Teacher expectation towards interactive multimedia integrated with STEM in learning physics: Preliminary study on geometry optic learning material

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Abstrak: Recently, the challenge of industrial revolution 4.0 has become a discourse in education. Education is a way for a country to face the development of modern science and technology. So, in this time, education requires systematic preparation in making interactive teaching materials as one of the important components in the learning process. This study aims to describe and analyze the perceptions of teachers and students about interactive teaching materials integrated STEM in physics learning. The study was conducted in high school in Bandar Lampung in class XI involving 133 students and 12 physics teachers. The method used is mixed method. The research instruments used were questionnaires and interviews. The results of the study show that the teacher has not fully used teaching materials with interactive multimedia, and the teaching materials used have not been integrated with Science, Technology, Engineering, and Mathematics (STEM), the kind of teaching material that is needed by students and teachers is teaching material that is interactive and integrated with STEM. STEM make it possible to students to explore their ability in Science, Technology, Engineering, and Mathematics.So, it is necessary to develop interactive teaching material integrated with STEM to face the challenges of the Industrial Revolution 4.0 and fulfill competency standards in the 21st Century. The lesson needed for developing interactive teaching materials is geometry optic.

1. Introduction

Education is currently facing the challenges of the Industrial Revolution 4.0 which requires students to compete globally [1]–[4]with the development of modern science and technology [5], [6]. In facing the development of science and technology, it is necessary to have the best facilities so that learning can achieve educational goals [6]–[8], so that education can produce graduates who are competent in the global competition [9]–[11]. One of the determining factors in creating competent graduates is interactive teaching materials [12], [13].

Teaching materials are a source of knowledge for students in schools that greatly support the process of teaching and learning activities [14]–[16]. By integrating teaching materials on technology, information and communication (ICT), students' learning motivation is expected to increase [17]–[19]. Interactive teaching materials require certain input from users to convey information through text, graphics, animated images, simulations and videos [20]. Usually interactive multimedia applications are designed to show specific results and provide feedback quickly [21], [22]. The types of teaching materials based on the subject are divided into: (1) teaching materials 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 [23]. In addition, teaching materials are grouped into four categories, including: (1) visual teaching materials including books, handouts, student worksheets, modules, brochures, leaflets, photographs, and models or prototypes; (2) audio teaching materials including cassettes, radios, vinyl records, and compact disk audio; (3) audio visual teaching materials such as compact disk videos and films; (4) interactive multimedia Computer Assisted Instruction (CAI) teaching materials, compact disk (CD) multimedia interactive learning and web-based teaching materials [24]. Then in the context of STEM education technology plays an important role, especially technology, information and communication [25].

The rapid change in education today requires students to have 21st Century competencies, they are: Communication, Collaborative, Critical Thinking, and Creativity[26]–[28]. 21st century learning focuses on students' abilities and learning skills [29]. But in learning science, especially physics, the part that students consider difficult is geometry optic [30]. Optical geometry is the study of phenomena related to light [31]. The effort that can be done to face this challenge is by integrating Science, Technology, Engineering, and Mathematics (STEM) in the learning process [32]–[35]. The importance of STEM integrated in education has been recognized by academics, government and society. In the future, STEM can bridge the gap between education and workplace with 21st century skills [36], [37]. But in Indonesia, STEM still has not received special attention, especially by teachers in Indonesia regarding the use of teaching materials integrated with STEM. Previous research has integrated STEM learning through robotics [38], and applying STEM learning [39]–[41]. While this study analyzes the perspective of the needs of students and teachers in interactive teaching materials integrated with STEM, so through this study we will know the kind of teaching materials needed to face the industrial revolution 4.0 and to improve 21st century skill.

2. Method

This study used mixed methods with the type of Sequential Explanatory Strategy. The research was conducted at a high school in Bandar Lampung, the subject of the study was a class XI IPA consisting of 133 students, and 12 physics teachers from several high schools in Lampung Province. The techniques used to collect data are questionnaire instruments and interviews. Questionnaires are given to 133 students to find out the teaching materials used during the learning process and the questioners. Questionnaires were analyzed quantitatively, then interviews were analyzed quantitatively and described qualitatively.

Table 1. Interpretation of Students' Perception about Physics Teaching Materials with Interactive Multimedia Integrated with STEM

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

Interviews were conducted to 12 physics teachers to analyze teaching materials that are often used in learning. The following is the teacher code interviewed by the researcher:

Table 2. Interview Code for Physics Teachers

Code	Gender	Subject	Degree	Years of Service
RU	Woman	Physics	Bachelor	21 years old
EN	Woman	Physics	Bachelor	18 years old
NH	Man	Physics	Bachelor	22 years old
AP	Man	Physics	Bachelor	10 years old
SU	Man	Physics	Bachelor	19 years old
SR	Woman	Physics	Bachelor	15 years old
NA	Woman	Physics	Bachelor	17 years old
HN	Woman	Physics	Bachelor	21 years old
RH	Man	Physics	Bachelor	22 years old
AS	Man	Physics	Bachelor	11 years old
IR	Man	Physics	Bachelor	9 years old
NU	Woman	Physics	Bachelor	15 years old

3. Results And Discussion

The following are the results of the research in detail regarding the perceptions of physics teachers and students oninteractive teaching materials integrated with STEM.

Table 3. Results of Student Questionnaire on Interactive Teaching Materials

No	Question	%	Category
1	I only use visual learning media	68%	Agree
2	I only use audio learning media	61%	Agree
3	I use audio visual learning media	78%	Strongly Agree
4	I use non-electronic modules in the learning process	74%	Agree
5	I use electronic modules in the learning process	61%	Agree
6	I don't use virtual laboratories in the learning process	66%	Disagree
7	I easily understand the lesson with text module teaching materials	63%	Agree
8	I easily understand the lesson with interactive teaching materials	81%	Strongly Agree
9	I only need text modules learning media	50%	Disagree
10	I don't need interactive learning media	81%	Strongly Disagree
11	Teachers deliver science material with stimulation or animation	67%	Agree
12	Teachers deliver science material with the Flipped classoom approach	61%	Disagree
13	Teachers deliver subject matter integrated with STEM (Science, Technology, Engineering, Mathematics)	49%	Disagree
14	I use mobile learning for the learning process	58%	Agree
15	My school is equipped with accessible wifi facilities	62%	Agree

Table 3 shows that students often use audio visual learning media, then students also often use print modules rather than electronic modules. Then students can better understand the subject matter by using interactive teaching materials rather than text modules, students need interactive learning media such as animation, demonstration and stimulation, teachers still rarely use the Flipped Clasroom approach in the learning process, and teachers have not integrated material with STEM, wifi facilities

are available which can facilitate the learning process and access to social media at school. Based on table 3, it can be concluded that in the learning process, Students: (1) use audiovisual learning media, (2) only a few use electronic modules, (3) easily understand the material with interactive teaching materials, (4) really need learning material interactive and (5) already using mobile learning in the learning process with available wifi facilities.

Table 4. Teacher's Questionnaire Results on Interactive Teaching Materials

Number	Question	Yes (%)	No (%)	Total	
				Yes	No
1	Do you use learning media in physics learning?	100%	0	12	0
2	Do you use teaching materials in physics learning?	91,66%	8,34%	11	1
3	Do you use teaching materials that are integrated with STEM (Science, Technology, Engineering and Mathematics)?	33,44%	66,66%	2	8
4	Are teaching materials that guide students in improving problem solving skills in physics learning needed?	100%	0	12	0
5	Do you use an approach to the physics learning process?	91,67%	8,33%	11	1
6	Do you use teaching materials using the Flipped Classroom approach?	33,44%	66,66%	2	8
7	Do you need interactive teaching materials?	100%	0	12	0
8	Should teaching materials can be accessed anywhere and accessed through mobile learning?	100%	0	12	0

Based on table 4, it is known that teachers have used the media in the physics learning process, but teachers still do not integrate learning material with STEM, the teacher really needs interactive teaching materials, then the teacher has used the learning approach, and teachers need teaching materials that can be accessed anywhere through mobile learning. This is supported by the results of the Teacher's interview. Teachers have used learning media such as power points, print modules and practicum tools (RU, AP, SU, SR), internet (EN, NA, HN, RH, AS), and made simple practicum tools as learning media (NH, IR, NU). The learning media that are used today are not fully representative, because they have to adjust several media in one learning (RU, AP, SU, SR), sometimes the material cannot be represented by the existing media (EN, NA, HN, RH, AS), they hope there is an interactive teaching material that is able to represent material in depth (NH, IR, NU). Teaching materials commonly used are printed books, print modules, and the internet (EN, NA, HN, RH, AS), articles, and materials from the internet (RU, AP, SU, SR), weaknesses of teaching materials used by teachers are that teaching materials cannot compete with current development (RU, AP, SU, SR), learning material that is not complete, then the language that is difficult to understand (NH, IR, NU), the modules used do not represent the entire material so learning is less effective and teachers do not have an interactive e-module that discusses the material in detail (EN, NA, HN, RH, AS).

Teaching materials needed by teachers are those that have components that are suitable for learning goals (NA), the content that must be present in teaching materials includes material, core competencies, basic competencies and indicators (HN, RH), the material must be interactive, such as video, animation, reality and fun design (AP, SU, SR), each material is explained in detail and clearly so that students can understand the material and apply it in their daily lives (IR, NU). Material that is difficult to understand such as geometry optic, especially in the reflection and refraction of light (EN, NA), so far the teacher is still having difficulty to teach those material (SU, SR) material that is

difficult to convey with practicum, provides animation, questions and interactive discussions (EN, NA, HN, RH, AS). So, it is important to give Scaffolding to the teachers to optimate the beneficial of ICT (information and communication of technology) on physics learning process [42], [43]. And then the teacher has not fully integrated the material with Science, Technology, Engineering, and Mathematics (STEM), RH and AS have integrated several materials with STEM. Special skills are needed to be able to integrate STEM in learning, and require interactive teaching materials to achieve learning goals with the help of interactive multimedia.

The following is the design of STEM integration in teaching materials according to the results of the observations and the interviews:

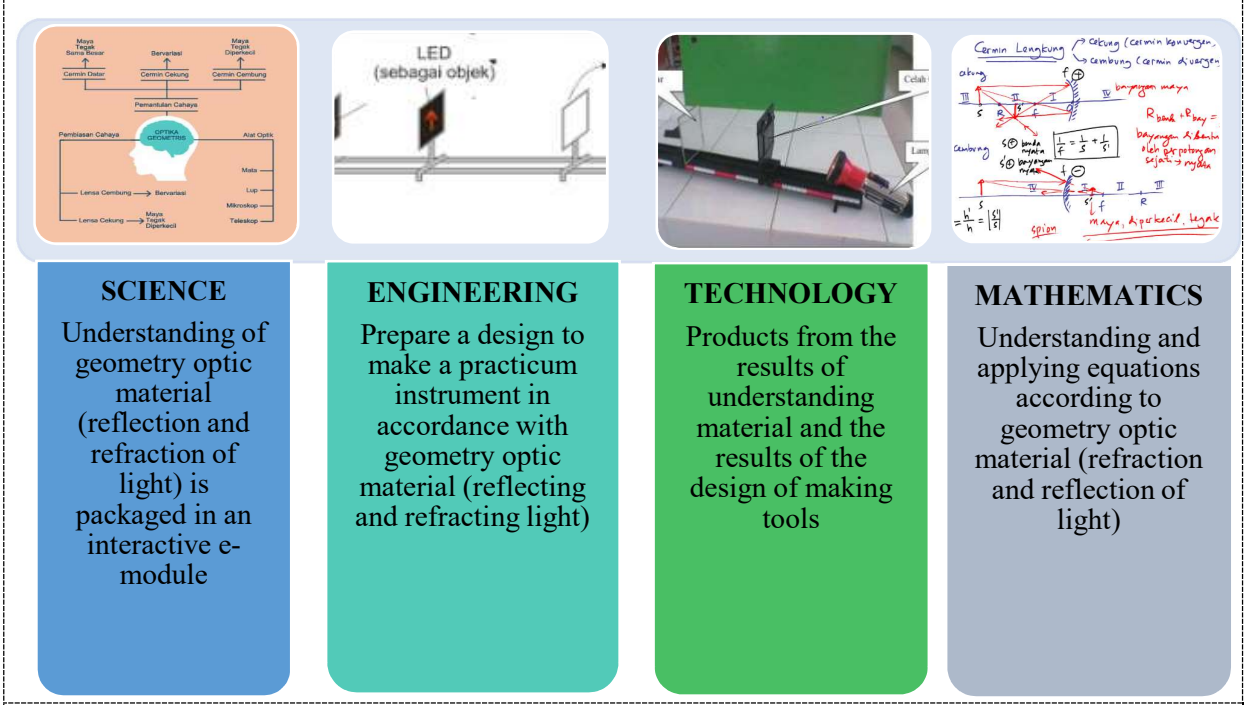

Figure 1. STEM Integration Design in Teaching Materials

Based on the results of the study, one of the few things that need to be considered in learning is the use of teaching materials, with quality teaching materials, we will get qualified graduates, because teaching materials are one of the sources to gain knowledge. Teaching materials have been developed and applied to research to improve the quality of graduates [39], [44]–[47]. Therefore, it is important to analyze the kind of teaching material that is needed by students and teachers to face the fouth industrial revolution. So, students and teachers will have the ability to compete globally.

Based on the results of the analysis, the kind of teaching material that is needed by students and teachers is teaching material that is interactive and integrated with STEM. STEM make it possible to students to explore their ability in Science, Technology, Engineering, and Mathematics. In this study, based on the interviews and the observations, the teaching materials needed are those based on interactive multimedia and integrated with STEM. The components that need to be included are: (1) interactive module components, including images, videos, animations, subject matter, internet links and summaries, (2) the components of teaching materials include: Core Competencies, Basic Competencies, indicators, goals, reality, definition, every material must be explained in detail, discussion of formulas and summaries, (3) video components, include: Core Competencies, Basic Competencies, objectives, indicators, up-to-date, using easy-to-understand language, complete and

material that is easy to understand, (4) the material expected in the interactive e-module is optical geometry (reflection and refraction of light).

4. Conclusion

Based on the results of the research and discussion it can be concluded that the teacher has not fully integrated the material with Science, Technology, Engineering, and Mathematics (STEM), the teaching materials used are not integrated with STEM, and the media used are not an interactive multimedia, so it is necessary to develop teaching material in the form of interactive electronic module integrated with STEM that is able to simplify the learning process especially on material that is difficult to understand. The design of interactive teaching material that is expected by students and teachers is: (1) interactive module components include images, videos, animations, learning materials and summaries, (2) in accordance to (Core Competencies, Basic Competencies, Indicators, and Learning Goals), (3) the language used is easy to understand and have complete material, (4) material expected in interactive e-module is optical geometry(reflection and refraction of light). And for the next research is expected to upgrade the teaching materials according to the skill needed in the fourth industrial revolution, so students will be able to compete globally.

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