THE MOVEMENT OF STEM EDUCATION IN INDONESIA: SCIENCE TEACHERS’ PERSPECTIVES

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ABSTRACT

Indonesia, as a large nation having a wealth of natural resources and abundant human resources, should be a nation which plays a great role in the development of science and technology. STEM education can be used in other scientific fields by utilizing the principles of science, technology, engineering, and mathematics as a basis for learning and developing potential students. This study is aimed at examining the teachers’ perceptions on STEM education in Indonesia including the understanding of STEM definition more deeply. The subjects in this study consist of 117 science teachers from Indonesia. A set of questionnaire consisting of open- and closed-ended questions about teachers’ perceptions and understanding regarding STEM education and the 21st century skills preparation were developed and implemented. Responses from the science teachers were analysed through interpretive methods in which the participants’ meanings and points of view were sought. The results indicate that STEM education is quite well understood by the teachers. It is important that we focus on the teachers as they play a crucial role in the success of new reforms. The implication is that there is a considerable need for awareness raising at both government and teacher levels to embrace STEM education.

INTRODUCTION

The term STEM is used to emphasize an understanding of the integrated disciplines of science, technology, engineering, and mathematics as well as their importance in the long-term academic success of children, economic well-being (Herro & Quigley, 2016), and community development (Hanet al., 2015). STEM education is promoted in many countries to prepare children for the century’s global economy (Yakman & Lee, 2012). The idea of developing STEM learning models in the U.S arose because results from the 2011 Trends in TIMSS (International Mathematics and Science Study) in mathematics unveiled that fourth graders in the United States ranked 11th and eighth graders in the U.S. ranked 9th when compared to other nations (Mullis et al., 2012). In science, the fourth graders in the United States ranked 7th when compared to other nations, and eighth graders in the United States ranked 10th. The relevance of STEM education in the United States is highlighted by the 5-Year Federal STEM Education Strategic Plan adopted in 2013 for pre-
paration of 100,000 new STEM teachers by 2020 and provides efficacious support to the current contingent of teachers (Martin et al., 2012). STEM education is now being implemented by several countries and becomes one of the primary trends in global education. In Taiwan, the learning curriculum began to be integrated with the STEM curriculum and made students the focus of learning activities (Lou et al., 2011). Malaysia Education Blueprint (2013) provides for STEM education reform which is started by enhancing the STEM education quality through the enhancement of curriculum, teacher training, and the use of integrated learning methods. In 2015, Australia adopted a national strategy for STEM education development in schools in 2016-2026. The National STEM School Education Strategy defines 5 key goals consisting of increasing the abilities, involvement and interest of students in STEM, increasing the capacity of teachers and quality of teaching of STEM subjects, supporting chances for STEM-education in schools, promoting effective collaboration with universities, business and industry, and establishing a sound database (Education Council, 2015). In 2013, a three-year university-based learning model (Musyaficili) that demands the organization and development of training courses for teachers with the support of the industrial sector was launched, with 11 countries taking part: Cyprus, Croatia, Greece, Great Britain, Lithuania, Netherlands, Norway, Turkey, and Spain (Hazelkorn et al., 2015). INSTEM project (2012-2015) intends to promote research training with the purpose of collecting innovative teaching methods and improve the interest of students in science, as well as provide comprehensive information on careers in the field of STEM in Austria, Germany, Greece, Great Britain, Italy, Ireland, Romania, Norway, and Turkey (Kezar, 2018).

The development of STEM in education in Indonesia demonstrates that STEM needs to raise in education in Indonesia for STEM is a paradigm that creates inter-disciplinary learning and provides achievement results of science, mathematics, engineering, and technology while doing so. Indonesia, through collaboration with USAID (United States Agency for International Development), began to develop STEM-learning model. Sukri et al. (2013) have examined the integration of STEM education in science learning and teaching in elementary and secondary schools in Indonesia, including the understanding of STEM definition. Many skilled workers in Indonesia come from other countries such as India, China, and numerous other countries. They enter Indonesia to compete for jobs. Many sources considered those countries a representation of developed countries. They have great inventions in STEM education. Actually, many people can recognize the changes. Unfortunately, Indonesia is at risk. It can be seen from the social and economic condition in some parts of Indonesia. The data show that PISA level is still low.

Recognizing the recent focus on STEM education is interesting and it emerges from STEM education in learning from an analysis. The research is conducted on STEM education from some conception and current condition in Indonesia. To increase the interest in STEM education in Indonesia, the researchers addressed the problem by exploring the following questions: How is STEM education movement implemented in Indonesia? How deep is the teachers’ understanding about STEM? How often do the teachers’ do their activities in STEM education?

METHODS

The researchers adopted a quantitative instrument. A survey research was conducted to examine the teachers’ perceptions of STEM education and the 21st century skills preparation. The survey was used in this study to collect data at a particular point in time with the intention of describing the nature of existing conditions (Cohen et al., 2007). The population in this study is science teachers in Indonesia, separated in each island. The sampling technique was purposive sampling as the researchers might imply thus choose representative samples to suit the needs. The participants in this study consisted of 117 science teachers from various island in Indonesia, such as Sumatera, Java, Bali, Borneo, and Celebes. They were from both private and public schools all over the country, aged between 20 and 60 years old (38.5% aged between 20 and 29 years old, 17.1% aged between 30-35 years old, 17.9% aged between 36-40 years old and 26.5% aged above 40 years old). A set of questionnaire consisting of open-ended and closed-ended questions about the teachers’ perception and understanding of STEM education and the 21st century skills preparation was developed and applied with a focus on the following questionnaire. The instruments were developed by considering judgements form the experts from UPI STEM center and from the government.

The questions can be shown below:
1. Do you know about STEM education or STEM education approach (Q1)?
2. Do you know what competencies and skills needed in the 21st century workforce (Q2)?
3. As a teacher, do you know and implement learning approach such as STEM education approach to facilitate students facing the 21st century? If the answer is yes, how do you implement it (Q3)?
4. Do you believe that the implementation of the current learning approach such as STEM education learning could help students improve their ability to prepare their competencies in the 21st century (Q4)?
5. Do you think that the government has done the best effort in preparing high quality teachers (Q5)?
6. School facilities and infrastructures become one of the important factors for instructional process. Are the facilities and infrastructures sufficient to support you to implement STEM (Q6)?
7. Are you involved in the Secondary School Subject Teacher’s Working Group (Musyaficili) (Q7)?
8. Do you find significant impact of Musyaficili activities in the way you conduct instructional processes (Q8)?
9. Are you still developing an ideal teaching method to be implemented in the classroom? How do you develop the ideal teaching method (Q9)?
10. Do you know about Higher Order Thinking Skills/HOTS (Q10)?

Responses from the science teachers were analysed through interpretive methods (Erickson, 1986), in which the participants’ meanings and points of view were sought. The terminology of survey research design can be described as statistical, explanatory, and cross sectional. As many as 177 respondents took the survey. Statistical method was used to analyse various factors and levels of engagement. The findings were documented by using descriptive methods. The data were in the form of questionnaires and examination documents. In this study, the documents were the result of research papers related to STEM education, qualitative document analysis is a qualitative content analysis which examines the relationship between the do-
documents and the research results. With a qualitative document analysis framework, the coding of the research paper could be done. Each research paper was given a descriptive point of view and became the thematic structure for STEM education in Indonesia.

RESULTS AND DISCUSSION

The result of the survey administered to science teachers about their perception towards STEM education and the 21st century skills preparation is provided in Figure 1 below.

![Teachers' Perception towards STEM Education and 21st Century Skills Preparation](image)

**Figure 1. Teachers' Perception towards STEM Education and the 21st Century Skills Preparation**

Figure 1 shows that most of the teachers are familiar with STEM education and the 21st century skills challenge. It can be seen from the percentage of the teachers who answered Yes, which is bigger than that of the teachers who answered No for each question. As for Question 6 (Q6), the percentage of the teachers who stated that school facilities and infrastructure were sufficient is only 35%.

The data revealed that among the participants who responded to question 1 (Q1) “Do you know about STEM education or STEM approach?” (N=117), 54% stated they know about STEM education and were able to adequately define it as education involving science, technology, engineering, and mathematics. The rest 46.8% did not have knowledge about STEM education. Many educators approach STEM education with precariousness because no single definition of STEM education exists, and many do not have an interdisciplinary understanding of STEM (Breiner et al., 2012). This is not entirely surprising because there is no ordinary understanding or agreement on the nature of STEM education as an integrated or multidisciplinary endeavor, only few guidelines and models that exist for teachers to follow regarding how to teach using STEM integration approaches (Roehrig et al., 2012). Based on this data, Indonesia, as one of the largest country in the world, needs to prepare teachers who have sufficient knowledge of STEM education.

The result of question 5 (Q5) shows that 72% of the teachers thought that the government has done the best effort in preparing high quality teachers. Most of the teachers stated that teacher training and professional development program including the STEM teacher training workshop held by the government was effective to improve the quality of science teachers in Indonesia. Meanwhile, 28% argued that the teacher training and professional development programs were usually unrelated from everyday practice of teaching, too generic, and unrelated to the curriculum or to the particular instructional problems teachers face, and they were infrequent and implemented as a one-shot event or led by an outside consultant who drops in to carry out a workshop and never returns to the school or district. These problems are in line with some previous researches demonstrating that the professional development has no effect on the students’ learning. A frequently-cited analysis of 1,300 studies unveiled that only nine of the studies show lucid, empirical evidence of the effect of professional development on the students’ achievements (Harris & Sass, 2011). Despite the challenges, there is a meticulous research on professional learning showing that it can, indeed, change the way teachers teach and how much students learn. There is also another study that investigated the relationship between several professional development activities and specific teaching practices related to early-reading instruction. The study found out a relationship between what teachers learned and how they later taught (Walpole et al., 2010). This result indicates that our government is still learning how to make sure that professional development delivers the results we wish. Another obstacle is whether designing and implementing professional-learning activities at the local level are able to reveal what programs give evidence of demonstrated effectiveness. What further complicates the work of selecting professional-learning activities is that there aren’t any features or programs that always work in every setting. Rather, professional development is as complex as teaching. To put it another way, professional development is about teaching teachers.

The result of question 6 (Q6) shows that 65% of the teachers in Indonesia stated that education infrastructure was still inadequate. This result coincidentally links with the the performance of Indonesian students in PISA results that are still low. Question 7 (Q7) and question 8 (Q8) explain the teachers’ involvement in the Secondary School Subject Teacher’s Working Group (Musyawarah Guru Mata Pelajaran/MGMP) and the impact of MGMP towards teaching the 21st century skills in the classroom. The result shows that 69% were involved in MGMP and 56% stated that MGMP helped them to teach the 21st century skills in the classroom. MGMP is expected to be a forum for information exchange and information delivery related to education that specialises in certain subject. The head of the LP4TK program explains the steps as follows:

![The Flowchart of the Structure and Function of MGMP Sector](image)
Based on the diagram above, the role of each related element now has its own duties and functions. It is expected that a clear system can improve the teacher's understanding and equi-
table information related to the government's programs. However, it is unfortunate that the-
re are still many teachers who are not involved in
MGMP. There should be special attention to
the role of the government and schools for pay-
ing more attention to the tasks and functions of
MGMP in the teaching sector in the distribution of
information. Dr. Eneng Susilawati, M.Pd. (the
head of the program) stated that the success of
education lies in the teacher's ability in imple-
menting learning approaches and methods. She
said that until now teacher trainings have been
carried out in every province in Indonesia and
were expected to be continued by those who par-
ticipated in the training. The comparison of te-
achers in the mainland of Java and the eastern
regions of Indonesia shows other unique things.
Teachers who are in the eastern part of Indone-
sia have a high level of creativity. This was revi-
ewed from the results of the tests administered by
P4TK when conducting teacher training in Eas-
tern Indonesia. According to the researchers, it is
necessary to re-examine the motivation of teacher-
s in the mainland of Java towards the advance-
ment of educational technology.

The government also concerns on how to
develop researches on STEM education and de-

The flow STEM education research in In-
donesia can be shown below. Universities which
place research concerns on researching and developing STEM
education among others are Indonesia Universi-
ety of Education (Universitas Pendidikan Indonesia),
Syiah Kuala University, and Yogyakarta State
University. Syiah Kuala University already built
a STEM Center by collaborating with a Malay-
sian university, meanwhile Indonesia University
of Education collaborates with the government
and MEQ QITEP as a partner Indonesia University
of Education contributed as an expert in developing STEM workbook,
project, etc. Some researches have already been
conducted and have a big impact (summarized
from Permanasari, 2016) in increasing students'
literacy in STEM, creativity, critical thinking,
causal reasoning, engineering literacy, technolo-
gy literacy, etc.

Several studies found the positive impact
of using models of PBLJ, PBL, Inquiry, IBL, etc.,
embedded with STEM. Those models include
introduction of engineering design cycle. Sejati
et al. (2017) developed a workbook on lever sys-
tem to enhance students’ STEM competencies.
Jauhariy et al. (2016) used STS model to PBLJ in
science learning that can improve scientific literacy,
motivation, and creativity. In line with
Jauhariy, Nurlaelty et al. (2017) used curricular
approaches to enhance the students’ concepts and
success was not found. It means the teachers lack of knowled-
ge of STEM education. The teachers’ perception
that STEM can enhance the students’ 21st century
skills is lower than the other models. The level of engagement of the teachers’ success in imple-
menting STEM education was unen. In most
respects, the patterns of understanding of STEM
education in some areas of Java island is higher
than the other parts.

CONCLUSION

In line with the next generation science
standard whose vision is “interwinding knowled-
ge, interest, and practice in learning experiences”, in
the next year, the implementation of science learning
should have a strong correlation with learning ex-
periences.

Triangulation

In order to describe the findings, the de-
tails of the survey can be used in the triangula-
tion process of research. The documents used in the
data aim to improve the quantitative findings and
the interpretation of data. Multi-methods were
used to converge the data. The artifact shows the
relation between the results and the theory. The data
were explained to uncover any unexpected
results of the level of understanding of STEM.
The research is in line with the theory that said
that STEM literacy in Indonesia is still low and
needs to be improved in order to gain the teach-
ers’ capability in enhancing the students’ skills in
the 21st century. The teachers’ forum (MGMP)
aims to enhance and improve the teachers’ under-
standing about the 21st century skills, but the flow
of structural activities can not answer the prob-
lems. Those problems can be seen from a deep
conversation with the government sectors and the
teachers’ understanding.

The relationship between the teachers’ per-
ception about the problems and successful is unen.
In most
respects, the patterns of understanding of STEM
education in some areas of Java island is higher
than the other parts.

This study examined the teachers’ percep-
tions of STEM education and the skills to face the
21st century. STEM education gains proliferated
attention in educational reforms worldwide.
The first conclusion is that STEM education is quite
well understood by teachers. It is essential that we
pay attention to the teachers as they play a critical
role in the success of the new reforms. The sug-
gestion is that there is a substantial need to raise
the awareness of both the government and the
developers who embrace STEM education. Guiding
STEM education and activities should also provide opportunities for the enhancement of STEM understandings. Structural organization has been created by the
government. In addition, the agenda requires a forum group discussion between the govern-
ment and the teachers to increase the teachers’
perception of STEM. This article has discussed the factors why the teachers need attention in order to overcome the problems. This research recommends a significant supporting program, retention, and access to support the teachers in understanding STEM education. This implies
that there is not only a need for awareness rais-
ing, but also for discussion on how STEM edu-
cation would be implemented. Schools that agree
to embrace STEM education may have different ideas of what it should look like, who should be
involved (in terms of students and teachers), and
how it should be implemented. Future researches
could focus on the development of instructional
models and curricula materials for STEM integ-
ration, connections between teacher education
programs for integration and teachers’ subse-
quently classroom teaching practices, and ways
in which teachers view STEM integration.

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