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Needs Analysis Development of SSI-Based E-Modules on Ecology and Biodiversity Materials to Empower Students' Creative Thinking Skills

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ABSTRACT

Creative thinking skills are important for students to develop innovative solutions. One of the learning approaches in Natural Sciences that is effective for training creative thinking is the SSI (Socio-Scientific Issues) approach. The purpose of the research was to analyze the needs of teachers and students in the development of SSI-based e-modules to empower students' creative thinking skills. Data were collected through questionnaires given to four science teachers and 119 seventh grade students from four schools located in Wonogiri, Sukoharjo, Klaten, and Gunungkidul districts. The results showed that 1) 75% of teachers have difficulties in learning science. 2) 100% of teachers feel limitations in teaching materials. 3) 75% of teachers need teaching materials that can help teach science concepts. 4) 100% of teachers agree with the development of SSI-based e-modules. 5) 54% of students feel there is something incomplete with the module used. 6) 52% of students have difficulty in learning material from books. 7) 98% of students have smartphones. 8) 96% of students need SSI-based e-modules. The conclusion of the research shows that teachers and students need SSI-based e-modules on ecology and biodiversity materials that are easily accessible and effective to empower students' creative thinking skills.

1. Introduction

21st century education requires students to compete globally, especially students studying science, technology, engineering and math. Science aims to make associations of ideas and understanding of natural phenomena. Students' conceptions of science phenomena are based on everyday observations and experiences (Lewis & Leach, 2006). Thus, the characteristics of students who are able to reason, solve problems, argue, communicate, be creative, critical, and collaborative by anyone are aspects that must be emphasized as well as a school priority (Böttcher & Meisert, 2013).

Science learning activities ideally use scientific approaches such as observing, asking, thinking, experimenting, and communicating. The use of this scientific approach aims to improve students' ability to think scientifically, logically, critically, creatively, and objectively (Genisa et al., 2020). Creative thinking is a mental process that involves the ability to generate new and original ideas, and solve problems with innovative approaches (Alfitriyani, et al., 2021). According to Fatmawati et al., (2022), creative thinking is identified through four main components, namely fluency, flexibility, originality, and elaboration. In line with that, creative thinking is an original cognitive ability and problem-solving process, creative thinking is also a cognitive ability and problem-solving process that allows a person to use their intelligence (Potur & Barkul, 2009).

Based on the results of the Trends in International Mathematics and Science Study (TIMSS) in 2015, Indonesia ranked 44 out of 49 countries that measured students' creative thinking skills in Mathematics and Science (Nizam, 2016). This finding shows that the level of students' creative thinking skills in Indonesia is still very low. Learning that does not encourage exploration and critical analysis can hinder their creative thinking skills. Ecology and Biodiversity materials are often presented without linking them to relevant social issues. This results in students not being able to see the relevance between the lesson and everyday life, leading to a lack of awareness of the importance of these issues. Current learning methods are often individualized, reducing the opportunity for students to learn from each other.

Despite the development of information technology, there are still few teachers who utilize e-modules in learning activities. This indicates a lack of training or understanding of the use of technology to improve learning quality (Koran-Scholl et al., 2023). One of the effective learning approaches to train creative thinking is the SSI (Socio-Scientific Issues) approach in teaching and learning, especially in Natural Sciences. SSIs are scientific issues that occur around students, for example environmental, medical, nutritional, and genetic engineering issues (Zeidler et al., 2009).

Scientific issues can not only test students' cognitive levels, but can also measure students' spiritual and emotional perceptions (Sadler, 2004). The integration of SSI in the science curriculum can also encourage students to develop independent attitudes towards learning, such as high curiosity, courage to express opinions, and willingness to seek deeper understanding of complex issues. Learning about SSI can be an effective means to streamline independent learning and the development of critical and creative thinking skills in students (Jeah, et al., 2022).

SSI that touches on the subject of biology can enhance their students to master the concepts taught more clearly (Reiss, 2006). Case studies conducted through observations and interviews found that the approach to social issues in biology can increase student motivation, but the effectiveness of this approach depends on the teacher's expertise in implementing it. Klosterman et al., (2012), stated that one way to learn science is to introduce the scientific issues approach, which is a very significant problem and issue especially related to natural phenomena. Indirectly

this activity has been passed down to students how to start a good practice before they face real people in the future society.

According to Husin et al. (2006), discussion of current issues related to socio-scientific issues often occurs in electronic media. This will improve students' reasoning and creative thinking skills (Chung et al., 2014). Reasoning skills are synonymous with well-planned strategies in the classroom (Pegg, 2006). Reasoning skills based on SSI are often used to ensure that science teaching and learning goes perfectly and can motivate students (Zeidler et al., 2009). Socio-scientific problems in classroom learning are basically to help students develop the skills of understanding scientific terms, making decisions, making judgments, providing evidence and concluding discussions of problems involving science concepts (Yoon, 2008). With students' attention and concentration on the subject content will continue to increase and make it easier for teachers to convey information. (Sampson et al., 2011).

Teaching materials are learning tools that are used to facilitate the delivery of learning materials. The fact is that in the 21st century there are fewer and fewer enthusiasts for printed teaching materials. This is because it is considered too monotonous (Najuah, 2020). One of the innovations that has emerged in the context of education in the 21st century is the use of teaching materials that utilize technology, such as electronic modules (e-modules). Almost all students already have smartphones that can be used to access e-modules. E-modules can be a learning media that can attract students to learn science material on ecology and biodiversity, and can empower students' creative thinking. E-modules are easy to use, there are learning videos, links to a website, concise and interesting material. These advantages can help in student learning independence, students can take the initiative to learn outside of school (Lestari, 2013).

SSI is used as a component in the e-module. SSI is a science issue or problem then combined with social that can help students to think rationally and objectively to achieve the right decision selection (Zeidler, 2019). SSI can encourage students to think creatively, so that students can take an attitude towards a problem that exists in their environment. One of the materials contained in science subjects is ecology and biodiversity. The thing that will be emphasized in the electronic module is about the conversion of ecosystems or land functions, such as forests. Students will be stimulated to think creatively about the conversion of forest to plantation land and its impact on biodiversity and the impact on life at large. The creative thinking in question is that students can take an attitude about differences of opinion or pros and cons that occur in society.

Based on the background and learning problems, this study aims to obtain information on whether students and teachers need SSI-based e-modules on ecology and biodiversity materials or not.

2. Methodology

This study aims to analyze the needs of teachers and students for the development of SSI-based e-modules on ecology and biodiversity materials to empower students' creative thinking skills. This research was conducted using a qualitative descriptive design. The subjects used in this study were 4 science teachers from 4 districts, namely 1 science teacher of SMP Negeri 1 Giritontro Wonogiri, 1 science teacher of SMP Negeri 1 Mojolaban Sukoharjo, 1 teacher of MTs Negeri 8 Klaten, and 1 teacher of MTs Negeri 9 Gunungkidul, and 119 students from the 4 schools. The time of this research was conducted from January to April 2025. The data collection technique is by using teacher and student questionnaires. The teacher questionnaire and student questionnaire each consisted of 16 questions.

The results of the teacher/student needs questionnaire on the development of SSI-based e-modules were analyzed with the equation:

$$\text{Percentage of Result} = \frac{\text{Number of Teachers or Students who Answered}}{\text{Total Teachers or Students}} \times 100\%$$

3. Results and Discussion

Results

Results of Data Analysis of Teacher Needs Questionnaire

The list of questions on the teacher needs questionnaire can be seen in Table 1.

Table 1. List of Questions on the Teacher Needs Questionnaire

No.	Question	Yes/No
1.	Do you have difficulties in teaching science concepts and processes to students?	
2.	Do you use science teaching materials as a learning resource?	
3.	If so, did you make the teaching materials yourself?	
4.	Do students already have textbooks to study science independently?	
5.	Do you have any other textbooks besides the ones given to students?	
6.	Do you feel limited in the teaching materials used?	
7.	Did you make the teaching materials (modules) yourself?	
8.	Are there any shortcomings in the module that can be fixed?	
9.	Does your school already have a science lab?	
10.	If your school already has a science laboratory, does the laboratory already have laboratory equipment to support the learning process?	
11.	Have you used a science laboratory for the learning process?	
12.	Have you been involved in learning that examines moral issues, that encourages critical and creative thinking?	
13.	Can the availability of libraries or laboratories support and help in science learning?	
14.	Does your library provide reference modules for science learning?	
15.	Do you need teaching materials to learn science concepts?	
16.	Do you agree that SSI-based e-modules should be developed so that science material is easier for students to understand?	

1. Limitations and difficulties felt by teachers in learning science.

The results of the questionnaire analysis show that there are limitations and difficulties felt by teachers in learning science as seen in Figure 1.

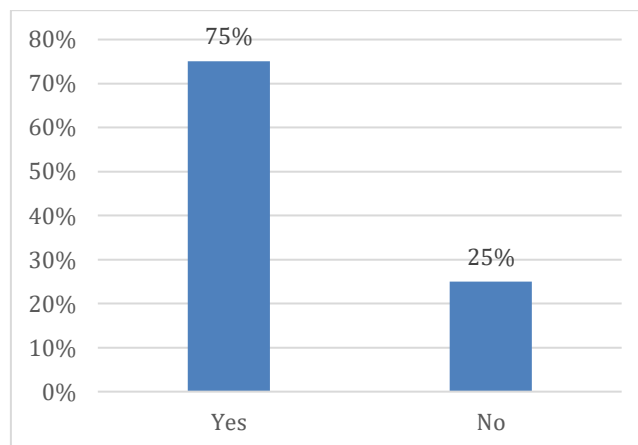


Figure 1. Limitations and Difficulties Felt by Teachers in Learning Science

The results of the analysis of the limitations and difficulties felt by teachers in learning show that 75% of teachers experience limitations and difficulties felt by teachers in learning science, while 25% of teachers do not experience limitations and difficulties felt by teachers in learning science. Difficulties in teaching science concepts and processes to students are due to limited learning resources and teaching materials.

2. Availability of learning materials and resources and their use

The results of the questionnaire analysis show that there are problems in the availability of learning materials and resources and their use as seen in Figure 2.

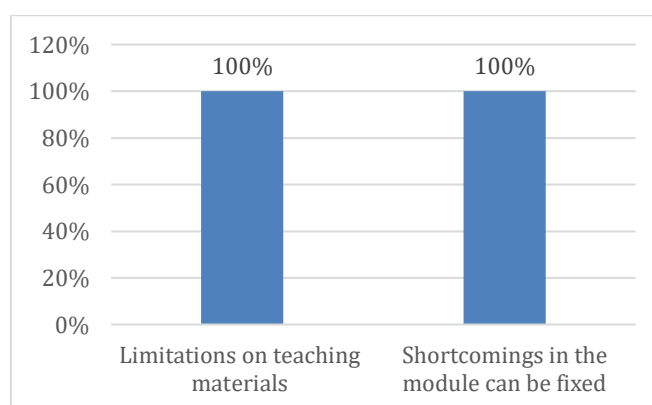


Figure 2. Problems with the Availability of Learning Materials and Resources

The results of the analysis of the availability of learning materials and resources and their use show that 100% of teachers feel the limitations of the teaching materials used, and 100% of teachers feel that in the module there are deficiencies that can be corrected.

3. Implementation of learning activities

The results of the questionnaire analysis show that there are problems in the implementation of learning activities as shown in Figure 3.

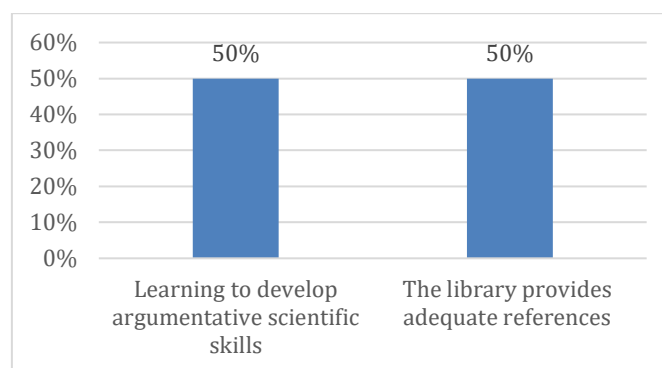


Figure 3. Problems with Implementation of Learning Activities

The results of the analysis of the implementation of science learning activities show that 50% of teachers implement learning that develops argumentative scientific skills, examines moral issues, develops moral reasoning that encourages critical and creative thinking, and 50% of teachers feel that the library at their school provides adequate modules and reference books for science learning.

4. SSI-based learning e-module requirements

The results of the questionnaire analysis show that there is a need for SSI-based e-modules as shown in Figure 4.

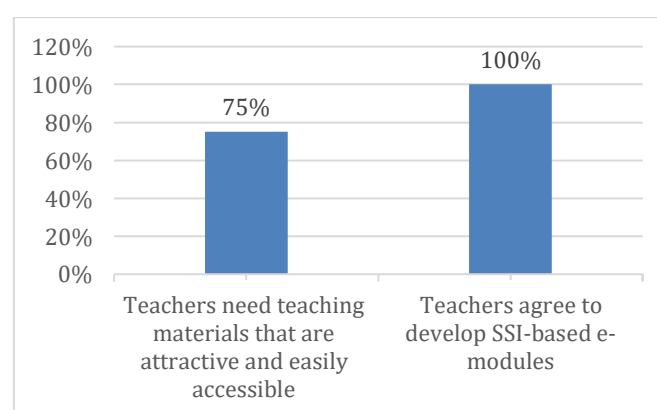


Figure 4. SSI-Based Learning e-Module Requirements

The results of the needs analysis of SSI-based science learning e-modules show that 75% of teachers need teaching materials that are able to help teach science processes and concepts in a more interesting and accessible way for teachers and students, such as SSI-based science e-modules, and 100% of teachers agree if SSI-based science e-modules are developed that link learning with issues in everyday life so that science material is more easily understood by students.

Results of Data Analysis of Student Needs Questionnaires

The list of questions on the student needs questionnaire can be seen in Table 2.

Table 2. List of Questions on the Student Needs Questionnaire

No.	Question	Yes/No
1.	Do you enjoy studying science?	
2.	Are your science study results satisfactory?	
3.	Do you have difficulty learning science material?	
4.	Are you given a book with complete material to study science independently?	
5.	Does the book make it easier for you to learn science?	
6.	Do you feel incomplete with the books used?	
7.	Do you have any difficulty in learning the material from the book?	
8.	Is the science material in the book used related to the natural events around you?	
9.	Does your school already have a science lab?	
10.	Have your teachers used science laboratories for the learning process?	
11.	Does your teacher give feedback on the understanding you gain?	
12.	Do you have a smartphone?	
13.	Do you need teaching materials that can be accessed with a smartphone?	
14.	Have you ever used e-modules in learning activities?	
15.	Is the science material you study always related to social-science issues?	
16.	Do you need an e-module whose material is related to social-science issues?	

1. Limitations and difficulties felt by students in learning

The results of the questionnaire analysis show that there are limitations and difficulties felt by students in science learning as shown in Figure 5.

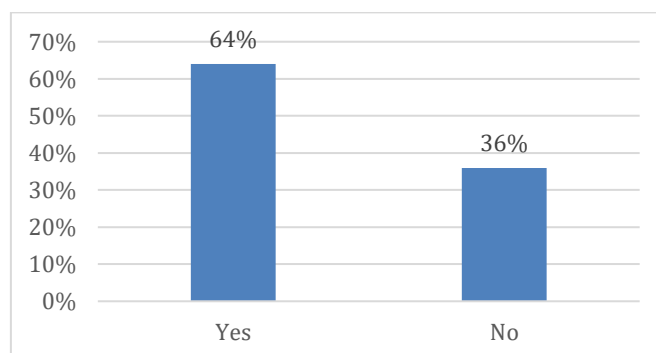


Figure 5. Limitations and Difficulties Felt by Students in Science Learning

The results of the analysis of the limitations and difficulties felt by students in learning show that 64% of students experience difficulties in learning science materials, while 36% of students do not experience difficulties in learning science materials.

2. Availability of learning materials and resources and their use

The results of the questionnaire analysis show that there are problems with the availability of learning materials and resources and their use as shown in Figure 6.

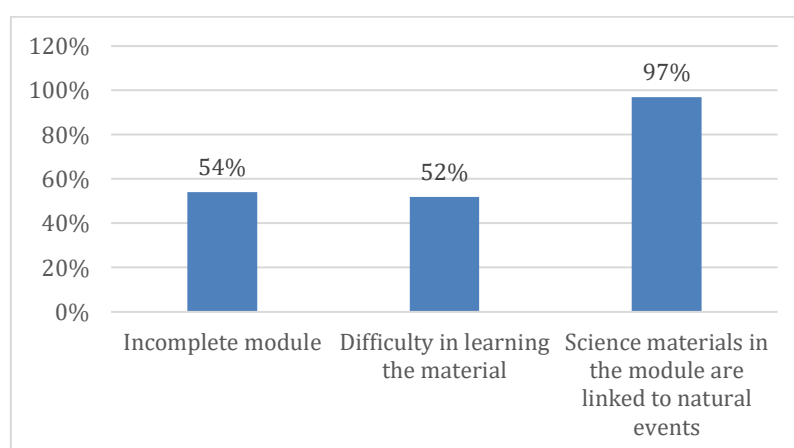


Figure 6. Problems with the Availability of Learning Materials and Resources

The results of the analysis of the availability of learning materials and resources and their use showed that 54% of students felt that there was something incomplete with the modules used, 52% of students had difficulty in learning material from books, for example because of incomplete material, explanation techniques, language, and format, 97% of students felt that the science material in the modules used was connected to natural events.

3. The need for teaching materials in learning

The results of the questionnaire analysis show that there is a need for teaching materials in science learning as shown in Figure 7.

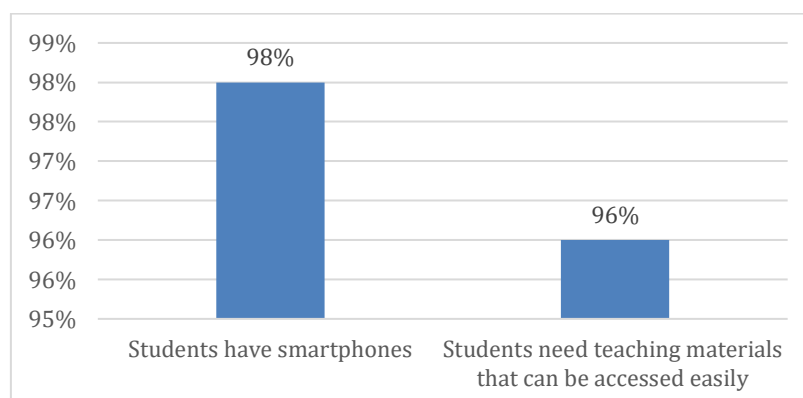


Figure 7. The Need for Teaching Materials in Science Learning

The results of the needs analysis of teaching materials in learning show 98% of students have smartphones, and 96% of students need teaching materials that can be accessed easily using smartphones.

4. The need for e-modules in science learning

The results of the questionnaire analysis show that there is a need for e-modules in science learning as shown in Figure 8.

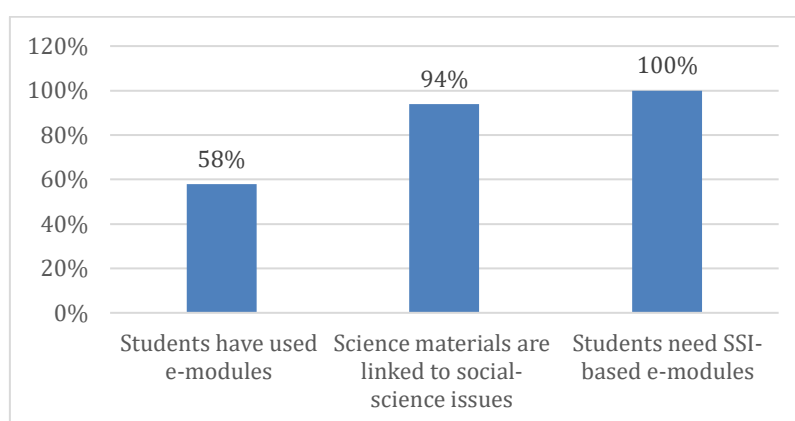


Figure 8. The Need for e-Modules in Science Learning

The results of the analysis of the need for e-modules in learning science show that 58% of students have used e-modules in science learning activities, 94% of students feel that the science material learned is always connected to natural events and social-science issues in everyday life, and 100% of students need SSI-based e-modules whose material is connected to natural events and social-science issues in everyday life.

Discussion

Results of Data Analysis of Teacher Needs Questionnaire

1. Limitations and difficulties felt by teachers in learning.

The results of the analysis of the limitations and difficulties felt by teachers in learning are 75% of teachers experience limitations and difficulties in learning science. Difficulties in teaching science concepts and processes to students are due to limited learning resources and teaching materials. Limited learning resources and teaching materials can significantly affect learning activities.

Limited learning resources and teaching materials can affect learning activities in several ways. Limited learning resources can cause difficulties in understanding the material being taught. Limited learning resources can cause difficulties in understanding the material being taught (Della Sala, 2017). Limited learning resources can cause students to have difficulty in understanding complex concepts. Limited learning resources can cause students' lack of motivation to learn (Aquino & Ching, 2022). Limited learning resources can cause students to feel unmotivated to learn.

Limited learning resources can also cause limitations in students' skills in applying the knowledge they gain. According to Montenegro (2016), limited learning resources can cause students to experience difficulties in developing the necessary skills. The use of limited learning resources and teaching materials can also affect learning activities. The use of online learning resources can help overcome the limitations of learning resources. According to Ferrer (2022), the use of online learning resources can increase the accessibility and flexibility of learning. The use

of technology can help overcome the limitations of learning resources. According to Kalyani (2024), the use of technology can improve the efficiency and effectiveness of learning.

2. Availability of learning materials and resources and their use

The results of the analysis of the availability of learning materials and resources and their use show that 100% of teachers feel the limitations of the teaching materials used, and 100% of teachers feel that there are deficiencies in the module that can be corrected.

The availability of relevant learning materials and resources can increase student motivation and participation in the learning process. The availability of learning materials and resources can influence learning activities. Relevant learning materials and resources can increase students' motivation to learn (Van der Kleij, 2015). Interactive learning materials and resources can increase students' motivation and make them more involved in the learning process (Shaifuddin & Nashir, 2022).

Quality learning materials and resources can improve students' understanding of the material being taught. Technology-based learning materials and resources can improve students' understanding of complex concepts. Relevant learning materials and resources can improve students' skills in applying the knowledge they gain. In line with Shaifuddin & Nashir, (2022) research, project-based learning materials and resources can improve students' skills in working together and solving problems.

In addition, the use of technology in learning materials and resources can improve the efficiency and effectiveness of learning. According to Foster (2014), the use of technology in learning materials and resources can increase the accessibility and flexibility of learning. The use of online learning resources can increase the accessibility and flexibility of learning. According to Richey and Klein (2017), the use of online learning resources can increase student motivation and participation in the learning process.

Modules that have deficiencies can be improved through several steps. According to Richey and Klein (2017), module improvement can be done by evaluating and revising. Module evaluation can be done by collecting data on the effectiveness of the module in achieving learning objectives. The module improvement process can be carried out in several steps, namely: 1). Identifying module deficiencies that need to be improved. According to Van der Kleij (2015), identifying module deficiencies can be done by analyzing data on module effectiveness. 2). Analyzing module deficiencies to understand their causes. Analyzing module deficiencies can be done using the SWOT analysis method. 3). Planning module improvements based on the deficiency analysis. According to Shaifuddin & Nashir (2022), planning module improvements can be done using the instructional design method. 4). Implementing module improvements. According to Shaifuddin & Nashir, (2022), implementing module improvements can be done using digital technology. 5). Evaluating module

improvements to ensure that the improvements made are effective. According to Foster (2014), evaluating module improvements can be done using formative evaluation methods.

3. Implementation of learning activities

The results of the analysis of the implementation of science learning activities show that 50% of teachers carry out learning that develops argumentative scientific skills, examines moral issues, develops moral reasoning that encourages critical and creative thinking, 50% of teachers feel that the library at their school provides adequate reference books for science learning.

Implementing learning that develops scientific argumentation skills is essential in fostering critical and creative thinking. According to Adamou (2021), scientific argumentation plays an important role in empowering critical thinking, evaluating evidence and making informed decisions. In addition, argumentation helps students develop their ability to articulate and defend their claims, which is crucial in various aspects of life.

Researching moral issues is also important in streamlining moral development and civic engagement. Research by Pattaro (2016) emphasizes the need for moral education to focus on the development of moral reasoning, and civic responsibility. In addition, examining moral issues helps students develop empathy, tolerance and respect for diverse perspectives, which are important in fostering a harmonious and just society (Meyer, 2024).

Fostering moral reasoning is essential in empowering critical thinking, moral judgment, and civic engagement. According to Chiasson et al. (2017), moral reasoning is essential in streamlining moral development, reducing aggression, and fostering empathy. In addition, moral reasoning helps students develop their ability to evaluate moral dilemmas, make ethical decisions, and engage in shared activities (Meyer, 2024).

4. The need for SSI-based learning e-modules

The results of the needs analysis of SSI-based science learning e-modules show that 75% of teachers need teaching materials that are able to help teach science processes and concepts in a more interesting and accessible way for teachers and students, for example SSI-based science e-modules, 100% of teachers agree if SSI-based science e-modules are developed that link learning with issues in everyday life so that science material is more easily understood by students.

By using e-modules, students will find it faster and easier to understand and learn learning materials with a learning process that is not only by reading textbook style but also by using several other methods (Padwa & Erdi, 2021) .

According to Zeidler (2019), SSI develop argumentative scientific skills, examine moral issues, develop moral reasoning, and engage in reflective criticism. SSI is a topic that encourages critical and creative thinking. In this case SSI as a base in the

e-module that can create contextual learning situations that provide opportunities to develop creative thinking skills. Social skills in learning through group activities are essential to develop students' personal competencies and support the achievement of learning outcomes (Zeidler et al. 2005).

Results of Data Analysis of Student Needs Questionnaires

1. Limitations and difficulties felt by students in learning

The results of the analysis of the limitations and difficulties felt by students in learning show that 64% of students experience difficulties in learning science materials, while 36% of students do not experience difficulties in learning science materials.

The availability of science textbooks in Indonesian schools is limited, making it difficult for students to learn science concepts. The lack of educational media, including audio-visual and multimedia aids, hampers the science learning process in Indonesian schools (Afifa & Astuti, 2024). Inadequate laboratory facilities in schools can hamper students' ability to conduct experiments and investigations, especially for science learning. Limited access to online media resources, including e-books, e-modules, and online tutorials can hinder students' ability to learn science concepts.

2. Availability of learning materials and resources and their use

The results of the analysis of the availability of learning materials and resources and their use show that 54% of students feel that there is something incomplete with the modules used, 52% of students have difficulty in learning material from books, for example because of incomplete material, explanation techniques, language, and format, 97% of students feel that the science material in the modules used is connected to natural events.

E-modules have several advantages over conventional textbooks or modules. E-modules can incorporate multimedia elements such as videos, animations, which can increase student engagement and motivation (Ikhsan et al., 2023). E-modules can be accessed anywhere, anytime, as long as they have an internet connection, making them more flexible than traditional textbooks (Yassine et al., 2023). E-modules can include interactive elements such as quizzes, games, and simulations, which can maximize active learning and improve student learning outcomes (Hamid et al., 2019). E-modules can be easily updated to reflect changes in the field or discipline, ensuring that students have access to the latest information and developments (Resmanti et al., 2024). E-modules can reduce the cost and distribution of education, making them a more cost-effective option than traditional textbooks (Ilie, 2019). E-modules allow students to learn at their own pace, which is beneficial for students to review the material before moving on (Rini et al., 2020).

3. The need for teaching materials in learning

The results of the needs analysis of teaching materials in learning show 98% of students have smartphones, and 96% of students need teaching materials that can be accessed easily. Smartphones can be utilized to access e-modules in various ways, including accessibility, interactivity, flexibility, digital skills enhancement, and collaboration. According to Al-Emran et al. (2016), mobile learning can increase student engagement and motivation. In addition, according to Sung et al. (2016), mobile devices can support personalized learning and improve learning outcomes. Picciano (2017) emphasizes the role of mobile devices in facilitating online learning and improving student success. Mobile devices can provide students with instant access to learning materials, anytime and anywhere (Sophonhiranrak, 2021). Mobile devices can support interactive learning experiences, such as gamification and simulation. By using e-modules that can be accessed using smartphones, students will find it faster and easier to understand and learn learning materials with a learning process that is not only by reading textbook style but also by using several other methods (Padwa & Erdi, 2021) .

4. The need for e-modules in learning science

The results of the analysis of the need for e-modules in learning science show that 58% of students have used e-modules in science learning activities, 94% of students feel that the science material learned is always connected to natural events and social-science issues in everyday life, and 100% of students need SSI-based e-modules whose material is connected to natural events and social-science issues in everyday life.

Students need SSI-based science e-modules because it can increase student engagement in science learning by connecting scientific concepts with social and environmental issues relevant to their lives (Kuhn & Pease, 2016). SSI enables students to think critically, creatively and analytically about complex issues involving science, technology and society (Sadler, 2004). SSI-based e-modules can help students understand scientific concepts in a broader context relevant to their daily lives. SSI prepares students to face global challenges such as climate change, sustainability, and public health by understanding the relationship between science, technology, and society (Chen & Xiao 2021). In addition, SSI-based e-modules can improve communication skills, creative thinking, collaboration in discussions and debates on socio-science issues (Ke, 2021).

4. Conclusion

Based on the results of the teacher needs questionnaire analysis, it shows that teachers experience limitations and difficulties in learning science. Limited learning resources and teaching materials can significantly affect learning activities. Teachers feel that deficiencies in teaching materials can be corrected. Teachers need teaching materials that can help teach science processes and concepts in a more interesting and accessible way. Teachers agree if SSI-based science e-modules are developed that can empower students' creative thinking skills.

Based on the results of the student needs questionnaire analysis, it shows that students feel that there is something incomplete with the modules used. Students have difficulty in learning material from books. Almost all students have smartphones that can be used to access e-modules. Students need an SSI-based e-module on ecology and biodiversity material that is easily accessible and easy to understand. The material in the e-module is connected to natural events and social-science issues in everyday life so that it can help students understand scientific concepts in a broader context and can empower creative thinking skills.

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