motivates a student to want to learn science more because they can build up and design some things by themselves by using four disciplines in their activity. STEM also teaches a student to have critical thinking and creativity skill”		
“I think STEM is an important aspect that a science teacher needs to know about, the knowledge about science only is not enough to develop student learning anymore. Knowing about STEM is very helpful to enhance student learning and have important 21st century skills such as problem solving skill.”	21st century skill such as problem solving skill, student learns to apply this knowledge to solve the problems in real life, and students can apply the knowledge to solve problems in real life.	STEM education is a science teaching way that leads students to have a 21st century skills especially problem solving skill.”
“I like STEM teaching because it enables students to have fun and make an active classroom. STEM is very important nowadays because STEM not only provides the knowledge in four disciplines but also teaches students to learn to apply this knowledge to solve a problem in real life too.”		
“STEM education is good because the students do not only study the knowledge in the book, but they can apply the knowledge to solve a problem in real life through the STEM activities as well”		

The second theme: *STEM education is an integrated four discipline approach: science, math, engineering and technology*. Many participants mention in their quote, “I think STEM really motivates students to want to learn science more because they can build and design some things by themselves by using the four disciplines in their activity.”

The third theme: *STEM education is a way of teaching science that leads students to have 21st century skills, especially problem solving skills*. It is quite easy to observe the phrase “problem solving skill” such as in “STEM is very helpful for enhancing students to learn and have important 21st century skills such as problem solving skills.” As one participant mentions, “the students can apply the knowledge to solve problems in real life through the STEM activities as well.”

After this finding, we can see the pre-service science teacher's perception that they view STEM teaching in

a variety of forms. Some may view STEM teaching as multiple subject concepts that merge or integrate the four discipline subjects together. These findings refer to teachers' perceptions of STEM integration, indicating that all of them STEM was seen by as a multidisciplinary approach (four subjects are taught collaboratively). Moreover, their perception indicated that all participants think STEM education is very fruitful for education in the 21st century. Their perceptions reflect that it not only involves the integrated four discipline science knowledge but also involves important 21st century skills such as problem solving, critical thinking and creativity skills. Moreover, some may view STEM teaching as an interesting activity more than content knowledge, and some may view STEM associated with the way of teaching to make a classroom exciting in that STEM provides challenging activities to motivate students to learn. It is very important

for students to have problem solving skills in real life situations. This finding is related to findings from Srikoom et al. (2017) that mention in-service teachers' view of STEM education, which is an integrated-discipline teaching approach to addressing real-world problems. Furthermore, teachers frequently used the terms “solving issues” and “learning by doing” to describe STEM education (Srikoom et al., 2017). All of these perceptions are positive perceptions about STEM teaching and show how pre-service science teachers believe and think about STEM education. Moreover, the finding also supports the idea that pre-service science teachers pay attention to how to incorporate STEM teaching by not only focusing on content knowledge but also focusing on STEM activities as well.

In the final part, the findings revealed that all participants could understand a definition of STEM. As shown in Table 3. We can see that all of them define STEM education as an integrated, four discipline approach to solve problems. This table show how they understand the basic meaning of STEM education even though some of them had limited knowledge and were unable to even interpret the definition of STEM education clearly.

The finding in Table 3 revealed previous research from Srikoom et al. (2017) that suggested a majority of Thai teachers had never heard of STEM education, and some of them couldn't even understand the meaning of STEM education clearly, but they thought STEM education was important. Moreover, the finding from Pitiporntapin et al.

(2018) supported Thai- in-service teachers had a strong initiative to incorporate STEM education perceptions into their classrooms. At the same time, pre-service science teachers were informed that even if they did not have any prior experience with STEM teaching directly, they could still provide the STEM concept and STEM definition correctly, which means they might be learning by themselves from STEM educative materials such as textbooks and teacher's guidelines documents from the internet, which are helpful resources for them to enact STEM approach in the classroom.

Furthermore, this study demonstrates that pre-service science teachers have a self-learning capability by searching and studying STEM topics by themselves through the internet and through other experiences, which we can assume means that the suburb area where they lived is not a problem for learning STEM. This is similar to research findings from Srikoom et al. (2017) that mentioned most teachers know and learn STEM through online sources (such as websites and social media), colleagues, and associated workshop activities. This result is very useful for how to prepare resources and equipment for training and practicing to learn STEM even if they live in remote areas.

Moreover, we discovered that a pre-service science teacher's perception of prior teaching experience was not a problem for teaching STEM in the future. The pre-service science teachers lacked any experience of STEM teaching in their prior learning and had barely heard about STEM learning from their teachers in high school because

Table 3 Experience with STEM teaching and definition of STEM

Participants	Prior experience with STEM teaching	Definition of STEM
Participant A	For myself, I never had a chance to learn STEM at school level, but I have once experienced STEM teaching observed when I joined the STEM camp in university.	“I think STEM education means when we integrated four subject together or we combine science, mathematics, engineering and technology together for students to solve a problem. An activity provided to the student might be a hands-on activity, which makes students use creativity and innovation skill”
Participant B	I had never heard about STEM teaching until last semester when I had a chance to observed STEM class, but just for 30 min teaching.	“I think STEM education means learning by doing. Teachers allow the students to do an activity by themselves and the teacher's role is a facilitator. STEM also requires teachers to know the four disciplines: science, mathematics, engineering and technology together”
Participant C	I heard about STEM, but I never learned about that deeply. I had one chance to design a STEM activity in a workshop. Mostly, I copied ideas from the Internet to design a STEM activity.	“I think STEM education means the subject that integrates four subjects related to science, mathematics, engineering and technology. Moreover, STEM education focuses on how to teach students to have creativity skill and problem solving skill in daily life”
Participant D	For myself, I never had a chance to teach STEM before but heard about STEM from You Tube channel.	“STEM education means the education that combines science, mathematics, engineering and technology together in one subject. I think, STEM education focuses on problem solving skill and teaches students to do an activity or create an activity by themselves. STEM provides student to have more teamwork skill and creativity skill”
Participant E	I never heard about STEM teaching when I studied in high school, but I learned about STEM from watching STEM activities from the Internet.	“I think STEM education means the subject that teaches students to build up or invent something by themselves for problem solving in daily life by using the knowledge from four disciplines: science, mathematics, engineering and technology”

STEM learning and STEM teaching have just recently been added to the Thai curriculum national standards, and the Institute for the Promotion of Teaching Science and Technology (IPST) has just recently promoted it. So, it is quite a new concept for pre-service science teachers in suburb areas. However, the perception response from all pre-service science teachers shows that they seem willing to teach STEM. This is similar to findings in research by Srikoorn et al. (2017) that mentions The teachers were unfamiliar with STEM education, but they still thought that the STEM teaching approach was very interesting.

In this study, the impressive results indicated that all pre-service science teachers had a good perception of STEM teaching and STEM education in a positive way. Moreover, most of them insisted that they were confident in teaching STEM in the future. They might need some educational materials to be adopted and adapted in the beginning, which can support them to implement STEM with their suburban environmental resources.

Discussion

According to the result, there are many distinct perspectives on STEM inclusion. In the first one, pre-service science teachers viewed STEM education as a way of teaching to make a classroom exciting, that means STEM can provide challenging activities to motivate students to learn. They can build interesting STEM activities to impress students to learn science.

In the second one, STEM was viewed as an integration of four disciplines: science, math, engineering and technology approach or a course that emphasizes four subjects together. Because STEM consists of only four major subjects, it might vary widely, and we presume it has a direct impact on teachers' instructional strategy decisions. In the third one, pre-service science teachers view STEM education as a science teaching way that leads student to have a 21st century skill especially problem solving skill and creativity skill. This finding can lead and guide STEM education policy that might merge the pre-service science teacher's concern into pre-service science teachers' development programs, which must not only focus on how to teach STEM; they must also be trained to search how to creating positive perception of STEM teaching concepts that are related to real-life situations and select the most appropriate concepts to employ for STEM lesson.

Moreover, when asked about the need for learning and teaching STEM, it was found that pre-service science students are willing and equipped to learn to prepare themselves to be effective STEM teacher. Even though they lived in remote areas, high-technologies are helpful to contribute to their own learning about STEM.

In addition, the results also indicated that a majority of pre-service science teachers were not familiar with STEM teaching in their classroom and may not have had practical STEM teaching experience before, but all of them reflected on good perception that they have belief they will able to teach STEM effectively in the future if they have a good guiding role model of STEM teaching. This finding is evidence which confirms even if teachers did not have any prior experience about STEM teaching directly, they can provide the STEM concept and STEM definition correctly. Likewise, the finding from Margot and Kettler (2019) supports that teacher's perception on prior teaching experience was not a problem for teaching STEM in the future, and teachers' years of experience are inconsistently related to their perceptions of STEM integration or education, and teachers' value or interest in STEM may mediate the relationship.

To understand the teachers' perception and understanding of STEM education, it is very helpful for educators to prepare for and implement STEM education in the current science classroom because many researchers believe that teachers' knowledge, thoughts, and that implicit and persistent perceptions about education and instruction serve as frames for a desirable teaching and learning process (Gess-Newsome, 2015).

Conclusion

We found out what pre-service science teachers thought about STEM education in order to bring it into the classroom. The findings indicated that all pre-service science teachers had strong perceptions in a positive way about STEM teaching and STEM education. Three themes of STEM view emerged from their responses: the first theme, STEM education is a way of teaching to make a classroom exciting where STEM provides challenging activities to motivate students to learn; the second theme, STEM education is an integrated four discipline approach: science, math, engineering and technology approach; and the third theme, STEM education is a science teaching way that leads students to have 21st century skills especially problem solving skills. Moreover, pre-service science teachers had a perception STEM teaching is an important way to prepare students to have real life problem solving skills in daily life. Moreover, it confirms that pre-service science teachers have a self-learning capability by searching and studying STEM topics by themselves through the internet and through other experiences, which we can assume means in the suburb areas where they live, it is not a problem for learning STEM because of advancements in technologies nowadays.

Understanding how science teachers think about STEM is a very important starting point for change. It is also believed that if we have clear understanding of teachers'

STEM perception, it will serve as a power tool to build a higher and more effective professional development program for teachers (Srikoom et al., 2017). Moreover, this study indicated the pre-service science teacher's perception on prior teaching experience was not a problem for teaching STEM. This finding of STEM perception can be fruitful to help science educators, curriculum developers, and others involved in teacher development as a starting point to design and develop professional programs concerning these perceptions. As a result, examining STEM-education perceptions is critical not just for instructors but also for the profession, school, and community.

Recommendation

Based on this study, the researchers recommend that a study of pre-service science teachers' perceptions in the next phase should focus on a large-scale participants and how to motivate STEM teaching for science teachers in suburb areas. It might be by providing more devices or technology resources that can enhance access to STEM knowledge even if they live in remote areas. Then a course can be designed for preparing and practicing STEM implementation that is suitable for the suburb environment.

Conflict of Interest

There is no conflict of interest associated with any of the senior author or other co-authors.

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