Pre-service teachers’ perception on science, technology, engineering, and mathematics (STEM) education

R Rifandi1,*, Y L Rahmi2, Widya3, E S Indrawati3
1 Mathematics Department, Universitas Negeri Padang, Jl. Prof. Dr. Hamka, Air Tawar Padang, Indonesia
2 Biology Department, Universitas Negeri Padang, Jl. Prof. Dr. Hamka, Air Tawar Padang, Indonesia
3 Physics Education, STKIP Adzka, Jl. Taratak Paneh No 7, Kuranji Padang, Indonesia

*Corresponding author: r.rifandi@fmipa.unp.ac.id

Abstract. STEM education has become a trending topic to be discussed among educational experts. However, there is still limited data about preservice teachers’ perception about it. Therefore, the aim of this study is to describe teachers’ perception about Science, Technology, Engineering and Mathematics (STEM) education. This study is a descriptive research using survey method. The data were collected through questionnaire. The collected data was analyzed by using percentage technique. The result shows that there is positive perception among the preservice teachers about STEM education and they are agree of implementing it to educational curriculum in Indonesia.

1. Introduction

STEM education, which is an acronym of science, technology, engineering, and mathematics, has become a trending topic to be discussed among educational experts. The initial idea of STEM education established in the USA in the 1990s and nowadays many countries (either developed or developing) promote STEM Education in their education systems. For examples, Australia has Australian STEM School Education Strategy 2016–2026 to prepare their students in STEM-related jobs [1], Malaysia has implemented STEM in schools since 2017 [2]. Moreover, STEM education awareness in many other countries also arise such as in Arab Saudi [3], South Korea [4], Thailand [5] and so on.

STEM education is essential for students’ to survive in this modern era where complicated problem of life occur. According to [6] to compete and survive in the modern economy, students should be prepared with several skills including the ability to adapt with many situations, ability to communicate in a higher level, ability in non routine problem solving, having a good self management and well developed systems thinking. The report also stated that STEM education will support students in their life after graduating from school since they have been prepared with skills such as ability on decision making which they can use in managing their health, conserving the energy used, concerning on environmental issue and reusable resources as well as national security [6]. Students can utilize those
skills and knowledge they got from STEM education experience to overcome their daily life problems. This is line with [7], a solid STEM education is ending up progressively perceived as a key factor of chance and it is predicted that the development of STEM will continuously grow up.

Indonesia is one of developing country in Southeast Asia. Since 2013 Indonesia has implemented the curriculum 2013 in its education system. The curriculum 2013 is the early gate to enter the 21st century education [8]. In addition, STEM education is proposed to be one of solution to address the 21st century demand [9]. Therefore, in order to success in the 21st century, Indonesia has to prepare to use STEM education in its education system.

One preparation of STEM education is preparing teachers. Particularly, the teachers are the main person who will implement or integrate the STEM education in the classroom learning [4]. Furthermore, teachers as the key actor of implementing curriculum should have the competence to implement the curriculum in the learning process in order to achieve educational goals [10]. Therefore, preparing pre-service teachers in the university level become essential to gain a successful educational reform in the school later on [11]. In addition, for effectiveness in curriculum development, and also to determine the role of teachers in that development process, it is necessary to know the extent of teachers' perceptions about their curriculum development competency [12]. Based on the aforementioned explanation, teachers need to be prepared with knowledge and skills to implement the STEM education even when they still in the university level. Then, as an initial stage, this research will try to find out and describe about perceptions of pre-service teacher for the implementation of STEM education.

2. Research Methode

The present study aimed to describe preservice teachers’ perception on STEM education. Participants of this study were 48 pre-service teachers in mathematics and science subject from Mathematics and Natural Science Faculty of Universitas Negeri Padang. The participants were asked to give respond to an online questionnaire about their perception on STEM education.

In general, the questionnaire consisted of three main parts. In the first part we were interested in whether the participant ever heard about STEM education or not, it followed by question on how they get to know it and their initial views on what relationship of each component in STEM has. Furthermore, we focused on participants’ perception which we got from their responses on the following six statements: (a) STEM is really necessary to be implemented in learning, (b) STEM purpose is to relate the learning process in the school with students’ daily life, (c) STEM is suitable to be integrated in all subjects, (d) STEM can be implemented in every level of education, (e) STEM is really connected to problem solving skill, (f) STEM is really connected to students’ preference on choosing a job in the future. The participants were required to respond on a four-scale disagreement-agreement. In the third part of the questionnaire, we would like to investigate the perception of the participant on what challenges might occur when implementing STEM education along with their suggestions. We provided the participants with a list of possible answers and the they could choose more then one option. As the last question, we asked the participants about their view whether Indonesia suit with the integration of STEM education on its curriculum. For this, we only provide yes or no option to be chosen by the participants.

3. Result and Discussion

Based on the research method, there are three categories of questions:

3.1 General View on STEM Education

Three main points will be described in this part. To begin with, the following figure 1 shown data about the pre-service teachers’ chosen on “Do know” or “Do not know” on STEM education term along with how they getting know about it. The chart provides information on whether preservice teachers ever heard on STEM education and its resources. For about 69 of them had heard of STEM
education and about 31% never heard it. It describes that most of the pre-service teachers were familiar on STEM education.

The participants get information on STEM education from various resources, such as internet about 43.7%, from lecturer (28.2%), from seminar (9.9%) and book about 8.5% then followed by friends 7% and others 2.8%. The result indicated that most of university students used internet as learning resources to get information on STEM education [5]. Although using online learning tools take the first position to spread information on STEM education but lecturers’ information were still needed.

![Figure 1. Preservice teachers heard on STEM education and its sources](image)

Furthermore, we asked the participants to choose one of the three pictures as it is shown in figure 2. Our intention is to know their initial view about approach to see the relation of each core subject included in STEM. The three options were based on approaches proposed by Roberts and Cantu [13] namely SILO approach, Embedded approach and Integrated approach. Interestingly, about three quarters of the pre-service teachers chose Integrated approach and the rest looked the relation as in Embedded approach. Meanwhile, none of them agree with SILO approach which state that Science, Mathematics and Technology and Engineering are isolate to each other. The result imply that all of the participants have initial view that in STEM education, the four domains are closely related. This is inline with experts’ view about the integration of some or all core subjects into one integrated lesson [14].

![Figure 2. Three approaches for teaching STEM education](image)

### 3.2 Pre-service Teachers’ Perception on STEM education

In this subsection we describe data about perception of the pre-service mathematics and science teachers on STEM education. Six statements were asked to the participants on their agreements or disagreements. Obtained data is presented in table 1. Based on the table 1, it can be seen clearly that the majority of university students had positive view on STEM Education. We found about 52.1% of the pre-service teachers who participated in this study were very agree and 45.8% agree on statement
that implementation of STEM education in the school is important. This finding is also supported by experts’ view that nowadays educational stakeholders need to give strong attention on providing students with STEM education experience [15].

Furthermore, no one preservice teachers disagree that STEM education linked to real life situations. Several studies have been conducted in relating the real life context into subject matter especially in the STEM related subject [16], [17]. Therefore, most of preservice teacher agree that STEM education is suitable to be included in all subjects and can be implemented in every level of education (elementry, middle and high school). This is inline with [18] who reviewed more than 50 articles which contain suggestions on how to implement STEM in whole school level. This implies that theoretically, STEM education can be implemented in every level of education. Moreover, almost all of our participants state agree or very agree that STEM relate with problem solving skill as well as connected with students’ preferences on their future workfield. Some experts have already researched about how to assess students’ problem solving ability within STEM education context [19] which mean that there is connection between problem solving skills and STEM education.

| Statements                                                                 | Percentage (%) |
|---------------------------------------------------------------------------|----------------|
| STEM education is really necessary to be implemented in learning          | 0 2.1 45.8 52.1 |
| STEM education purpose is to relate the learning process in the school with students’ daily life | 0 0 52.1 47.9 |
| STEM education is suitable to be integrated in all subjects               | 0 12.5 66.7 20.8 |
| STEM education can be implemented in every level of education             | 0 14.6 68.8 16.7 |
| STEM education is really connected to problem solving skill               | 0 2.0 56.3 41.7 |
| STEM is really connected to students’ preference on choosing a job in the future | 0 4.2 58.3 37.5 |

3.3 Challenges and Suggestions on STEM Implementation
The last part in the given questionnaire was intended to know challenges and suggestion about STEM implementation based on the the pre-service teachers’ perception in this study.
In term of challenges, as can be seen in figure 3, the big problem for pre-service teacher on STEM implementation was time consume for preparing STEM instructional, it was about 28.1 %, whereas only 12.5 % mentioned that implementing STEM in the classroom will increase teacher workload. Moreover, points about administrative things, insufficient funding, and adaptation in using new tools to support STEM instruction share about the same percentage, that is around 20% for each. The collected data in this study support what already discussed among other researchers on challenges which might be occured in implementing STEM education [20], [21].

Accomplishing the challenges data above, we asked the participant to choose one from the two suggestions listed in the questionnaire. The first suggestion focusing on socialization and training for teachers/pre-services teachers on STEM education, while the second one pointed out about supporting tools and facilities in implementing STEM. Figure 4 indicates that the two point percentages are not that difference, 54 % and 46 % respectively. This implies that seemingly our participants take the both options as the importance aspects to be improved in supporting STEM implementation, either by government or other related stakeholders.

![Figure 4. Suggestion on supporting STEM education implementation](image)

Last but not the least, we collected data on participants’ respond to the following question: “Does STEM education suitable to be implemented in Indonesian Curriculum?”. Our intention was to look on the participants’ agreement whether they think that STEM fit with Indonesian context. Interestingly, 94% of them gave a “yes” answer on this question which mean that almost all of the participants feel positive towards STEM education and recommend it to be used in Indonesia.

4. Conclusion
The present paper provides an overview perception of pre-service teachers in mathematics and science subject on STEM education. In general, most of the pre-service teachers in this study show positive perception towards STEM education and they are agree to integrate it in Indonesian curriculum. The data analysis of the perception suggest that implementation of STEM is essential, it can be a bridge between the classroom lesson and students’ daily life. Moreover, applying STEM is not only for certain subject as well as not limited to a particular level of education. Besides, it has close relation with problem solving skills and contribute to students’ consideration in choosing a job after graduate from school.

STEM implementation will face many challenges, in specific, our participants in this study highlight that the preparation phase when they want to conduct a learning by integrating STEM will consume much more time. The pre-service teachers suggest that government and other related sectors should provide training and socialisation about STEM along with supporting facilities and equipments.
Finally, further research and discussion is needed in how to prepare the teachers since the beginning. This is not merely about integrating STEM in university level but it is more on formulating how teacher education in university provides their students with experience and skills on how to teach within STEM education paradigm.

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