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HOW DOES TEACHERS' PERCEPTION ON STEM LEARNING FOR LOW CARBON EDUCATION?

ANNISA NURRAMADHANI[1,2], R. RIANDI[1,*],
ANNA PERMANASARI[2], IRMA RAHMA SUWARMA[1]

[1]Universitas Pendidikan Indonesia, Bandung, Indonesia
[2]Universitas Pakuan, Bogor, Indonesia
Corresponding Author: rian@upi.edu

Abstract

Research purposes is how to elaborate teachers' perception toward Science, technology, engineering, and mathematics (STEM) learning and teachers' understanding toward low carbon education. Qualitative research with survey method is used to elaborate teachers' perceptions pertaining STEM learning for Low Carbon Education. This survey is given to 58 teachers in educations, there are 45 elementary schools' teachers and 13 middle schools' teachers in Bogor, Indonesia with various duration of teaching experience. The instrument that is used is 22 questions include in questionnaire about Low Carbon Education (LCE) comprehension, STEM comprehension, and STEM implementation at school. Beside the questionnaire, there were an interview to the teachers pertaining the implementation of STEM learning in general and environmental learning that related to the Low Carbon Education in classes. Research results described that most of teachers in Bogor already have some understanding of STEM learning in general. Although there are still misconceptions related to it. The implementation of STEM learning in the classroom has been carried out by several teachers in several subjects, one of them is environmental learning. However, there is no implementation of STEM learning in environmental learning specifically related to low carbon education because teachers' understanding of LCE is still low. So, it can be concluded the implementation of STEM learning can be influenced by a teacher's understanding of it, their interesting on it, and it can affect to the development of students' important skills.

Keywords: Low carbon education (LCE), STEM learning, Teachers' perceptions

1. Introduction

Science, technology, engineering, and mathematics (STEM) is one of the most famous approaches in educations [1-3]. STEM also has already immerse in education curricula for several country in the world. Mostly, this learning approach are helpful to foster active learning and build students' skills to be ready to face their workface. Increasing students' performance and narrows achievement gaps for underrepresented students in several subjects [4, 5]. STEM learning also could cultivate students' 21st century skills as problem solving skills, critical thinking skills, creative thinking skills, collaboration, and communications [6-8]. Those skills are needed for students to face global issues surround them, for instance climate changes as environmental issues which is needed to be solved.

STEM is one of approach that is suitable to cultivate the environmental awareness. Previous research has already investigated that it also requires skilled educator, a strong interest in implementing STEM learning in the classroom [9], length of teaching does not affect teachers' skills in STEM learning [10], and teachers' perceptions of STEM learning and low carbon education (LCE) is also important [11, 12]. Thus, 21st century skills are developed, especially problem solving. so far in Indonesia, especially Bogor, not too many teachers have applied STEM learning in the classroom. Teachers still don't really understand STEM learning. Teachers have implemented STEM learning as in their own opinion in certain subjects such as science, mathematics, and environment. However, environmental learning here is not yet leading to LCE [13].

This research aims to elaborate teachers' perception toward STEM learning and teachers' understanding toward LCE. Qualitative research is conducted to several teachers in Bogor, Indonesia by giving them 22 statements in questionnaire pertaining LCE comprehension, STEM comprehension, and STEM implementation at school. The implementation of STEM learning in the classroom has been carried out by several teachers in several subjects, one of them is environmental learning. However, there is no implementation of STEM learning in LCE because teachers' understanding of LCE is still insufficient. This contradicts the research results which state that teacher perceptions of STEM and LCE are highly influential [11, 12]. This research could be as initial research related STEM learning and LCE which affects later on to student important skills.

2. Theory: STEM for Low Carbon Education

LCE is an awareness and habituations related to environmental situations to reduce carbon emissions [14], such as greenhouse gases, CO_2 emissions, global warming, green energy, climate change, and green technology which are applied in daily life activities. Carbon footprints that are caused by carbon emissions from greenhouse gases which increase in atmospheric concentrations, for instance CO_2, CH_4, SO_2, and CFCs (Fig. 1). The world government, including Indonesia, takes part in reducing carbon emissions by forming a low carbon development (LCD) program. Based on the LCD concept, public awareness is the most important thing to realize a carbon-free environment, one of solution is to initiate LCE [15, 16]. However, in Indonesia, that term is not familiar and has not been included in the learning curriculum explicitly. This also requires qualified learning to introduce it to students. One of them is STEM learning. The main characteristic in the STEM approach is the integration of science, technology, engineering and mathematics to solve real-life problems. LCE brings real life problem and suitable with the characteristic of STEM learning. There are three patterns of STEM approaches that are commonly recognized by the education community, as known as Silo, Embedded and Integrated patterns [17, 18].

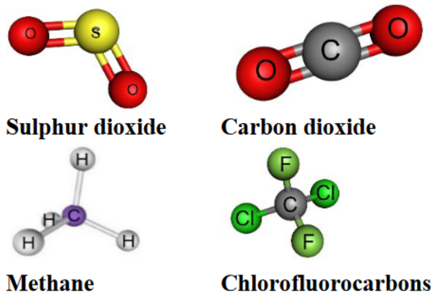

Fig. 1. 3D models of greenhouse gases.

3. Method

Qualitative research with survey method is used to elaborate teachers' perceptions pertaining STEM learning for LCE. This survey is given to 58 teachers in basic educations, there are 45 elementary schools' teachers and 13 middle schools' teachers in Bogor, Indonesia with various duration of teaching experience. The instrument that is used is 22 questions include in questionnaire about LCE comprehension, STEM comprehension, and STEM implementation at school. Interview to the teachers was also done pertaining the implementation of STEM learning in general and environmental learning that related to the LCE in classes. This research is conducted for about two months. Before the instrument are distributed to respondents, 3 experts validated it. The questions in the instrument are developed based on the research questions (i) How is teachers' perception or understanding about STEM learning? (ii) How is the implementation of STEM learning in classroom? (iii) How is teachers' understanding about LCE? Data analysis is done by descriptive analysis. The data from the questionnaire are proceeded by simple statistic calculating based on the mean and percentages from the respondent's answers, then delivered by the bar chart.

4.Results and Discussion

Teachers' perception pertaining STEM learning in general showed that 60% of teacher, especially in Bogor, Indonesia, has already known pertaining what STEM learning. They also thought that STEM learning is identically with project learning. Learning which initiated by the problem, then students should identify the problem with scientific activity, then design the solutions to overcome the problem as engineering, whether in the form of ideas, designs, or prototypes. Some of them also said technology as a solution in STEM learning. Most of teachers also thought that environmental problem is the hot issue which could be delivered to the students and its problems can be solved by STEM learning. While the rest 40% teachers did not know what STEM learning since they think STEM learning is only for science mathematic and engineering courses.

Teacher should understand and comprehend pertaining science, technology, engineering, and mathematics topics separately. Only science and mathematics teacher who could conduct STEM learning in the classes. Those thinking is erroneous. STEM learning is integration of learning, whether it is in science or non-science courses, even in economic, social, language courses, STEM learning could be conducted with integration in multidiscipline [17, 18]. STEM integrated model is the best approaches in learning. In the multidisciplinary model, students are directed to be able to find connections between different subjects that are also taught at different times [19-21]. This model requires good collaboration between subject teachers to ensure that students understand the interconnectedness of the concepts of the material being taught [22]. That approaches model initiate a learning through real-life problems. It suitable with environmental learning especially LCE which has various problem that should be solved from different point of view and subject. The problem that LCE offers, such as carbon footprint and emissions that related with social environment are needed to be solved by multidisciplinary aspect. The method, pattern and degree of integration between each discipline are categorized into several specific patterns determined by many factors [3, 17]. The STEM approach for LCE is more suitable with integrated patterns (Fig. 2).

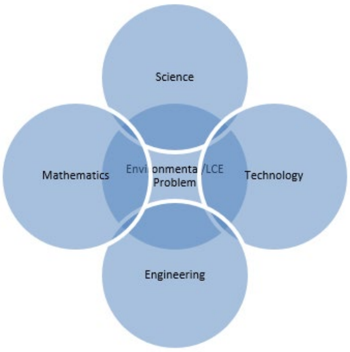

Fig. 2. Diagram of STEM for low carbon education approaches.

The perceptions of teachers pertaining STEM learning would influence its implementation in the classroom [23]. 74.83% teachers have already implemented STEM learning in their classroom. This group of teachers at least used STEM learning approach in their classroom for one until two topics in whole semester. Most of them implement STEM learning using embedded model approach. The embedded pattern is widely recognized as an approach that emphasizes knowledge gained through the study of real-world problems and problem-solving techniques in social, cultural and functional contexts [18, 24], especially in environmental learning. The implementation of the embedded pattern is an approach that is quite suitable for STEM needs because it requires multidisciplinary skills from materials and content that students acquire from various subjects or previous experiences. For example, science teachers applied STEM learning in the classroom, and science becomes a topic of emphasis in learning.

However, it is unfortunate that unlike the integrated model that applies multidisciplinary approaches, the problems on LCE topics are discussed thoroughly and integrated from various scientific perspectives, not only science but technology, engineering, and mathematics with LCE as the centre. Most of the teacher who conducted STEM learning are only science teachers or who has a background in mathematics educations. This result has the same idea with other research that science teacher is more confident to implement STEM learning [25-27]. The rest teachers (25.64%) who did not conduct STEM learning come from non-science subject. This does not mean that they do not implement STEM learning, but there is a stage that is very identical to STEM, namely the engineering design process (EDP), which is not carried out by these teachers. EDP is the important stages in STEM learning to see students' engineering literacy [28-30].

Other stages, except engineering design process, such as giving problems, identifying problems, building solutions, communicating results and discussing have been implemented by these teachers in their learning, especially environmental learning. Environmental learning topics that teachers taught to the students [31, 32]. It actually has already covered indirectly as LCE in several topics. For example, concept of climate changes, air pollutions, and renewable energy [33]. Figure 3 elaborates the paradigm of low carbon in educations. Low carbon is about mitigation to reduce greenhouse gases (GHG) emissions from carbon footprint in daily life related to material embodied carbon (construction, transportation, waste, foods, energy) [34, 35]. Both direct and indirect carbon emissions such as low carbon food, the use of lighting and air conditioning energy at home, home building materials, and the use of technological devices.

Climate change mitigation in LCEs could be immersed in several topics in LCE learning [36-38]. Those topics are (1) clean energy, technology, and transportations, (2) waste to resources (3) local sourcing plantations, (4) water management, and (5) energy efficient building. Teachers also should comprehend and provide those topics into a problem that is given to the students in the classroom discussions. If students have comprehended all those topics, it would promote their sustainability awareness and the goal that climate change reduction could be reached. However, most of teachers do not know what LCE is explicitly [12]. They only know low carbon has related to air pollutions from vehicle, industrial residual, and ozone damage. They use common teaching approach in environmental learning, such as problem-based learning, project-based learning, and case method, but not much know what STEM learning is, especially with LCE topics.

Thus, teachers' perceptions related to STEM learning and teachers' understanding of LCE can affect the learning in the classroom. Students' developing skills will also be influenced based on this. It similar with [39, 40] that perception of teachers about STEM could affect students' skills as an outcome. STEM learning will be succeeded is not dependent on teachers' experience year, but their interest [10]. If the teachers have understood the steps of a good STEM learning approach and have understood the concepts related to low carbon education and its materials, it is certain that students will understand the concept of low carbon education well and they can develop their 21st century skills to find solutions to environmental problems related to low carbon emissions. This will also increase both students and teachers' awareness of carbon emission mitigation which has a major impact on the environment around them. Because sustainable consciousness of low-carbon emissions is central to sustainable climate mitigation. So, it can be said that education has a big role in changing people thinking patterns and awareness.

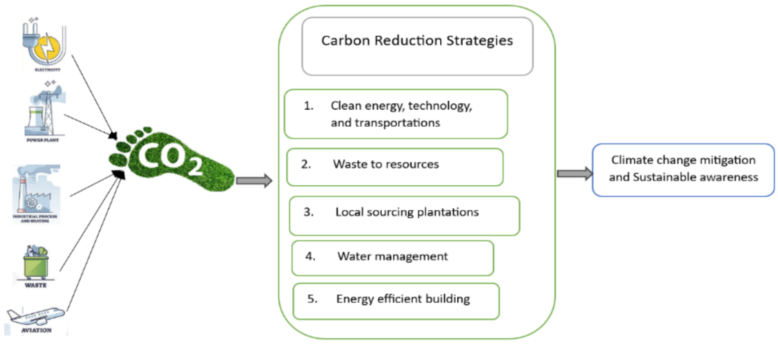

Fig. 3. Carbon reduction and climate changes mitigation strategies.

5.Conclusions

Based on results and discussions, this research can be concluded that most of teachers in Bogor already have some understanding of STEM learning in general. They though science and mathematics teacher only implement STEM. The implementation of STEM learning in the classroom has been carried out by several teachers and subjects, one of them is environmental learning. However, there is no implementation of STEM learning in specifically related to LCE because teachers' understanding of LCE is still low. The implementation of learning can be influenced by a teacher's understanding of the topic that delivered and can affect the skills of students formed.

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