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STEM literacy load analysis on the planning and implementation of science learning on the topic of simple machine

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Abstract. The purpose of this study was to determine STEM literacy in the planning and implementation of science learning on the topic of simple machine. This research method is a descriptive qualitative method. Data were obtained using observations, document analysis, and interviews, which involved 200 junior high school science teachers in six districts of Lampung province, data analyzed with percentage. The results of STEM literacy analysis on the planning of natural science learning on the topic of simple machine have a high category of planning average (61%) and the average category of implementation is also of a high category (65%). Data analysis shows that learning science in simple machine material had integrated STEM but focused more on science and rarely used technology in student learning. Also, teachers realize that applying the STEM approach makes student learning more relevant, stimulates the emergence of meaningful experiences, encourages students to think higher and solve problems and increase retention. So that by the demands of the revolutionary education era 4.0.

1. Introduction

The objectives of science education include knowledge and understanding, exploration and discovery, imagination and creativity, attitude and science, and application [1]. Science has the characteristics that distinguish it from other fields of science, namely having scientific value, systematically arranged, theoretical knowledge, and relating a series of concepts and concept charts that have developed as a result of experiments and observations that are useful for further experimentation and observes. Science must be viewed from 4 dimensions, namely as a way of thinking, a way to investigate, as a body of knowledge, and its interactions with technology and society [2]. So every science learning activity must include 4 dimensions so that the purpose of science education can foster students with scientific literacy.

Science literacy is a person's ability to understand science, communicate science, and apply science knowledge to solve problems so that they have a high attitude and sensitivity towards themselves and their environment in making decisions based on scientific considerations [3]. Scientific literacy is important to be mastered by students concerning the way that students can understand the environment, health, economy, and other problems faced by modern societies which are highly dependent on technology and progress, and the development of science [4].

Based on TIMSS (Trend in International Mathematics and Science Study) and PISA (Program for International Student Assessment) surveys. The ability of scientific literacy of students in Indonesia is still lacking, this is evidenced in the results of TIMSS and PISA in Indonesia is still in the bottom order, namely in the order of 62 out of 70 countries in children aged 15 years who participated in the field of scientific literacy with a score of 403. Students in Indonesia obtained the results achieved are still far from satisfying. This shows the ability of Indonesian students to apply science knowledge in different situations around 0.8% and still below the OECD average of 15.3%. Indonesian students who have not been able to identify science problems and interpret data are around 42.3% and are still above the OECD average of 13% [5].
The lack of scientific literacy because students in Indonesia are less trained in solving contextual questions, demand reasoning, argumentation and creativity in solving them, and questions that are not yet charged with STEM literacy, where those questions are characteristic of TIMSS questions, these questions demand students to think low level to high level [6]. To improve students' STEM literacy abilities, teachers begin to introduce and teach material by using various strategies that have STEM literacy aspects, including learning the material through experiments that stimulate high-level, contextual thinking.

Contextual science learning is related to technological development and innovation or engineering to help students think critically and creatively, following the curriculum that runs in Indonesia, the 2013 curriculum that directs students to support 21st-century abilities, namely communication, collaboration, critical thinking, and creative. One approach that can support the 21st century is by integrating the STEM approach in learning. STEM is a global movement in educational practice that integrates with various patterns of integration to develop the quality of human resources in accordance with the demands of 21st-century skills, and STEM-based science learning as one form of STEM education is compatible with the current curriculum system in Indonesia [7].

Integrating and implementing STEM approaches in the curriculum in Indonesia is not easy, it requires the creativity and skills of educators to integrate the learning process based on the curriculum by integrating and implementing aspects of STEM so that learning outcomes can create students who are ready to face the world of work in the 21st century, namely students who have the ability and ability to solve everyday problems that cannot be separated from the use of technology and innovation, so many parties must work hard in efforts to improve the quality of education in Indonesia [8]. This study aims to analyze the STEM literacy load in the planning and implementation of science learning on the topic of simple machine.

2. Research Methods

This research uses a descriptive qualitative method. Data obtained using observation, document analysis, and interviews, involving 200 junior high school science teachers in six districts of Lampung province, such as Pesisir Barat, Tanggamus, Central Lampung, East Lampung, Metro City, and Bandar Lampung City. This research is centered on the needs and development of STEM literacy load analysis on the planning and implementation of science learning on the topic of simple machine in SMP Lampung province. To interpret the results of the STEM literacy charge interview analysis on the planning and implementation of science learning on the topic of simple machine. The following interview criteria for STEM literacy content in the planning and implementation of science learning on the topic of simple machine [9] are seen in Table 1. Data were analyzed using a percentage.

Table 1. Criteria for interviewing STEM literacy loads in the planning and implementation of science learning on the topic of simple machine

Percentage	Criteria
0,00 – 20,00	Very Low
20,10 – 40,00	Low
40,10 – 60,00	Moderate
60,10 – 80,00	High
80,10 – 100,00	Very High

3. Results and Discussion

The results and discussion of this data obtained in the form of an interview analysis of STEM literacy content in the planning and implementation of science learning on the topic of simple machine. The data can be seen in Table 2.

Table 2. Results of STEM literacy load interviews on the planning and implementation of science learning on the topic of simple machine (n = 140)

No.	Statment	Precentage (%)	Criteria
1.	Planning		
	a. The implementation of the 2013 curriculum focuses on mastering literacy by students	64	High
	b. Already trained students to have scientific literacy	71	High
	c. Have measured the ability of students' scientific literacy	56	Moderate
	d. Measure students' scientific literacy skills using worksheets	53	Moderate
Average		61	High
2.	Implementation		
	a. The teacher needs STEM literacy	100	Very High
	b. The teacher has planned and implemented STEM literacy from the LESSON PLAN	30	Low
Average		65	High

Based on Table 2. shows that the implementation of the 2013 curriculum focuses on mastery of literacy in the high category (64%), the teacher has trained students to have scientific literacy in the high category (71%), the teacher has measured the ability of scientific literacy of students in the medium category (56%), teachers have measured the ability of scientific literacy by using worksheets in the medium category (53%), teachers need STEM literacy in very high categories (100%), teachers have planned and implemented STEM literacy from lesson plan in the low category (30%). So the average planning has a high category (61%) and the average category of implementation is also in the high category (65%).

Analysis of the suitability of the STEM literacy lesson plan component was obtained from school surveys from each school in six districts of Lampung province, teachers of science subjects presented in Figure 1. below.

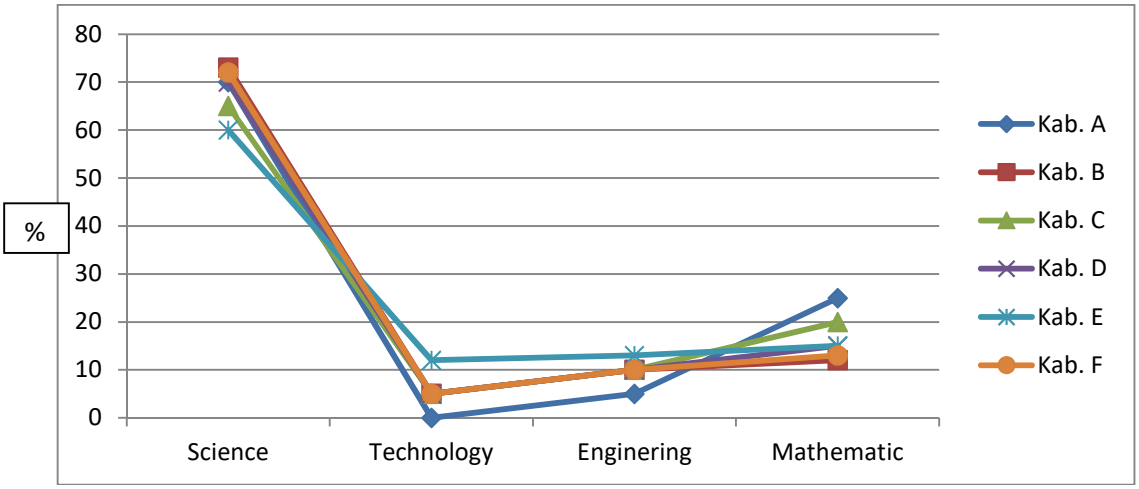

Figure 1. Compatibility of STEM literacy lesson plan components (n = 60)

Figure 1. shows that the analysis of the suitability of STEM literacy lesson plan components in district 1 was the highest percentage, namely 70% science, and the lowest was 0% technology. Regency 2 has the highest percentage of science with 73% and the lowest with 5% technology. Regency 3 the highest percentage of science is 65% and the lowest is technology 5%. Regency 4 has the highest percentage of science at 70% and the lowest is technology at 5%. District 5 the highest percentage of science is 60% and the lowest is technology 12%. Regency 6 has the highest percentage of science at 72% and the lowest is technology at 5%. Based on the results of Figure 1, it was revealed that the science learning plan for simple machine material was integrated with STEM but focused more on science and rarely used technology.

Simple machine material in science learning in junior high school integrates levers in the human body. In studying simple machine material students will learn about the concept of levers contained in the human body as well as the technology that will be used in everyday life. Simple machine material can also explain the benefits that can make it easier for humans to work in daily activities. This material is under the learning STEM (Science, Technology, Engineering, and Mathematics), in this case, students will learn about the concept of science, namely how muscles can move the human body that has similarities with the work system on the lever. The technology in this material is a variety of lever technology that can facilitate human work. Engineering on this material is about the design, design, and manufacture of better lever technology. The mathematics in this material is used to calculate the mechanical advantage of the lever.

Based on the results of Figure 1 the simple machine material lesson plan component is complete but in reality is contrary to the results of Table 1 (No. 6) namely planning and implementing STEM literacy from the lesson planhas a low category (30%). This is allegedly due to the copy-paste of lesson planfrom fellow teachers and the internet. This was made clear in the interviews of several teachers who explained that the lesson plans used in learning were only for completing the learning tools so that the contents contained in the lesson plans were not seen. Also, several reasons teachers have not implemented integrated science learning include the fear of teachers about the content of curriculum materials not being delivered and the absence of examples of integrated science learning in several books. [10]

The current implementation of the curriculum results in pressure for teachers to adopt different pedagogies, which place more emphasis on developing 21st century student skills, student-centered approaches, and active learning [11], with the STEM approach teachers can apply integrative approaches that are linked with a national curriculum, educational models, awards, and support in the context of

school-specific students [12]. STEM education was developed to produce meaningful learning through the systematic integration of knowledge, concepts, and skills [13]. Integrated STEM literacy is supported by intentional integration of two or more disciplines (science, technology, engineering, mathematics), and potentially with other subject areas, focusing on authentic problem solving or product creation, including the application of engineering design processes (eg brainstorming, creating, testing, improving) [14].

The integration of the STEM approach will help students in analyzing and solving problems that occur in real life so students are ready to work [15]. Integration in STEM subjects will be more effective when using a strategic approach in its implementation to make students learn more relevant, stimulate the emergence of meaningful experiences, encourage students to think at a higher level and solve problems and increase retention [16]. Learning activities that are integrated with STEM can be an alternative solution to serve all the skills needed in the 21st century. [17].

One strategy that can be combined in cooperative learning is scaffolding. Scaffolds are dynamic, situation-specific aid provided by a peer teacher to help the learning process. Scaffolding requires teachers to continuously diagnose the understanding of learners and provide timely support based on student responses [18]. Scaffolding model comprised three steps facilitated by the teacher/mentor: modelling, demonstrations, and building frameworks. Engin noted that teacher and learner needed to fully understand their roles for successful scaffolding and that effective communication was also critical [19]. So the importance of providing scaffolding to teachers and students in optimizing the growth of STEM literacy in science learning [20, 21].

4. Conclusions

Based on the results and discussion, it can be concluded that the average teacher in designing planning has a high category (61%) and the average category of implementation is also categorized high (65%). The lesson plans used in science learning, especially simple airplane materials, are more focused on science and rarely use technology. The STEM approach is carried out through assignments that require a prior study of the basic competencies to be achieved by students so that the combination of STEM subject integration can be aligned with the applicable curriculum in Indonesia. Implementation of the STEM approach makes students more relevant learning, stimulates the emergence of meaningful experiences, encourages students to think at a higher level and solve problems and increase retention. Learning evaluation tool planning is also expecteddemanding aspects of STEM literacy.

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