

# Primary Teacher's View on STEM Education: A Case of Pre-Service Teachers in a Profesional Development Program

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**Abstract.** This study seeks to identify primary teachers's perception about integrated learning, identify teachers's perception regarding STEM (Science, Technology, Engineering, and Mathematics) education and its interdisciplinary nature, and to identify the factors that facilitate this education. This study elicits primary teacher's through the use of qualitative methods. The instruments are STEM questionnaire, focus group discussion and interview manual. This study ends with recommendations that could lead develop a professional development model of what primary teachers need in terms of pedagogical content knowledge to enact STEM education in class It was revealed that the teachers need support and training on how to integrated STEM in Indonesian Curriculum that has not incorporated STEM in primary education. Preliminary findings suggest that many teachers are interested in integrated approaches to STEM, but do not believe they are well prepared to implement them. At the implementation level, findings above also suggest that it is crucial for teachers to cooperate with their peer teachers and to develop interdisciplinary (open-ended and creative) instructions on their own.

## INTRODUCTION

A good economic growth requires a skilled human resources and the master of science undergraduates especially in the field of Science, Technology, Engineering and Mathematics. National Science Foundation stated that in ten years into the future jobs will require the ability to the competence of science, technology engineering and mathematics. The mastery of science will help the process to understand the world and the ability to take decisions. The ability to master the technology useful to analyze the influence of new technology to the community. Mastering the technique can help to understand how technology can be developed through the design process. The ability to control of mathematics is expected to be able to analyze the reasons, communicate ideas and find the solution. Four areas has become the main gate development in the country, especially in preparation for the field of career in the world of education in Indonesia. One only with the implementation of STEM education.

STEM is the acronym of Science, Technology, Engineering, and Mathematics. Today STEM education has been adopted by some developed countries and developed. These various movements done as efforts to meet the challenges of economic development in the twentieth century, including in education. STEM is seen as a way out of the problem of the quality of natural resources and global competitiveness. In education, STEM is expected to be the solution fulfilling the challenge 21<sup>th</sup> century. [1] STEM education can promote skills that are relevant in our information-rich 21<sup>st</sup> century Western economy, such as problem solving and evidence-based thinking. Many countries start to develop STEM and its implementation in education. [2] For example, in the United States there are many efforts to support STEM education (e.g., STEM Coalition, and NGSS (Next Generation Science Standards), which stress science and engineering knowledge and practices. The United Kingdom has a nationwide network for STEM (i.e., STEMNET), while science coursework in Singapore stresses inventive thinking and activities. The Korean government has driven the integration of school science with other disciplines through STEAM (Science, Technology, Engineering, Arts and Mathematics) education. Awareness of STEM education

has started to appear in the Indonesian education. This is marked with there is a study group who do research and develop STEM based education. [3] When educators want to develop the STEM education in Indonesia so as an initial step that needs to be done is to realize the importance of STEM education and improve the understanding of STEM education. Furthermore the learning method of STEM can be included in the educational curriculum.

Student foundational knowledge of science, technology, engineering, and mathematics (STEM) is formed in their elementary education [4]. The elementary school can be the main entrance of STEM education applied in Indonesia. Primary school age children can learn lessons with more fun and more meaningful. How to think children who are still abstract, adjustments themselves from previous learning environment and interaction with new people make a challenge for the primary school teachers. The foundations of STEM competence are laid in early childhood. Engaging children in science before the ages of 11 to 14 is critical to generating long-term interest in the discipline [5]. STEM education begins in primary school [6] and teachers make a serious difference [7].

STEM is a combination of four subjects, namely science, technology, engineering and mathematics, and they are integrated into the teaching and learning process in schools. STEM approach to train higher-order thinking students (HOTS) [8]. The superiority of STEM is in teaching and learning to integrate the content and skills of science, technology, engineering and mathematics. The aim is to preparing students to be ready facing the challenges of the twentieth century. Beers mengemukakan proposed that STEM curriculum involves four "C" from the skills of the twentieth century 21 , i.e. Creativity, Critical thinking, Collaboration and Communication [9]. The field of study in the stem should not be taught in isolation on their own. Characteristics of the field in the stem is depicted as follows: Science is the study of the natural world, including the laws of nature associated with physics, chemistry, and biology and the treatment or application of facts, principles, concepts, and conventions associated with these disciplines. Science is both a body of knowledge that has been accumulated over time and a process—scientific inquiry—that generates new knowledge . Knowledge from science informs the engineering design process [10]. Most of the subjects in elementary school raises the natural world and the environment. Some process that can be used to find the meaning of these means is through scientific method, discovering and exploring. Technology, while not a discipline in the strictest sense, comprises the entire system of people and organizations, knowledge, processes, and devices that go into creating and operating technological artifacts, as well as the artifacts themselves . Throughout history, humans have created technology to satisfy their wants and needs. Much of modern technology is a product of science and engineering, and technological tools are used in both fields [11]. The technology makes it easier to doing activity. In the learning, technology can become a communication tool that can facilitate the understanding and delivery of the material with more accurately. Engineering is both a body of knowledge about the design and creation of human-made products and a process for solving problems [12]. Aspects of engineering took the role in hardskill knowledge to design and mengkontruksi equipment, the system or the process is useful. Mathematics is the study of patterns and relationships among quantities, numbers, and space . Unlike in science, where empirical evidence is sought to warrant or overthrow claims, claims in mathematics are warranted through logical arguments based on foundational assumptions [13]. Mathematics is used in science and technology and engineering. From the above exposure, STEM can facilitate the integration of learning in primary schools. STEM can be used as one of the alternative school teachers create integrated learning. This time, education in Indonesia using the 13<sup>th</sup> curriculum as one way of improving education. The 13<sup>th</sup> curriculum advancing scientific method in which contains the activities observed, asked, menalar, try and communicate [14]. Through these activities are expected to be able to develop the skills of the twentieth century. Important skills 21 century include learning to know, learning to do, learning to be and learning to live together. Four principles of each contain special skills that need to be empowered in learning activities such as critical thinking skills [15].

Results of interviews with Pre-Service Class Teachers in a Professional Development Program found the information that the teachers who background Bachelor of Education has gained knowledge about how to do integrated learning, especially thematic learning. Teachers never do integrated learning in class. Based on their experience, they do integrated learning only by combining the two subjects and it is still be seen the differences. When they do evaluation, eventually also done separately, is not integrated and authentic. This means that the teachers do not have the knowledge of how to do integrated learning theme thoroughly. Primary school teachers have the opportunity to teach the lessons of integration but not yet can be done optimally. Primary school teachers who have knowledge of the content and knowledge of pedagogic skills which is expected to be a good teacher capital to innovate and develop good lessons in primary schools. Based on issues above, researchers want to examine the views of Pre-Service Teachers in a Professional Development Program about thematic learning and STEM education that became one of the alternative education approach in primary schools.

## METHODS

This research was conducted using descriptive qualitative method. Data was analyzed using the Winstep program. The instrument used in this research in the form of STEM-administered questionnaire and manual interviews. This study focused to identify primary class teachers's perception about integrated learning, class teachers identify's perception regarding STEM education and its interdisciplinary nature, and to identify the factors that facilitate this education. Participant of this study included pre-service class teachers in a professional development program at Atma Jaya Catholic University of Indonesia. A total of 24 class teachers were involved in the study.

## RESULT AND DISCUSSION

The data obtained from 24 responden with 28 statement produces the reliability of the items and the reliability of the person. Testing of the instrument questions on a person can be seen from the value of MNSQ infit and outfit MNSQ. To person MNSQ infit values is 1.01 and MNSQ outfit is 1.00 which means that the overall answer pattern response on the instrument is good. This is a good thing if the value of infit and outfit ZSTD near 0. The more the values approaching 0 then the data has estimated that logically. In this research, the value of infit and outfit ZSTD is - 0.2 and -0.3. It means overall patterns of answers respondents have compliance with the model. Person reliability is 0.43, its mean that reliability of the person of low items while the item reliability is 0.88 which means high. The interaction of person with the item is shown from the value of Cronbach Alpha of 0.54, this means that the interaction of person low against the item. This possible caused because the value of the reliability of the person who is low, the consistency of the answers from the respondents is weak but the quality of the items in the instrument good. The consistency of the answers from the weak responden probably caused because of ignorance about STEM information or the possibility of respondents working with the derived.

Seen from the map distribution of the person and the item as shown in picture 1, respondents 21L is the respondent who is easy to approve the items while respondents 17p and 19p are respondents who most difficult to approve item statement. The difficult statement items approved by the respondents is item B4 and F5, namely "Integrated learning can be integrated with the using of technology" and "Teaching STEM in a way that it relates to real life situation is important to inspire the students." This means that the respondents have the view that integrated learning cannot be integrated with the acceptance of our technology. Teachers thought of technology cannot be integrated with the use of technology. Teachers have thought that for elementary school age children have not yet been able to follow if learning using technology. It's strengthened by the results of the interpretation (item E3) that T on the stem is limited to the hardware and the application usage. Respondents confused about how to integrate the learning. In addition respondents have agreed to teach STEM can connect to the condition of life in the future and inspires him. After the focus group discussions, this is due to the fact that the respondents did not have the knowledge about it. Almost all respondents had never do integrated learning in primary schools.

**TABLE 1.** The findings of the most difficult items for approval and easiest to approved

Item Statement Criteria	Item Number	Statement
The most difficult to be approved statement items	B4	"Integrated learning can be integrated with the using of technology"
	F5	"Teaching STEM in a way that it relates to real life situation is important to inspire the students."
The easier for approved statement items	A1	"I always teach using lecturing method"
	F1	"I never experience teaching that integrates STEM."

As outlined in the map distribution (Figure 1) and the Table 1, item A1 items and F1 are items that easier for approved respondents. A1 items about "I always teach using lecturing method" and F1 about "I never experience



**TABLE 2.** The findings of the method that is often used in learning elementary school

Items	Strongly agree	Agree	Disagree	Strongly disagree
I always teach using lecturing method	-	17	7	-
I am glad that I asked the students to group discussions	5	2	17	-
Demonstrations and experiments (activities in the laboratory) has always been a mainstay i teach the material	2	8	14	-
I never use various methods in teaching	10	14	-	-

All class teachers select a group discussion as the method that most considered can enable students. Teachers acknowledge that demonstration and experiments can help to make their learning more meaningful. The majority of the teachers who participated in this study never use variety of methods. It also showed that primary teachers may be less know how to design lessons that the methods are more varied. The lack of knowledge of teacher regarding the preparation of primary teaching and learning activity became one of the factors why obstacles primary teachers difficulty doing thematic learning.

The frequency of using integrated learning and integrated learning understanding: Table 3 show that almost all respondents have never do integrated learning. It's travelled screened the integrated learning is learning that combine cleared subjects. However, respondents assume that in the integrated learning can raise the value of the characters and the attitude. All respondents can integrate technology in teaching and learning integration. More information, integrated learning never responden do in learning elementary schools both in class low and high class. One of the obstacles encountered in the implementation of the thematic learning is lack of knowledge of teachers so that ignorance of teachers and education providers against thematic learning can be fatal to the results of the study learners. There are many benefits that have been connected with the use of integrated learning [16]. In low grade teachers feel hassle with classroom management while in the higher classes, teachers less knowledge material content. The class teachers admitted to arrange integrated learning requires a large amount of time and cumbersome. This is due to the fact that teachers must provide various media, activity sheet and insulting indicators that must be met in each meeting. Using an interdisciplinary or integrated curriculum provides opportunities for more relevant, less fragmented, and more stimulating experiences for learners [17]. Of course it is very regretful, primary school teachers who have the opportunity to ahead integrated learning is not even do so. The teacher can design lessons that more meaningful through the STEM. STEM education include making students better problem solvers, innovators, inventors, self-reliant, logical thinkers, and technologically literate [18]. Students receiving education in STEM are thought to be capable of thinking logically and utilizing technology independently to solve problems, innovate, and invent. Integrating STEM disciplines has been associated with positive effects on attitudes in school achievement and learning [19]. With all of the possible benefits of integrated STEM education, it is important to ascertain how teachers can teach integrated education in primary school effectively. This issues include material needed and integrated teaching practices are vital to consider.

Teachers views of STEM teaching and learning: the finding of this study showed in Table 4, teachers unprepared to use STEM education in their school. STEM learning model need to exemplified to teachers so that teachers get the picture of how design and do STEM education. The majority of the teacher ( 15 respondents) believed that technology in STEM (T) as computer, laptop, camera and so on is a focus for integrated STEM education. It showed that the teachers who participated in this study have an adequate understanding of the nature of STEM education. The role of technology in the primary classroom is The use of technology does not fundamentally alter the learning activity, but enables elements of the task to be completed more easily. For example, editing and revising a document is more expeditiously andneatly accomplished using Microsoft Word than it is manually, using a pen and paper [20].

Teachers views of STEM integration: in this study, 15 teachers (62,5%) who participated have never been integrating STEM in their learning. They believed that STEM education can train students thinking skill. They also ackonowledge STEM will be getting students to be able to collaborate and problem solving. Some acknowledge the STEM education are able to sharpen their ability to examine. More information, that with STEM can meet some of the challenges of the twentieth century to 21. In P21's Framework for 21st Century Learning state that "a focus on creativity, critical thinking, communication and collaboration is essential to prepare students for the future." [21]. So, with STEM education in primary school can meet the challenges of education in the 21th century. Teaching STEM by connecting to the real life need to do so that students will inspiring their future. Even when the local culture integrated in lessons will induce students interest in STEM education. It is important to take advantage of the

local culture and raise awareness of the applications of STEM through science lessons [22]. Integrated STEM education can motivate students to careers in STEM fields and may improve their interest and performance in mathematics and science. Effective STEM education is vital for the future success of students [23]. Teachers suggested that a direct discussion between primary teacher, science teacher or scientist, engineer and math teacher. It is a discussion about STEM activity and how to work together to design model of STEM education. STEM education also required collaboration among stakeholders to supporting it.

**TABLE 3.** The findings of the frequency of using integrated learning and integrated learning understanding

Items	Strongly agree	Agree	Disagree	Strongly disagree
I never do integrated learning/integrated/thematic	7	15	1	1
For me, except with subjects, integrated learning also integrate subjects with the attitude and character of the	9	15	-	-
Integrated learning can be integrated with the use of technology	11	13	-	-
I always do the integrated learning/integrated/thematic	2	9	13	-
I always do the integrated learning/integrated/thematic	8	15	1	-
I always use integrated learning in the higher classes	1	12	11	-
I need a lot of time to prepare the integrated learning	8	11	5	-
Preparing integrated learning is cumbersome for me	3	13	6	2
Learning time allocation is not enough to implement the integrated learning	4	8	10	2

**TABLE 4.** The finding of Teachers views of STEM teaching and learning

Items	Strongly agree	Agree	Disagree	Strongly disagree
I do not know the preparation of what must be done when performing an integrated learning by STEM	3	11	9	1
Equipment for integrated learning STEM is cumbersome	1	13	8	2
T on STEAM focus on the use of the hardware (computer, LCD monitor)	3	15	6	-
According To me, Science, Technology, Engineering, Art and Math cannot be taught in a holistic approach (comprehensive) and integrated	1	5	18	-

**TABLE 5.** The finding of Teachers views of STEM integration

Items	Strongly agree	Agree	Disagree	Strongly disagree
I had never done learning by integrating between STEM	-	8	15	1
STEM education can train students thinking skills	7	17	-	-
STEM education will be getting students to be able to collaborate and solve the problem	9	15	-	-
Ability to doing research cannot be trained if it was done by STEM education	1	-	21	2
Teaching by connecting to the condition of life is actually need done to inspire the students future	11	13	-	-
Local culture that are integrated will improve the implementation of the learning	11	12	1	-
It needed special discussion between science teacher, mathematic teacher, engineer and researcher	7	15	2	-
Teachers and engineers can work together in learning activity	3	18	3	-

## CONCLUSION AND SUGGESTION

This study provides an illustration on how pre-service teachers in a professional development program perceived STEM education in their context. It was revealed that the teachers need support and training on how to integrated STEM in Indonesian Curriculum that has not incorporated STEM in primary education. Preliminary findings suggest that many teachers are interested in integrated approaches to STEM, but do not believe they are well prepared to implement them. Learning model of STEM need to meet in elementary school as the main road the development of education in Indonesia. At the implementation level, findings above also suggest that it is crucial for teachers to cooperate with their peer teachers and to develop interdisciplinary (open-ended and creative) instructions on their own. It is especially important to organize a group of teachers from different disciplines, to establish effective means of communication with each other, and to cope with problems that arise in the process of STEM education. Professional subject knowledge and pedagogical knowledge should be integrated appropriately. Candidates for primary school teachers are required to teach the integrated learning, especially thematic learning. Primary school teachers with the background of basic education has not been carrying out integrated learning in class teachers is expected to be able to develop integrated learning, especially with STEM education as the answer from the challenges of education in the twentieth century

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