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Need Analysis for Developing STEM Integrated Electronic Teaching Material of Alternative Energy to Promote Students' Creative Thinking Skills

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ABSTRACT

Twenty-first-century education requires students to possess several skills, one of which is creative thinking skills and student-centered learning, where teachers only act as facilitators to develop learning tools, one of which is teaching materials. This research aims to obtain an analysis of the need for the development of integrated STEM electronic teaching materials on alternative energy to enhance students' creative thinking skills. Data collection was carried out through teacher interview instruments, student characteristic questionnaires, and creative thinking skills test questions. Data were analyzed using descriptive statistical analysis techniques. The subjects of this study consist of one physics teacher and 30 students at SMAN 1 Payakumbuh District, as well as one physics teacher and 20 students at SMAN 1 Mungka District. Based on the data analysis conducted, three research findings were obtained. First, the constraints in the development of teaching materials and students' interest in electronic teaching materials in physics learning are categorized as very good with scores of 87.1 and 90.2, respectively. Second, the characteristics of students are categorized as good with a score of 73.5, and the characteristics of students consist of four aspects: students' interest in learning, students' attitudes, students' motivation to learn, and students' learning styles. Lastly, students' creative thinking skills are categorized as very poor with scores of 35.42 and 25.95. The research results indicate the need for a needs analysis for the development of integrated STEM alternative energy electronic learning materials to enhance students' creative thinking skills.

Keywords: *Electronic teaching materials; STEM; Creative thinking skills.*

I. INTRODUCTION

Education is very important in the development of a nation. Education can build and develop the potential that exists within the nation's generation. The potential of a ready generation must be able to face the challenges and problems of the 21st century. In the 21st century, Indonesian education faces more complex and different challenges compared to the past. These challenges have brought Indonesian education to a sharper point. It is important to think about how education can meet the needs of modern society. The role of education appears as a key in forming individuals who are ready to face and overcome various challenges. In addition to these challenges, Indonesian education is expected to be able to answer the challenges of the 21st century because education must be able to change the previous order of life through science and technology [1].

The demands of the 21st century make technology-based learning important. The orientation of 21st century learning requires education to be practical with high connectivity to learning resources [2]. 21st century skills are also known as 4C skills. These skills consist of critical thinking, communication, creativity and innovation, and collaboration [3]. In addition, 21st century learning emphasizes a student-centered approach with the aim of providing students with thinking skills, including: (1) critical thinking, (2) problem solving, (3) metacognition, (4) communication, (5) collaboration, (6) innovation and creativity, (7) information literacy [4]. So the challenges of the 21st century require us to master various skills, one of which is creative thinking skills.

Creative thinking skills are one of the skills that generate and develop new ideas or concepts from existing ideas. This process involves the ability to see a problem from various perspectives, connect different information, and explore previously unthinkable solutions. With creative thinking skills, individuals are not only able to generate innovative ideas, but can also adapt and improve existing ideas to make them more relevant and effective. This is very important in various fields, such as education, technology, art, and business, where the ability to think outside conventional boundaries can produce significant progress. Creative thinking skills can improve the quality of education and make learning more meaningful [5]. Thus, creative thinking skills are one of the cognitive aspects that must be considered in the learning process [6]. In addition, creative thinking skills can also solve problems that occur in learning from various different perspectives [7]. In response to this, the government is trying to develop students' creative thinking skills, one of which is by implementing it in the curriculum.

The curriculum plays an important role in achieving educational goals. One type of curriculum currently being implemented is the independent curriculum. The independent curriculum focuses on the development of students' competencies and skills in accordance with the needs of the 21st century [8]. The independent curriculum has positive aspects, such as allowing students and teachers to choose essential materials, giving students the freedom to learn according to their characteristics, and allowing teachers to use teaching approaches that match the characteristics of the students and the materials being studied [9]. The independent curriculum also aims to provide students with independence in learning, enabling them to develop their potential optimally [10]. In the independent curriculum, teachers act as facilitators, which requires them to develop teaching tools, one of which is teaching materials.

Teaching materials are one of the supporting media used by teachers and students in the learning process, so that learning becomes more focused. Without teaching materials, teachers will tend to use the lecture method, which results in the learning process being inefficient. With teaching materials, the learning process will run more effectively and efficiently [11]. The ideal condition expected from teachers is to present teaching materials that make it easier for students to learn [12]. A teacher must be able to present teaching materials that are not only interesting, but also make it easier for students to understand the material in a clear and structured way. This includes the use of various teaching methods, approaches that are appropriate to students' learning styles, and the application of educational technology that can support the learning process effectively. Thus, students can more easily master the material, feel interested in learning, and have the opportunity to develop their potential optimally. Systematic teaching materials will facilitate learning activities, making it easier for students to learn independently [13]. Teaching materials can increase students' interest in learning by adding images, videos, and animations. Teaching materials also encourage students to learn independently, so it can be concluded that the existence of teaching materials is very important.

The existence of teaching materials is important because teaching materials are components that must be studied, examined, learned, and used as material that students will master, while also providing guidelines for learning them [14]. Teaching materials usually always adhere to the applicable curriculum [15]. The purpose of having teaching materials is to encourage students to use their intellectual abilities during the learning process. One of the efforts that can be made is by developing teaching materials that are integrated with an approach. One of the approaches that aligns with the demands of the 21st century and the independent curriculum is the STEM approach. (Science, Technology, Engineering, dan Math). The STEM approach aims to help students solve problems and draw conclusions, then apply them through science, technology, and mathematics. so that students become creative individuals in facing the challenges of the 21st century. The STEM approach also guides students' mindsets towards problem-solving, inventors, innovators, building independence, logical thinking, using technology, and being able to connect education with the world of work [16]. STEM can make students think critically and provide creativity in line with the demands of the 21st century.

The most important step before the process of designing electronic teaching materials is to conduct a student needs analysis. This is important as initial information in the development of STEM integrated electronic teaching material of alternative energy to promote students' creative thinking skills according to the needs of teachers and students at school. The purpose of this study is to obtain need analysis for developing STEM integrated electronic teaching material of alternative energy to promote students' creative thinking skills.

II. METHOD

This study uses a quantitative descriptive research method. This study presents data systematically and factually, without aiming to draw general conclusions [17]. The purpose of this study is to answer the formulated

questions and provide a comprehensive understanding of a phenomenon through a quantitative approach [18]. Numerical data obtained during the study serve to draw conclusions related to the issues studied [19]. Through a quantitative approach, it becomes easier to identify patterns that are not visible through qualitative methods [20].

The subjects in this study consisted of several research subjects. First, one physics teacher and 30 students at SMAN 1, Payakumbuh District. Second, one physics teacher and 23 students at SMAN 1, Mungka District. Needs analysis was conducted to obtain information about the problems and needs in physics learning at the school. For physics teachers, this study focuses on the analysis of related issues in physics learning and problems in the use of electronic teaching materials in learning. Meanwhile, for students, this study focuses on the analysis of student characteristics, student interest in electronic teaching materials, and students' creative thinking skills.

The data collection instruments used in this study were teacher interviews and student questionnaires, as well as students' creative thinking skills tests. The teacher interview sheet contained issues related to the use of electronic teaching materials in learning. The student characteristics questionnaire sheet included interests, attitudes, motivations, and learning styles. The creative thinking skills test questions were in the form of essay questions in the form of discourse. In addition, the questions given referred to indicators of fluency, flexibility, originality, and elaboration aspects [21].

The data in this study were analyzed using descriptive statistical analysis techniques. Descriptive statistical analysis functions to collect, simplify, and present data clearly and easily understood [22]. In this study, the results of descriptive statistical analysis are presented through graphic tables and data group summaries in order to describe quantitative data more clearly. The data from the needs analysis were calculated using the Likert scale equation. The Likert scale equation can be seen in Equation 1. Then, the percentage of values obtained were interpreted based on the needs survey category which can be seen in Table 1.

$$\text{Nilai} = \frac{\text{Score Obtained}}{\text{maximun score}} 100\% \qquad (1)$$

The percentage of the obtained values was interpreted based on the needs survey categories, which can be seen in Table 1.

Table 1. Category Interpretation Value Needs Analysis

Interpretation	Criteria
80-100	Very Good
70-84	Good
55-69	Fair
40-54	Poor
0,30	Very Poor

(Source: [23])

III. RESULTS AND DISCUSSION

Results

The results of the study showed that needs analysis can be used as a basis for developing electronic teaching materials on alternative energy materials to encourage students' creative thinking skills. The first research result is an analysis of physics learning problems and students' interest in the use of electronic teaching materials in physics learning at SMAN 1 Payakumbuh District and SMAN 1 Mungka District. The instruments used were teacher interviews and student questionnaires. The results of interviews with both teachers showed that teachers tended to teach using the lecture method, students' lack of interest in learning, and teachers were constrained in developing electronic teaching materials because they lacked understanding in designing and using software in developing electronic teaching materials so that existing teaching materials could not be used by students. While most students have a very good interest in electronic teaching materials. The results of the analysis of students' interest in electronic teaching materials can be seen in Table 2.

Table 2. Statistical Parameter Values of Students' Interest in Electronic Learning Materials

Parameter Statistic	SMAN 1 Payakumbuh District	SMAN 1 Mungka District

Average	87.1	90.2
Median	87.5	87.5
Mode	100.0	100.0
Standard Deviation	13.5	10.4
Minimum	100.0	100.0
Maximum	50.0	63.0
Range	50.0	38.0

Based on Table 2, it can be explained that the average student interest in the use of each teaching material is 87.1 and 90.2, both categorized as very good. The median value in the analysis of student interest in electronic learning materials is the same at 87.50, categorized as very good. The value that frequently appears in the analysis of students' interest in electronic learning materials is 100.0, which can be categorized as very good. The standard deviation values from the analysis of student interest in electronic teaching materials were 13.5 and 10.4, respectively. Then, the highest value obtained from the analysis was the same at 100.0, which falls into the very high category. However, the lowest scores obtained were 50.0 and 63.0, respectively. The range of the analysis results on students' interest in the use of electronic teaching materials in physics learning is between 50.0 and 38.0, respectively. Based on the analysis of students' interest in electronic teaching materials in physics learning, we can conclude that electronic teaching materials are very important to develop because a significant number of students are interested in electronic teaching materials, which can later influence students' increasing interest in learning.

The second research result is an analysis related to the characteristics of students from SMAN 1 Payakumbuh District and SMAN 1 Mungka District. The instrument used in the analysis of student characteristics is in the form of a student questionnaire. The results of the analysis of the student characteristic questionnaire in physics learning consist of 4 aspects, namely. The aspect of students' interest in learning, the aspect of students' attitudes, the aspect of students' motivation, and the aspect of students' learning styles. For the aspect of students' learning interest, it can be seen in Table 3.

Table 3. Statistical Parameters of Students' Interest in Learning Physics

Parameter Statistic	**SMAN 1 Payakumbuh District**	**SMAN 1 Mungka District**
Average	66.0	72.0
Median	62.5	69.0
Mode	56.0	69.0
Standard Deviation	13.9	12.3
Minimum	100.0	88.0
Maximum	38.0	50.0
Range	63.0	38.0

Based on Table 3, it can be explained that the average interest in learning of students from SMAN 1 Payakumbuh District and SMAN 1 Mungka District in physics learning is 66.0 with a sufficient category and 72.0 with a good category, respectively. The median value in the analysis of students' interest in physics learning for each school is 62.5 and 69.0, categorized as very good. The values that frequently appear in the analysis of students' interest in physics learning are 56.0 and 69.0, which can be categorized as good. The standard deviation values from the analysis of students' interest in physics learning were 13.9 and 12.3, respectively. Then, the highest scores obtained were 100.0 and 88.0, which fall into the very good category. However, the lowest scores were 38.0 and 50.0, respectively. The range of the analysis results of students' interest in learning physics is between 63.0 and 38.0. Based on the analysis results of students' interest in physics learning, it can be stated that students' interest in physics learning is very important to enhance because it affects teaching and learning activities.

The second result of the student characteristic analysis is the analysis of student attitudes. The attitudes assessed are those related to students' seriousness, honesty in physics learning, efforts to find solutions to problems faced, and working in groups during physics lessons. Data analysis for the attitude aspect can be seen in Table 4.

Table 4. Statistical Parameters of Students' Attitudes in Physics Learning

Parameter Statistic	**SMAN 1 Payakumbuh District**	**SMAN 1 Mungka District**

Average	79.7	79.0
Median	77.5	80.0
Mode	75.0	90.0
Standard Deviation	10.5	11.7
Minimum	100.0	100.0
Maximum	60.0	60.0
Range	40.0	40.0

Based on Table 4, it can be explained that the average student attitudes in physics learning are 79.7 and 72.0 respectively in the good category. The middle value in the analysis of student attitudes in physics learning has a value of 77.5 and 80.0 respectively in the good category. The values that often appear in the results of the analysis of student learning attitudes in physics learning have a value of 75.0 which is in the good category and 90.0 which is in the very good category. The standard deviation values from the results of the analysis of student attitudes in physics learning are 13.9 and 12.3 respectively. Then the highest value obtained is the same, namely 100.0, which is in the very good category. However, the lowest value is the same, namely 60.0. The range of the results of the analysis of student attitude values in physics learning is in the same range, namely 40.0. Based on the results of the analysis of student attitudes in physics learning, it can be stated that student attitudes in physics learning are good, both in terms of honesty, sincerity in learning, and working together in groups.

The third analysis of student characteristics is the analysis of student motivation. The motivation assessed is related to the frequency with which students create a pleasant environment, the enthusiasm of students in participating in learning, the effort to find solutions to problems, and working in groups during physics lessons, the students' grades in physics learning, and the students' interest in using innovative learning resources in physics. The data analysis for this aspect of motivation can be seen in Table 5.

Table 5. Statistical Parameters of Student Learning Motivation in Physics Education

Parameter Statistic	**SMAN 1 Payakumbuh District**	**SMAN 1 Mungka District**
Average	72.7	67.0
Median	71.9	75.0
Mode	75.0	81.0
Standard Deviation	11.8	15.5
Lowest score	100.0	100.0
Highest score	56.0	38.0
Range	44.0	63.0

Based on Table 5, it can be explained that the average student motivation towards physics learning is 72.7, which falls into the good category, and 67.0, which falls into the sufficient category. The median value in the analysis of student motivation towards physics learning is in the good category with values of 71.9 and 75.0, both categorized as good. The most frequently occurring values are 75.0 and 81.0, indicating that student motivation towards physics learning is in the good category. The standard deviation values from the analysis of student attitudes in physics learning are 11.8 and 15.5, respectively. The highest values obtained are both 100.0, which fall into the very good category. However, the lowest values are. The range of the analysis results for students' learning motivation in physics education is between 44.0 and 63.0. Based on the analysis results of students' motivation towards physics education, it can be stated that students' learning motivation towards physics education is quite good. However, improvements are still needed to create enjoyable learning and to foster enthusiasm for participating in the lessons.

The results of the analysis of the four student characteristics are the analysis of student learning styles. The learning styles assessed are related to the learning styles used by students to quickly understand the material, such as writing, reading, demonstration, and observation. The data analysis for this aspect of learning styles can be seen in Table 6.

Table 6. Statistical Parameters of Students' Learning Styles in Physics Learning

Parameter Statistic	**SMAN 1 Payakumbuh District**	**SMAN 1 Mungka District**
Average	87.4	83.7
Median	92.9	96.0

Mode	93.0	96.0
Standard Deviation	10.4	8.9
Minimum	100.0	100.0
Maximum	57.0	61.0
Range	43.0	39.0

Based on Table 6. it can be explained that the average learning style of students in terms of reading, writing, listening, and seeing physics learning at SMAN 1 Payakumbuh District and SMAN 1 Mungka District is in the very good category with values of 87.4 and 83.7 respectively. The middle value of the results of the analysis of students' learning styles towards physics learning are 92.0 and 96.0 respectively with a very good category. The values that often appear each have values of 93.0 and 96.0 which indicate that students' learning styles towards physics learning are in the very good category. The standard deviation values from the results of the analysis of students' attitudes in physics learning are 10.4 and 8.9 respectively. Then the highest value obtained is the same, namely 100.0, which is in the very good category. However, the lowest values are 57.0 and 61.0 respectively, indicating that students' learning styles of reading, writing, seeing, and hearing are quite widely owned. The range of results of the analysis of students' learning style values in physics learning is in the range of 43.0 and 39.0 respectively. Based on the results of the analysis of students' learning styles in physics learning, it can be stated that the learning styles of reading, seeing, and hearing are very much owned by students, but some students have different learning styles. Therefore, it is necessary to develop teaching tools in the form of electronic teaching materials that can support the learning process and can be utilized with different learning styles of students, both those who have learning styles of seeing, hearing and learning styles of moving through materials, images, videos and learning activities contained in electronic teaching materials later.

The third research result is an analysis related to the creative thinking skills of students from SMAN 1 Payakumbuh District and SMAN 1 Mungka District to develop electronic teaching materials. The instrument used in the analysis of students' creative thinking skills was in the form of essay questions. The analysis of students' creative thinking skills consisted of 4 aspects: fluency, flexibility, originality, and elaboration. The results of the analysis of students' answers to the creative thinking skills questions are presented in Table 7.

Table 7. Statistical Parameters of Students' Creative Thinking Skills in Physics Learning

Parameter Statistic	SMAN 1 Payakumbuh District	SMAN 1 Mungka District
Average	35.4	25.9
Median	31.4	25.0
Mode	31.5	25.0
Standard Deviation	14.9	13.5
Minumim	81.3	68,8
Maximum	9.4	3.1
Range	71.9	65.6

Based on Table 7, it can be explained that students' creative thinking skills have respective scores of 35.4 and 25.9, which are categorized as very poor. The median values in the analysis of students' creative thinking skills are 31.5 and 25.0, both categorized as very poor. The most frequently occurring values are 31.5 and 25.0, indicating that the creative thinking skills of students at SMAN 1 Kecamatan Payakumbuh and SMAN 1 Kecamatan Mungka are in the very poor category. The standard deviation values from the analysis of creative thinking skills were 14.9 and 13.5, respectively. The highest scores obtained were 81.3 with a very good category, and 68.8 with a sufficient category. However, the lowest scores were 9.4 and 3.1, indicating that the students' creative thinking skills were very lacking. The range of the analysis results for students' creative thinking skills has respective ranges of 71.9 and 39.0. Based on the analysis results of the creative thinking skills of students from SMAN 1 Kecamatan Payakumbuh and SMAN 1 Kecamatan Mungka, overall, they are still very lacking, and further innovation and creativity are needed.

Discussion

The research results indicate that needs analysis can be used as a basis for developing electronic teaching materials on alternative energy to encourage students' creative thinking abilities. The first study is to analyze the problems in physics learning and students' interest in electronic teaching materials in physics learning. The analysis results show that the implementation of physics learning at SMAN 1 Payakumbuh District and SMAN 1

Mungka District faces several obstacles. The constraint is that teachers tend to teach using the lecture method. The use of the lecture method without any innovation makes students feel bored, tend to be passive, and have low activity levels [24]. Teachers are hindered in the development of electronic teaching materials due to a lack of understanding in designing and using software for the development of electronic teaching materials, resulting in the existing teaching materials not being usable by students. Meanwhile, the use of technology in 21st-century learning is very important to assist teachers in carrying out the learning process [25]. Furthermore, teaching materials are crucial in physics education as intermediaries for physics lesson content [26]. The lack of student interest in studying physics impacts student learning outcomes, and the lack of student understanding of physics material makes the learning process less conducive.

The second analysis result is the analysis of student characteristics. The analysis results show that student characteristics are in the very good category. The analysis results of student characteristics consist of 4 aspects. The first aspect is students' interest in learning physics. The analysis results show that students' attitudes towards learning are adequate. Meanwhile, the interest in learning is very important for the continuity of the learning process. The factor that influences students' interest in learning is monotonous teaching [27]. One way to vary teaching is by using teaching materials in the learning process. Because students' interest in learning can increase through the use of teaching materials in learning [28]. In addition, electronic teaching materials can provide interesting content, images, animations, and videos, thereby increasing students' interest in reading and learning.

The second aspect is the students' learning attitudes towards physics education, which fall into the good category. This indicates that students in both schools have a high level of awareness and attitude towards learning physics. However, it should be noted that there are still score differences between the two schools, which can serve as a basis for reflection to improve further. Attitude is one of the very important domains to be developed [29]. One of the important attitudes for students is the attitude of learning independence. The attitude of learning independence is related to students' academic achievement; the better the attitude, the better the academic achievement obtained by the students [30]. Therefore, it is necessary to identify the factors that influence students' learning attitudes and develop intervention strategies to improve the quality of physics education.

The third aspect is students' motivation towards physics learning, which falls into the good and sufficient categories. Learning motivation plays an important role in providing stimulation, enthusiasm, and enjoyment in learning so that students are motivated to carry out the learning process [31]. A lack of student learning motivation will make the learning process less conducive. Another factor that influences student learning motivation in the learning process is the quality of the teacher in teaching [32]. Therefore, the role of the teacher is very important in increasing student learning motivation, especially in the subject of physics.

The learning styles in physics education at SMAN 1 Payakumbuh District and SMAN 1 Mungka District fall into the very good category. Learning styles are very important for teachers to pay attention to. Because students' learning styles are very interconnected and mutually supportive, and they determine the success of learning [33]. The learning styles possessed by each student are certainly different from one another, so an innovation is needed that can create a learning experience that can be utilized by students with different learning styles. The preparation of teaching materials that align with students' learning styles can enhance learning outcomes [34]. One of the electronic teaching materials that can provide features that can be utilized by anyone.

The latest research is analyzing students' creative thinking skills. From the analysis, it was stated that students' creative thinking skills are still very lacking. The lack of creative thinking skills also affects students' creativity in solving problems. Meanwhile, in 21st-century education and the independent curriculum, students are required to possess 4C skills, namely creative thinking skills. for that reason, an approach is needed that can enhance students' creative thinking skills, one of which is the STEM approach. The STEM approach will later be incorporated into the teaching materials. Because teaching materials have a very good and effective impact on improving creative thinking skills [35]. Thus, teachers must be able to create learning experiences that can develop the competencies of 21st-century students [36].

IV. CONCLUSION

Based on the research conducted at SMAN 1 Payakumbuh District and at SMAN 1 Mungka District, three conclusions were obtained from the results of the needs analysis. The results of the first study stated that the lack of utilization of teaching materials is still not optimal, teaching materials are still printed, less interesting, and the utilization of technology in teaching materials is still lacking. Then, students' interest in electronic teaching materials in physics learning is in the very good category, with values of 87.1 and 90.2 respectively. The results of the second study of needs analysis at SMAN 1 Payakumbuh District and SMAN 1 Mungka District stated that student characteristics consist of 4 aspects, namely the aspect of student learning interest with a good category value with each school's value of 76.4 and 69.1. The next aspect is the aspect of student attitudes which is classified as good with values of 79.7 and 79.0 respectively. The third aspect is learning motivation with values

of 72.7 with a good category and 67.0 with a sufficient category. The fourth aspect is the students' learning style, it can be seen that on average students are more dominant in having a reading, seeing, and hearing learning style with respective values of 87.4 and 83.7 which are categorized as very good. The results of the latest study stated that students' creative thinking skills were considered very lacking with each school's value of 35.4 and 25.9. Based on several research results, it can be concluded that the development of integrated STEM electronic teaching materials is needed on alternative energy materials to encourage students' creative thinking skills.

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