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The prospective science teaching material based on Integrated-STEM approach: Analysis of teachers and students expectations

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Abstract. The implementation of learning in Indonesia is expected to prepare graduates to be able to face the 21st century. One factor that determines competent graduates is teaching material. Teaching material is an important factor in supporting the learning process. However, in learning there are still many print science teaching materials used, science teaching materials downloaded from internet sites and there are no science teaching materials based on integrated STEM approach. This study aimed to describe and analyze the expectations of teachers and students for science teaching materials based on Science, Technology, Engineering, and Mathematics (STEM). The study was conducted in Junior High School in Lampung Province in 8th grade involving 120 students and 50 Science teachers. The method used in this study was mixed method with Sequential Explanatory Strategy. The research instrument used observation, questionnaires and interviews. The results showed that to support STEM-based learning, future science teaching materials were needed included interactive books, e-worksheets, video animation, stimulation and virtual lab. Materials needed in the development of science teaching materials include the pressure of substances and their application in daily life. In the 2013 curriculum the teacher had not prepared science teaching materials based on integrated STEM approach. So in the future it is necessary to develop science teaching materials based on integrated STEM approach to support the learning process that is designed to the maximum and integrated with technology.

1. Introduction

Learning conducted in Indonesia is expected to prepare competent graduates to be able to face the challenges of the 21st century [1]. One factor that determines competent graduates is teaching material [2]. Teaching material is an important factor in supporting the learning process [3], [4]. Teaching material has several functions, namely as a guide for teachers, guidelines for students and as a learning evaluation tool [5]. The learning process by using teaching materials can increase the value of knowledge, value of skills, and attitudes of students [6].

Types of teaching materials based on the subject consist of [7]: (1) teaching materials that are deliberately designed for learning such as books, handouts, student worksheets and modules (2) teaching materials that are not designed but can be used for learning such as newspapers, clippings, films,



advertisements, or news, in addition, the directorate of high school development classifies teaching materials into four categories namely visual teaching materials, audio teaching materials, audio visual teaching materials, interactive multimedia teaching materials and web-based teaching materials.

The results of preliminary observation conducted at Junior High School in Lampung Province showed that 85% of student stated that teaching materials used in learning in schools were print form and only 15% of student responses using downloadable teaching materials from internet websites and 68% of student responses stated that there were no teaching materials integrated with the integrated STEM approach. In addition, 77% of the responses of Science teachers stated that they had never applied STEM based learning due to the lack of teacher knowledge about the application of STEM based learning [8]. Even though STEM-based learning is an integration of science, technology, engineering, and mathematics learning that is suggested to help train students' creative thinking skills. [9].

Creative thinking skill becomes important things that need to be instilled in every learning according to the mandate of the 2013 curriculum on aspects of the competency standard of junior high school / MTs graduates [10]. Science teaching materials integrated with STEM is expected to train students' creative thinking skills, namely science in finding concepts, technology that can be taught by explaining various applications of technology related to the material, throughs students technique can be taught to make simple tools related to material and mathematics used to formulate mathematical equations related to the concept of matter as well as in terms of calculations [11].

STEM is very well applied in learning because STEM-based learning is able to create a cohesive learning system and active learning because all four aspects are needed simultaneously to solve problems [12], [13]. The implementation of these four aspects is student can do work in accordance with the skills and can reduce the unemployment rate. STEM is suitable to lead the development of student skills [14]. STEM education has become a worldwide trend [12], [13], [15], [16]. However, in Indonesia STEM has not received special attention and the reality of what is happening to teachers in Indonesia is still unknown about the application of STEM-based teaching materials. Previous research developed teaching materials in the form of STEM-based worksheet [17], applying STEM learning [18] - [19]. While this study analyzes the components that need to be present in future STEM-based Science teaching materials in the perspective of teachers and students.

2. Methodology

This research was mixed method research. The mixed method strategy used was Sequential Explanatory. The study was conducted in Junior High School / MTs Lampung Province. Research subjects in class VIII consisted of 120 students and 50 Science teachers. Data collection used observation instruments, questioners and interviews. The questionnaire was given to 120 students and 50 Science teachers to find out the teaching material used during the learning process. The questionnaire was analyzed quantitatively and the interview was analyzed descriptively qualitatively.

Table 1. Interpretation of teacher and student perception of science teaching materials based on integrated STEM

Interval %	Favorable	Unfavorable
$75 < x \leq 100$	Strongly agree	Disagree
$50 < x \leq 75$	Agree	Less agree
$25 < x \leq 50$	Less agree	agree
$0 < x \leq 25$	Disagree	Strongly agree

Interviews was conducted on 4 Science teachers to find out teaching materials that are often used in learning. The following are the teacher code interviewed by researchers:

Table 2. Interview code for science teachers

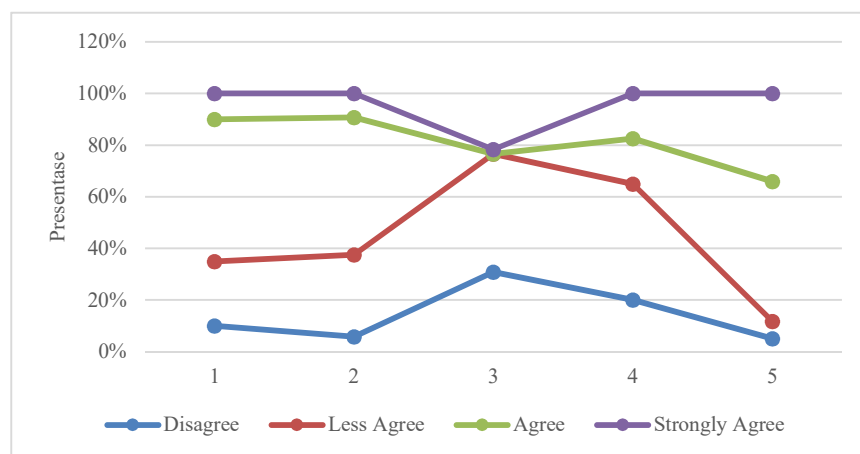
Code	Education Field	Teaching Experienced
MS	Science	5 year
CP	Science	5 year
LW	Science	15 year
RD	Science	12 year

3. Results and Discussion

The following detail results related to the expectations of students and Science teachers on STEM-based teaching materials.

Table 3. Results of student *questioner* to science teaching materials

No.	Statement	Disagree	Less Agree	Agree	Strongly Agree
1	I use audio visual learning media	10,00% (n = 12)	25,00% (n = 30)	55,00% (n = 66)	10,00% (n = 12)
2	I use non-electronic teaching materials in the learning process	5,80% (n = 7)	31,70% (n = 38)	53,30% (n = 64)	9,20% (n = 11)
3	I do not need interactive teaching materials	30,80% (n = 37)	45,80% (n = 55)	21,70% (n = 26)	1,70% (n = 2)
4	Teachers deliver science material with stimulation videos and animations	20,00% (n = 24)	45,00% (n = 54)	17,50% (n = 21)	17,50% (n = 21)
5	I use technology in learning	5,00% (n = 6)	6,70% (n = 8)	54,20% (n = 65)	34,20% (n = 41)

**Figure 1.** Results of student questioner graphic to science teaching materials

In Figure 1, 55% of students stated that they used audio visual learning media from Science and audio only more often, or only 53.3% of students said they used non-electronic books from Science and electronic books more often. 45.8% stated students need interactive media, 45% delivery of science material with the addition of stimulation videos, animations, and 54.2% of students stated utilizing technology in learning. Based on Table 3 it can be concluded that (1) student used audiovisual learning media, (2) lack of use of electronic teaching materials, (3) the need of interactive teaching materials (4)

easy to understand material with interactive teaching materials, (5) utilize technology in the learning process.

Table 4. The results of teacher *questioner* result to science teaching materials

No.	Statement	Disagree	Less Agree	Agree	Strongly Agree
1	I use learning media during teaching	4,00% (n = 2)	22,00% (n = 11)	54,00% (n = 27)	20,00% (n = 10)
2	I use non-electronic teaching materials in the learning process	16,00% (n = 8)	40,00% (n = 20)	34,00% (n = 17)	10,00% (n = 5)
3	I do not need interactive teaching materials	38,00% (n = 19)	42,00% (n = 21)	14,00% (n = 7)	6,00% (n = 3)
4	I know STEM-based learning	30,00% (n = 15)	45,00% (n = 22)	15,00% (n = 8)	10,00% (n = 5)
5	I use technology in learning	20,00% (n = 10)	17,49% (n = 9)	45,00% (n = 22)	17,51% (n = 9)

In Figure 2, 54% of teachers stated that they had used learning media during teaching, 40% of teachers said they used non-electronic teaching materials more than Science and electronic teaching materials. The teacher stated that they need interactive teaching materials by 42%. The teacher said that they did not know about learning using the STEM approach and 45% of the teacher stated that they used technology in learning and needed teaching materials that are integrated with technology, (can use computers and Android smartphones). Based on Table 4 it can be concluded (1) Teachers used learning media (2) lack of electronic teaching materials, (3) require interactive teaching materials (4) lack understanding of STEM-based learning (5) utilize technology in the learning process

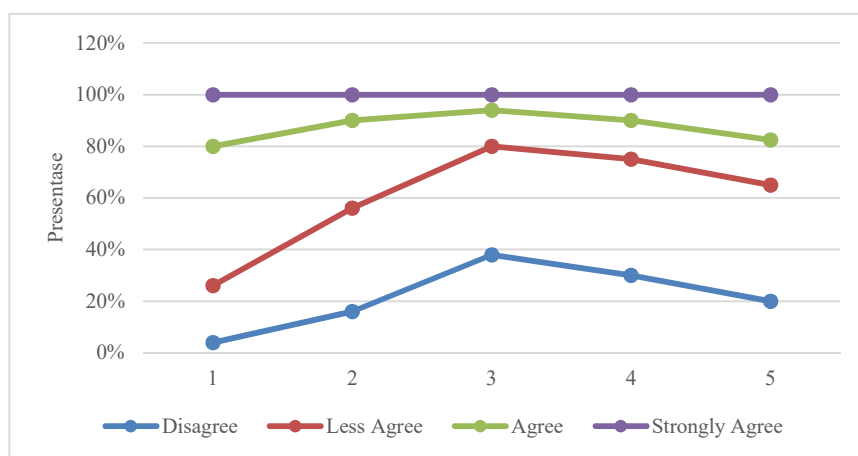


Figure 2. The results of teacher questioner to science teaching materials

Table 4 and Figure 2 are strengthened by interview results with 4 Science teachers. It is known that all teachers stated that using media when teaching such as figures, graphs, diagrams, practical tools and PowerPoint. Several simple practical tools and materials used were obtained from the surrounding environment (MS). Teaching materials commonly used by teachers in the learning process were printed books provided at school, books in the library, modules (CP), e-worksheet downloaded from the internet (RD), printed worksheet (LW), and other teaching materials downloaded from internet (MS).

The need of integrated teaching materials with technology can be used on computer devices, smartphones and easily accessed anywhere (CP, RD and LW), because it can facilitate the learning process and be more efficient (MS). One of them is e-worksheet teaching material needs to be applied

because there is no teaching material that discusses the material in detail and it is packed up in such a way (RD, MS), but to be implemented it is necessary to look at the situation and condition (MS). Components that must be present in teaching materials are IC, basic competency, indicators, objectives, concept maps, figures, animated videos, stimulation, easy language, knowledge, simple experiments, virtual labs and exercises.

As for the learning process in the class known that teacher has not fully implemented STEM-based learning (CP, LW), and not all the material has been applied because it requires extensive skills the STEM-based learning (RD, MS). Through STEM-based learning, students are expected not only to memorize concepts, but also students can understand and comprehend the concepts of science and their linkages in daily life [11].

Based on the results of previous studies, one of the things that need to be considered in conducting learning is teaching materials because it supports better learning [20], [21]. The learning process that uses teaching materials has a significant influence on improving student competence covering three aspects, namely students' knowledge, attitudes, and skills [22]. Quality teaching materials will generate qualified graduates because the main source of teaching materials is improving knowledge. Teaching materials have been developed and applied in previous studies to improve the quality of graduates [18], [23] - [26].

The importance of providing scaffolding strategies by teachers is closely related to the characteristics of the Science ability in developing learning media [27-28]. The provision of scaffolding strategies for students can maximize the skills possessed by students [29]. As for some indicators to maximize students' creative thinking skills regard to achievement of learning outcome, achievement of student learning activities, achievement of teacher performance, and positive student responses [30].

This study analyzed future Science teaching materials based on STEM. Based on observations, questioners and interviews that consist of (1) teaching materials in the form of interactive books, e-worksheet, video animation, stimulation and virtual lab. To date teacher's teaching materials have not been integrated with STEM; (2) the components of teaching materials included KI, KD, indicators, goals, concept maps, figures, video animations, stimulation, easy language science, simple experiments, virtual labs and practice questions; (3) Scaffolding strategy is very closely related to the characteristics of the ability of Science in developing learning media and can train students' creative thinking skills; (4) Science material on teaching material that is the pressure of substances and the application in everyday life.

Based on the analysis of teacher and student expectations, the hypothetical model of Integrated STEM science teaching materials is shown in Figure 3.

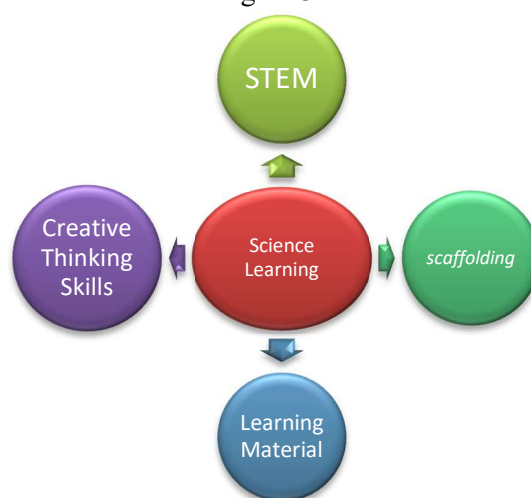


Figure 3. Hypothetical model of integrated STEM science teaching materials

As stated before, the integration of STEM in learning Science can increase student activity and creativity that is quite high, because students are trained to analyze a technology engineering and understand concepts well [31]. Integrated STEM in teaching materials begin by providing a problem or phenomenon to be able to train students' creative thinking skills so that STEM learning can develop when it is associated with the environment in daily life [11], [32]. STEM learning requires students to connect different STEM subjects, the integration of the subject begins with the identification of real problems occurs in the student environment by using high-level thinking and problem solving skills so that the conclusion can be drawn as an effort to solve the problem [33-35]. Based on the teacher's view of Science teaching materials as the way to increase student interest and involvement in STEM learning is by using multimedia that optimizes the wide utilization of information and communication technology (ICT) in teaching and learning STEM [12], [36].

4. Conclusion

Based on observation, questioners and interviews that the teacher had not made and applied science teaching materials with the integrated STEM approach, to support STEM learning required science teaching materials in the form of interactive books, e-worksheets, video animation, stimulation and virtual lab. The components of science teaching materials included KI, KD, indicators, goals, concept maps, easy language science, simple experiments, virtual labs and practice questions. It is expected that in the future it is necessary to develop science teaching materials based on integrated STEM approach to support the 2013 curriculum learning that is designed to the maximum and integrated with technology.

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