An Analysis of Student Perspectives on STEM through Science Learning in Bandung City, Indonesia

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Abstract: In this 21st century, STEM (Science, Technology, Engineering, and Mathematics) - based Science learning has been widely applied in schools. To produce better STEM-based science learning, information is needed about students' perspectives on STEM. The required information includes students' perspectives on interests, careers, and STEM content. This research was conducted to obtain information about interests, careers, and STEM content. The sample used was grade IX (nine) students in one State Junior High School in Bandung. The method of the study employed a survey method using a five-scale Likert questionnaire and was analysed using descriptive statistics. It categorized students' perspectives on STEM learning in five categories namely very positive, positive, less positive, negative, and very negative categories. The results showed that most of the students' perspectives on the interests of using STEM were in the positive category with a percentage of 64%. Most of the students' perspectives on the STEM careers were in the positive category with a percentage of 80%. And students' perspectives on the content of STEM were mostly in the positive category with a percentage of 62%.
Keywords: STEM; Science Learning, Student Perspective

1. Introduction

STEM stands for Science, Technology, Engineering, and Mathematics. The definitions of science, technology, engineering, and mathematics (STEM) are as follows; Science is a subject that studies scientific knowledge such as physics, biology, chemistry, and earth science to understand the natural world, study the facts, and phenomena of the universe. Technology is change, innovation, and modification with or manipulating our natural resources to satisfy human needs, and also to learn how to acquire, utilize and manage technological tools to solve science, mathematics, and engineering problems. Engineering is knowledge in developing technology through a technique design process to solve problems. Engineering is used in the process of creating technology using science and mathematics. Mathematics is the study of patterns or relationships to formulate, solve, interpret questions and solutions in science, technology and engineering (Torlakson, 2014).

Hays Blaine (in Suwarma, 2019) argues that Science, Technology, Engineering, and Mathematics (STEM) is called a meta-discipline where teachers teach STEM with the disciplines of Science, Technology, Engineering, and Mathematical aspects that are not separated but integrated as one dynamic whole. According to Morrison, et al (in Suwarma, 2019), STEM is an interdisciplinary approach to learning in which students use Science, Technology, Engineering, and Mathematics in a real context that connects schools, the world of work, and the global world, therefore, STEM is able to help students compete in new economic era. An interdisciplinary approach can foster an understanding of the STEM concept in real-world problems (Tanenbaum, 2016). According to Bybee (2013) STEM is emphasized on creating a STEM-literate society, a quality workforce for the 21st century economy, and continued development that focuses on innovation. Furthermore, according to Larkin (2016) STEM through Creative Projects is also able to facilitate students to think outside the box. STEM learning steps are carried out based on the engineering process. There are seven important steps in the engineering process according to Suwarma (2015), namely as follows. 1) Ask: Identify the Need & Constraints, 2). Research the Problem, 3) Imagine: Develop Possible Solutions, 4) Plan: Select a Promising Solution, 5) Create: Build a Prototype, 6) Test and Evaluate Prototype and 7) Improve: Redesign as Needed. Changes in learning in the world of education can prepare the students for the 21st century which demands four basic skills. The four skills (4C) needed are Critical Thinking and Problem Solving, Creativity and Innovation, Communication (ability to speak, listen, write, and read using various media) and Collaboration.

STEM based learning is very important nowadays for several reasons. First, there is lack of workforce with the high quality needed for the industrial sector. Second, teaching mathematics is still delivered in the form of drilling or memorization not bringing them into practice. Previous research was conducted by Chumbley, et.al (2015) which identified student attitudes towards STEM learning showing that after STEM learning student motivation in learning increased. Besides motivation, according to Malcon (2016) STEM learning affects interest, self-concept, and persistence in STEM disciplines. Apart from interest, STEM learning also affects student careers towards STEM (Maltese & Tai, 2011 in Suprapto 2016). Therefore it is necessary to have information that examines students' attitudes towards STEM that include interests, careers, and STEM content.

Interest is a person's tendency to pursue a particular activity. Interest in STEM is the tendency of students to pursue STEM. The indicator of STEM interest in this study is an important indicator in STEM-based science learning since according to research conducted by Beier and Rittmayer (2008) it shows that interest significantly influences the choice of continuing studies and STEM careers, as well as student performance in STEM. There is no way for students who are not interested in STEM will be able to complete STEM well. Interest in learning in a particular subject (e.g, physics, mathematics, English) is related to achievement in that lesson. For example, students who are interested in computers usually obtain better score than students who do not share the same interests (Beier and Rittmayer, 2008). According to Hurlock (2012) factors that affect the development of individual interest can be grouped into internal factors consisting of physical factors, physical maturity, and physiological factors that are innate and external factors which consist of social factors including family and school environment, cultural factors such as customs, science and technology, physical environmental factors such as housing facilities, climate, the last are spiritual factors.

STEM careers are a series of attitudes and behaviors based on patterns of learning experiences undergone by students. Career is the goal of implementing STEM-based learning in America but the Career Demand for secondary students in the United States to follow STEM disciplines is stunted. There are still relatively few high school students who are motivated to choose careers in the post-secondary STEM field. Thus it needs to be prepared to enter a STEM career in the future. Career choices are influenced by several factors, namely intrinsic factors that influence career choices, including interests, abilities, and personality and extrinsic factors that affect career choices. Those include parents, teachers, and friends. Schools can inspire and strengthen students' careers in STEM, preparing them to take STEM. The subjects include mathematics, science, engineering and or technology, as well as a list of jobs connected to each subject area (such as physicist, chemist, astronomer, biological scientist, mathematician, laboratory technician, analyst, veterinarian, etc.) (Bottia , et al., 2017).

STEM content is science content taught using the STEM approach. STEM content can be seen from the content of science and mathematics material contained in student textbooks, namely the 2013 Curriculum Science and mathematics books issued by the Ministry of Education and Culture. The Ministry of Education and Culture has developed Textbooks, which are the main textbooks students use to study. The book was compiled by material substance experts, learning experts, and other experts involved. The 2013 Curriculum book has been used by students and teachers in schools throughout Indonesia. There are several studies that analyzed the 2013 Curriculum Science and mathematics books issued by the Ministry of Education and Culture, including Nugroho, et al. (2017). Their research analysed the science content in the 2013 curriculum science textbook, and the results showed that the integrated science textbook for grade 7 published by the Ministry of Education and Culture in semesters 1 and 2 met the core of competency standards and basic competencies in the 2013 curriculum syllabus and meet textbook standards that can be used for teaching and learning. Muklis (2015) conducted research on the analysis of the 2013 curriculum on mathematics textbook for grade 7 in terms of the implementation of the scientific approach and authentic assessment. The results suggested that the mathematics textbook with 2013 curriculum for grade 7 in semester 1 had a compatibility of 91.875% with a very good category and amounted to 97.5% with very good category in semester 2.

STEM based learning is very important nowadays for several reasons. First, there is lack of workforce with the high quality needed for the industrial sector. Second, teaching mathematics is still delivered in the form of drilling or memorization not bringing them into practice (Simarmata, 2020, p.13). In order to enhance the quality of STEM-based learning, it is necessary to have information about students' perspectives on STEM. In this literature review, some information was presented about students' perspectives on STEM through science learning. In this paper we analyzed the STEM interests, careers and content according to the students.

2. Method

The population in this study were all students of grade IX (nine) in a public junior high school in Bandung, Indonesia, academic year 2020/2021. The sampling technique used was probability sampling with a sample of 90 students who had conducted STEM-based science learning. The method used in this research was a survey method. Survey was a useful method for assessing student attitudes towards STEM (Guzey et.al, 2014). The data collection techniques employed questionnaires and interviews. The interview used in this study was an unstructured or open interview to explore information related to research based on the opinion of science teachers and it was conducted online using Google Form. The questionnaire used was a Likert scale with five scales and a questionnaire statement totalling 20, conducted online using Google Form. The questionnaire was validated using Content Validity Ratio (CVR) and Content Validity Index (CVI) with results of 0.73 which indicated the very high category.

Table.1. Interpretation of CVI and CVR score (Lawshe, 1975)

Intervals	Criteria
0,68 – 1,00	Vary High
0,34 – 0,67	High
0,00 – 0,33	Very Low

The data analysis technique used was descriptive statistics. The data were categorized into five levels of student perspective orientation towards interests, careers, and STEM content by using very positive, positive, less positive, negative, and very negative categories obtained through the conversion of raw scores to mature scores as in Table 2.

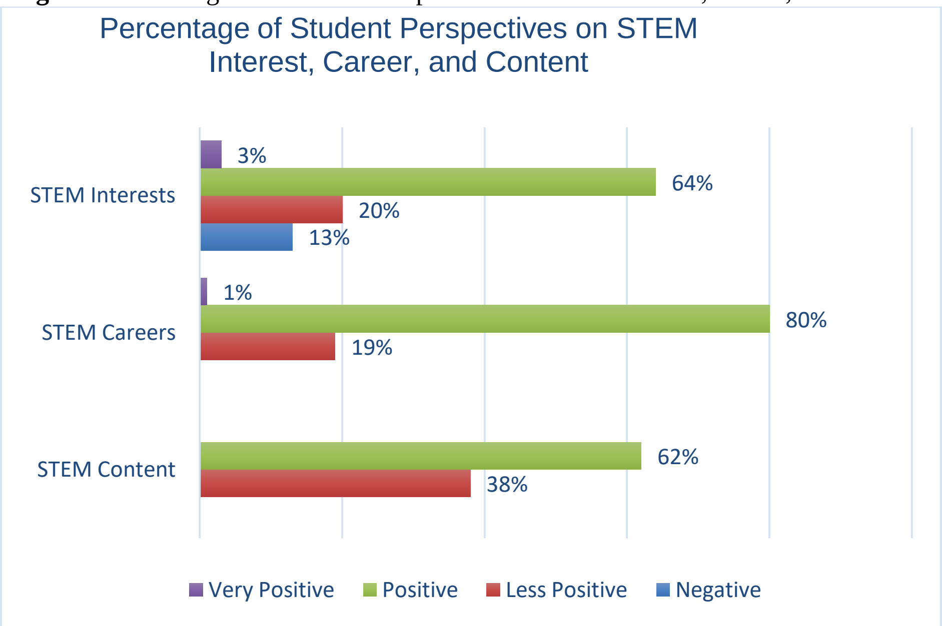
Table.2. Conversion of Raw score to Fixed Score

Raw score scale	Category
$\mu + 1.5\ \sigma < X$	Very Positive
$\mu + 0.5\ \sigma < X \leq \mu + 1.5\ \sigma$	Positive
$\mu - 0.5\ \sigma < X < \mu + 0.5\ \sigma$	Less Positive
$\mu - 1.5\ \sigma < X \leq \mu - 0.5\ \sigma$	Negative
$X \leq \mu - 1.5\ \sigma$	Very Negative

3.Findings and Discussion

Based on the treatment of research data, the presentation of student perspectives on STEM through science learning can be depicted in Figure 1. The graph is a combination of 3 indicators of STEM disciplines. The graph is based on information from all indicators in accordance with interest and content. Thus, it can be seen that the students' perspectives on STEM interest are mostly in the positive category with a percentage of 64%. Most of the students' perspectives on STEM careers are also in the positive category with a percentage of 80%. Students' perspectives on STEM content are mostly in the positive category with a percentage of 62%.

Figure.1 Percentage of Students' Perspectives on STEM Interest, Career, and Content



Based on these data, in general, most of the students' perspectives on STEM interests, careers, and content were included in the positive category. Meanwhile, students' perspectives on STEM interest were in the less positive category with a percentage of 20%. Students' perspectives on STEM careers were in the less positive category with a percentage of 19% as well as students' perspectives on STEM content were in the less positive category as much as 38%. According to Beier and Rittmayer (2008) interest significantly affects STEM study and career choices, as well as student performance in STEM. Students who were not interested in STEM would not be able to complete STEM well. Interest in learning in a particular subject (e.g, physics, mathematics, English) is related to achievement in each student. For example, students who are interested in computers usually get better score than students who do not share the same interests (Beier and Rittmayer, 2008). Likewise in this study, if it was analyzed from the results of daily tests in science lessons, the average score of students before and after STEM learning changed. Based on the evidence of daily scores and the results of interviews with the teacher, the average score of students' daily tests after implementing STEM learning has increased. Therefore, it can be concluded that students had a good interest, career, and STEM content. To clarify the research findings regarding students' perspectives on STEM interests, careers, and content, each of the findings are discussed as follows.

Figure.2 Percentage of STEM Interest Indicators

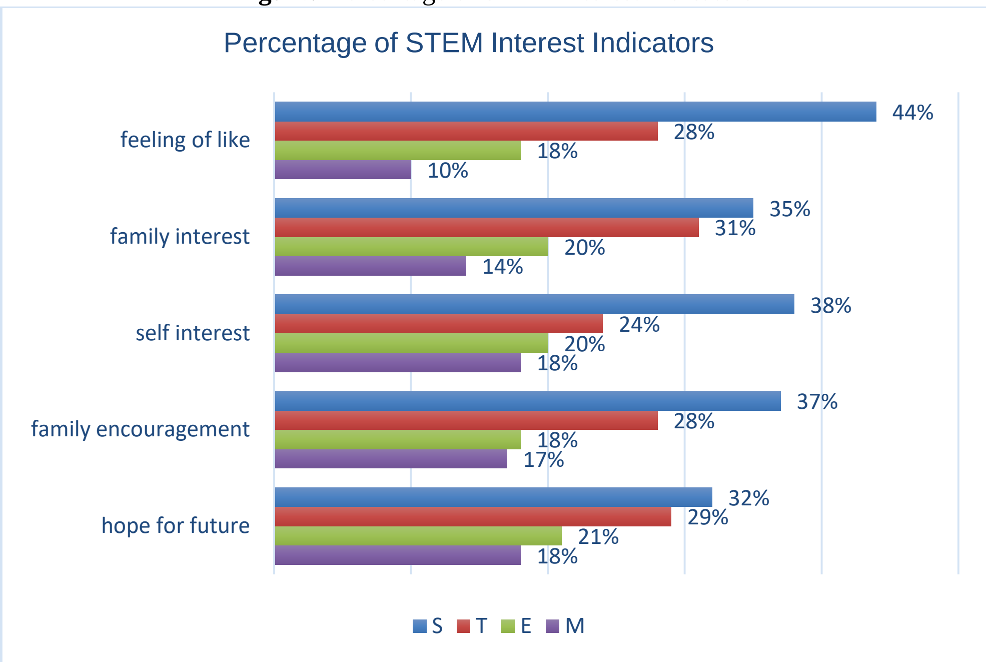
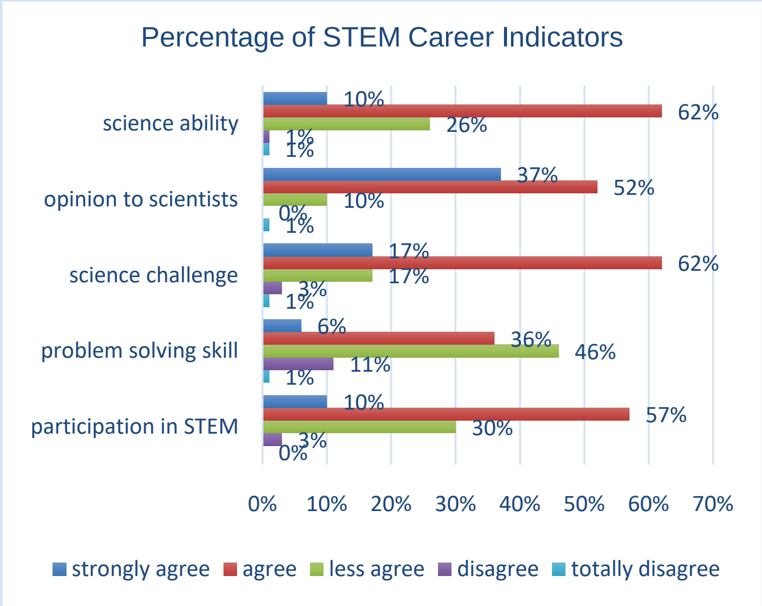


Figure 2 shows the results of processing and analysis of STEM interest data. The graph illustrates percentage of each indicator of student interest in S, T, E, M from 90 students. In general, the results of the research on each indicator of interest in S, T, E, M provide information that most of the students have an interest in science. As many as 32% of students are motivated to learn more on science, 37% of students have a family drive towards science, 38% of their family are interested in science, 35% of students have an internal interest in science, and 44% of students like science.

Based on the data on the graph, in general, most of the students' interest are in science. Followed by technology with a percentage of 29% of students are motivated to pursue technology, 28% of students have a family drive towards technology, 24% of their family students are interested in technology, 31% of students have an internal interest in technology, and 28% of students enjoy technology. Students are mostly interested in science for all statements and then they are interested in technology rather than engineering and mathematics. In fact, this is because their families gave the most encouragement to science and technology.

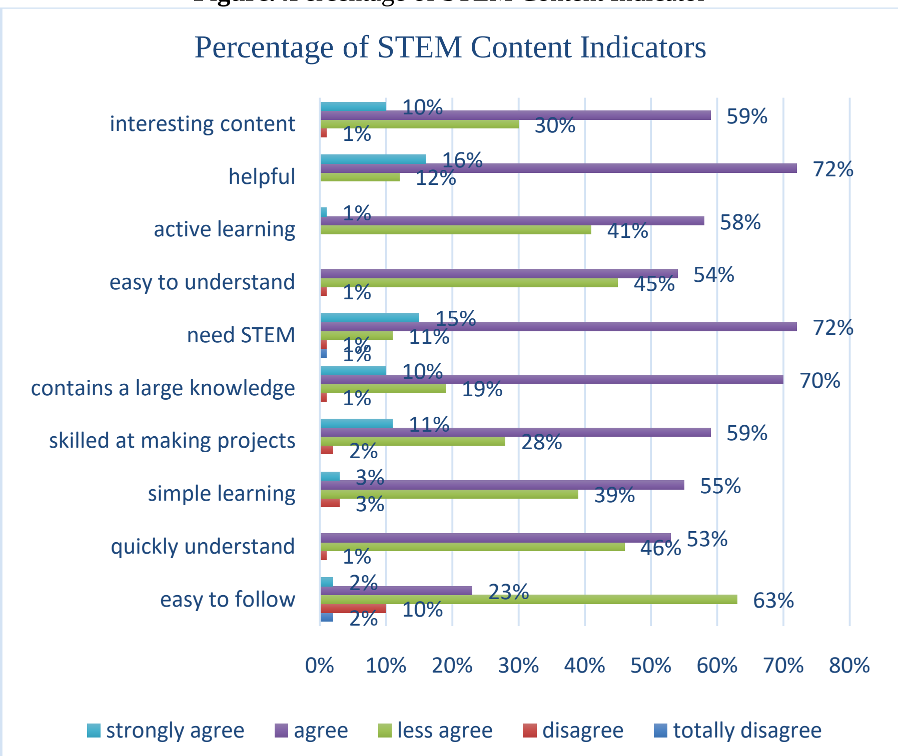
The results of processing and analysis of STEM career statement data are shown in Figure 3. In general, the results of the research on each STEM career statement provide information that most students agreed to have a STEM career. 62% of students agreed that being able to do science makes it easy for them to cooperate with others, 52% of students agreed that their opinion about scientists can make a big difference to the world, 62% of students agreed that science is a challenge in their future, and 36% agreed that if there is a natural disaster problem, they find it difficult to solve the disaster problem. Moreover, 57% of students agreed they want to participate more in STEM. Based on these data, in general, most students agreed with statements 1,2,3, and 5. Whereas in statement number 4, 46% of students said that they disagreed with the statement "if there is a problem with natural disasters, I find it difficult to solve the disaster problem”. When viewed from the results of the questionnaire, students provided information that they did not agree that solving problems is difficult. But the fact that during the learning activity, researchers obtained information from the teacher that students had difficulty solving problems when given problems during STEM learning. This occurred because the students were lack of self-assessment. Self-assessment is an assessment technique in which students are asked to assess themselves in relation to the process and level of competencies they have learned in certain subjects based on the references or criteria that have been prepared.

Figure.3 Percentage of STEM Career Indicator



The results of processing and analysis of STEM content statement data are presented in Figure 4. In general, the results of the research on each STEM content indicator provide information that most students agreed with the STEM content statements. Based on these data, it was found that 63% of students said that they disagreed with the statement "STEM learning is easy for me". This can be seen from the process of making a STEM project. It is in line with the statement of their teacher saying that students needed much time to make a project.

Figure.4 Percentage of STEM Content Indicator



4.Conclusion

After processing data on STEM interests, careers, and content, the results of students' perspectives on interest in STEM learning through science learning were mostly in the positive category of 64%. Most of the students 'perspectives on STEM learning careers through science learning were mostly in the positive category of 80% and the students' perspectives on STEM learning content through science learning were mostly in the positive category by 62%.

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