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Students Attitudes towards STEM based on Gender

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Abstract

Increasing demand for workers at various skill-levels in the fields of Science, Technology, Engineering, and Mathematics (STEM) is motivating government and schools to increase the quality of graduates with STEM competencies. Teachers and institutes have been working to develop integrated education programs. One of their efforts is implementing STEM integrated learning. The purpose of this study was to investigate students attitudes towards STEM differed by gender through survey study. The participants were 52 seventh grade junior high school students (69,23% female and 30,77% male) who were studying at Junior High School in Aceh. Questionnaires were used to examine students attitudes towards STEM after integrated STEM learning was conducted in mathematics lesson. The results of this study indicate that female students showed more positive results compared to male students in all component of STEM. The results also indicated that technology/engineering became the dominant preference among male students and following by 21st century skill and mathematics. Meanwhile, 21st century skill became the dominant preference among female students and following by technology/engineering and mathematics.

***Keywords*—Students attitude, STEM, gender**

I. INTRODUCTION

In the 21st century, STEM learning is used so that students have scientific and technological literacy. This can be seen from students when reading, writing, observing, doing and being able to develop and apply what they already have in solving problems related to STEM learning (National STEM Education Center, 2014). Rather than teaching the four disciplines as separate and discrete subjects, STEM integrates them into a cohesive learning paradigm based on real-world applications (Hom, 2014)

The national economy is said to benefit from the integration of STEM (science, technology, engineering, and mathematics) education. Institutions and educators have been striving to offer the most integrated education package (David and Sharon, 2006). Enhancing students' problem-solving skills, independence, creativity, logical thinking, and technology literacy are just a few advantages of STEM education (Morrison, 2006). After applying STEM education, students are expected to be able to master science and technology literacy through reading, writing, observing, following skills involved in science activities, and able develop these skills to use in solving the problems of daily life. With this kind of insight, more countries are beginning to concentrate on the learning circumstances of their kids in the hopes that they can be enhanced by creating conditions that are suitable for STEM education.

Engaging students in high quality STEM education requires programs to include rigorous curriculum, instruction, and assessment, integrate technology and engineering into the science and mathematics curriculum, and also promote scientific inquiry and the engineering design process. In particular, the concept of STEM in Aceh became popular in recent years, especially in higher education level. It can be said that the concept is gradually developing in Aceh, Indonesia.

Therefore, it is important for a country to improve their creativity and competitiveness through STEM education.

Regarding the importance of synergies between science, technology, engineering and mathematics, then students need to be stimulated towards a positive attitude about them at the beginning. Gender has been found to have an interactive effect on attitudes and interest in STEM careers. Female students tend to have more negative attitudes toward science classes and careers than males (Cannon & Simpson, 1985; Weinburgh, 1995). Therefore, the purpose of this study was to investigate students attitudes towards STEM differed by gender.

II. STEM-PjBL

STEM is a learning approach that integrates four fields—science, technology, engineering, and mathematics—into a unified whole that is viewed holistically (Bybee, 2013). Therefore, STEM is considered a suitable approach to be applied in mathematics learning because it makes mathematics more tangible and relevant to various real-world domains. In 21st-century education, STEM is used to meet curriculum demands that require students to possess scientific and technological literacy. This can be observed when students are able to read, write, observe, perform, and further develop and apply their knowledge to solve problems related to STEM disciplines (National STEM Education Center, 2014).

One instructional model that can implement the STEM approach is the Project-Based Learning (PjBL) model. PjBL is a student-centered learning method facilitated by teachers, where students direct their own learning through collaboration and inquiry/discovery to research and create a project that reflects their understanding (Bell, 2010).

PjBL is an active, student-centered learning model characterized by student autonomy, constructive inquiry, goal setting, collaboration, communication, and reflection in real-world contexts (Kokotsaki, Menzies & Wiggins, 2016). The steps in implementing the PjBL model include formulating essential questions, designing project plans, creating schedules, monitoring students and project progress, evaluating outcomes, and reflecting on the experience (Ministry of Education and Culture, 2014).

The implementation steps of the PjBL model can be illustrated in the following Figure 1.

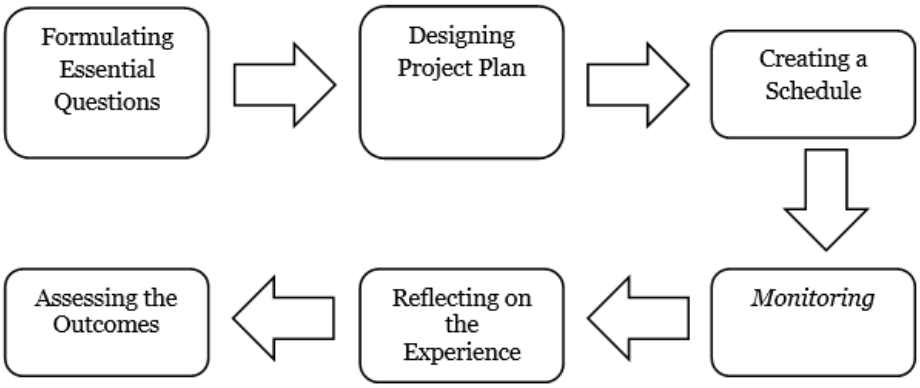

Fig. 1: Implementation Steps of the Project-Based Learning (PjBL) Model

Learning that adopts the Project-Based Learning (PjBL) model can assist teachers in enabling students to construct their knowledge through projects with collaborative guidance, ultimately producing a desired product. This instructional model emphasizes contextual learning through complex tasks or activities that students are required to complete. Learning through PjBL has been shown to enhance motivation, problem-solving skills, collaboration, resource management abilities, as well as critical and creative thinking skills (Wena, 2014).

STEM-based PjBL presents challenges and motivates students to think creatively (Lestari, 2018). The benefits of the STEM-PjBL approach include increasing students' interest in learning and fostering active learning through processes such as constructing, designing, and producing student-generated outcomes (Belland et al., 2017). Therefore, applying STEM-PjBL in learning can provide students with new experiences that activate, encourage, and enhance their learning motivation and engagement.

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III. METHOD

The purpose of this study was to investigate students attitudes towards STEM differed by gender through survey study. This study was conducted in first semester of academic year 2019/2020 in Junior High School in Aceh. The participants were 52 seventh grade junior high school students (69,23% female and 30,77% male) who were studying STEM integrated learning in mathematics lesson, more precisely in ratio and scale chapter. Students must use their abilities in STEM fields (except Science) and 21st century abilities in group learning to achieve learning goals. Students are divided into 3 to 4 people in each group. Each group was assigned to create a house plan using the ratio and scale concept manually and using sketchUp software.

After the integrated STEM mathematics learning process is conducted, the students 'attitude questionnaire are conducted to determine the students' attitudes towards STEM learning. To measure students' attitudes towards STEM learning, researchers used a questionnaire developed by Friday Institute for Educational Innovation (2012) which consisted of three dimensions of assessment namely mathematics, technology/engineering and 21st century abilities as in Table 1 to table 3 below.

Table 1: Students attitudes towards STEM in mathematics.

1	Math has been my worst subject.
2	I would consider choosing a career that uses math.
3	Math is hard for me.
4	I am the type of student to do well in math.
5	I can handle most subjects well, but I cannot do a good job with math.
6	I am sure I could do advanced work in math.
7	I can get good grades in math.
8	I am good at math.

Table 2: Students attitudes towards STEM in technology/engineering

1	I like to imagine creating new products.
2	If I learn engineering, then I can improve things that people use every day.
3	I am good at building and fixing things.
4	I am interested in what makes machines work.
5	Designing products or structures will be important for my future work.
6	I am curious about how electronics work.
7	I would like to use creativity and innovation in my future work.
8	Knowing how to use math and science together will allow me to invent useful things.
9	I believe I can be successful in a career in engineering.

Table 3: Students attitudes toward 21st Century Skills

1	I am confident I can lead others to accomplish a goal.
2	I am confident I can encourage others to do their best.
3	I am confident I can produce high quality work.
4	I am confident I can respect the differences of my peers.
5	I am confident I can help my peers.
6	I am confident I can include others' perspectives when making decisions.
7	I am confident I can make changes when things do not go as planned.
8	I am confident I can set my own learning goals.
9	I am confident I can manage my time wisely when working on my own.
10	When I have many assignments, I can choose which ones need to be done first.
11	I am confident I can work well with students from different backgrounds.

IV. RESULTS AND DISCUSSION

Questionnaire students attitudes towards STEM learning measure separately the attitudes of students towards mathematics (8 items) and technology/engineering (9 items). This questionnaire uses a five-point Likert response scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree) and measure self-efficacy. The next 11 items measure the attitudes of students towards 21st century skills.

In general, the results of this study indicate that 21st century skills is the most dominant dimension with a

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mean of (4.10) and standard deviation of (0.96), followed by technology/engineering dimension with a mean of (3.99) and standard deviation of (0.93). Meanwhile, the dimension of mathematics appeared in the last rank with a mean of (3.25) and standard deviations (0.96). The two top dimension (21st century skills and technology/engineering) show better results compared to the total of mean (3.78). The dimension of mathematics at the last position shows lower results compared to the total mean (3.78). This indicates that mathematics is a subject that is considered difficult by most students. This is shown in the table 4 below.

Table 4: Summary of the degree of attitude towards STEM

Dimension	Mean	SD	Rank
Mathematics	3,25	0,96	3
Technology/Engineering	3,99	0,93	2
21st Century Skills	4,10	0,76	1
Total	3,78	0,88	

When comparing female and male student attitudes toward STEM, generally the result of this study indicate that female students showed more positive results than male students in all dimension of STEM, as shown in the following figure 2.

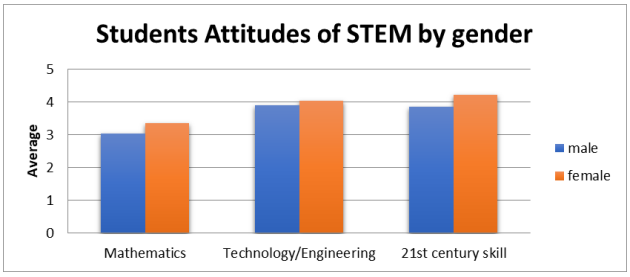

Fig. 2: Students Attitudes toward STEM based on gender

The results of this study also indicated that technology/engineering became the dominant preference among male student and following by 21st century skill and mathematics. Meanwhile, 21st century skill became the dominant preference among female student and following by technology/engineering and mathematics, as shown in the Table 5 and 6 below.

Table 5: Summary of the degree of attitude towards STEM

Dimension	M	SD	Rank
Mathematics (M)	3,04	0,93	3
Technology and Engineering (TE)	3,90	1,00	1
21st century skill	3,86	0,89	2

Table 6: Summary of the degree of attitude towards STEM

Dimension	Mean	SD	Rank
Mathematics	3,35	0,95	3
Technology/Engineering	4,03	0,90	2
21st Century Skills	4,21	0,67	1

Mathematics was the least popular subject within STEM learning. The results of the interview raise the issue that the majority of students found difficulties during mathematics education. This might cause students to have insufficient competence to work well in mathematics compared to the other subjects. Similar results can be seen in Stone et al. (2008) study. They argued that students' low interest in learning mathematics was due to the perceived difficulty of the subject. Moreover, Bingolbali et al. (2007) further suggested that the major reason for students' low interests in learning mathematics was because its principles are difficult and time consuming to understand. Furthermore, the results suggested that students actually realized the importance of mathematics. They recognized that mathematics is a fundamental subject that is essential to learning, so they have to learn it even if it is difficult. Bingolbali et al. (2007) argued that the major reason for students wanting to learn mathematics was that it is strongly related to their further career and real world lives. Students who are planning to become mechanical engineers especially see mathematics as an important foundation of expertise. Educational authorities need to increase the effectiveness of instruction in mathematics in the future and further encourage an increase in learning interest.

V. CONCLUSION

When comparing female and male student attitudes toward STEM, generally the results of this study indicate that female students showed more positive

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results compared to male students in all component of STEM. The results of this study also indicated that technology/engineering became the dominant preference among male student and following by 21st century skill and mathematics. Meanwhile, 21st century skill became the dominant preference among female student and following by technology/engineering and mathematics.

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