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The Potential of Implementing Website-Based Learning Media for ESD-Oriented Energy Sources in Physics Learning

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Abstract. This study aims to analyze the potential of implementing ESD (Education for Sustainable Development) oriented website-based learning in Physics learning. This research is a qualitative descriptive study. Questionnaires, observation, and documentation methods were chosen as data collection techniques. The results of data collection were analyzed using data triangulation. The survey results showed that 86% of teacher respondents were in the proficient or very proficient category, which indicates a high readiness to adopt website-based learning media. Although related to the implementation of ESD in learning, it shows that 45% of teachers have integrated ESD in their learning, 41% of teachers have understood the concept of ESD but have not integrated ESD in learning, and 14% of teachers have not understood the concept of ESD in learning. These results indicate a great opportunity to strengthen the understanding and practice of ESD through the development of website-based teaching materials. This data is supported by the results of the student questionnaire which showed that as many as 20 of 22 students (91%) agreed or strongly agreed that the use of digital media in learning provides benefits. These results show that most students have experience and comfort in digital-based learning. The results of the questionnaire show that both teachers and students have positive perceptions and readiness in integrating digital technology, especially website, in ESD oriented Physics learning. Development website Interactive and ESD-oriented Physics learning is a strategic step to improve the quality of learning in the digital era.

Keywords: learning media, website, education for sustainable development

1. Introduction

Rapid changes have brought education into the digital world. Recent technological advances have transformed the world of education, particularly through the integration of web-based learning media *web.* This digital platform offers a flexible, personalized, and interactive learning experience, allowing students to access materials anytime and anywhere [1]. Educational technology has shown a positive impact on the development of critical thinking skills, creative problem solving, and collaboration in mathematics learning [2]. Curriculum adaptation is needed to address the complex challenges of the 21st century while maintaining alignment with national education goals [3].

In the context of science learning, particularly physics, critical thinking skills are essential for understanding complex scientific concepts. Furthermore, digital literacy is becoming increasingly important as technology advances, enabling instant access to information real-time. Critical thinking skills and digital literacy are essential in science education, particularly physics, to understand complex scientific concepts and navigate the digital age. Digital literacy, the ability to access, understand, and utilize digital information, is essential for participation in modern society [4]. Research has shown that scientific literacy and critical thinking skills significantly influence students' mastery of basic scientific concepts, highlighting the importance of both in science education [5]. Similarly, research on elementary

school students shows a positive correlation between scientific literacy and critical thinking skills, with the contribution of scientific literacy to critical thinking skills being 13.6% [*6*].

Learning media based on website can be an effective learning resource to improve students' digital literacy and critical thinking skills. Development of a learning resource center based on websit*e* proven to improve students' digital literacy skills [7]. In the context of education, website. As a learning medium, it acts as a learning resource that provides a variety of materials, including text, images, videos, animations, and interactive simulations. Websites are a medium that can make it easier for teachers and students to find information. The use of website-based learning media is an alternative to improving the quality of learning [8].

Besides that, integration Education for Sustainable Development (ESD) in the curriculum can raise students' awareness of sustainability issues. Education for sustainable development (ESD) is an integral part in supporting the Sustainable Development Goals (SDGs) program, where ESD is a global issue that has 17 sustainable development goals (SDGs). One way to achieve these sustainable development goals is through education, where education is a means to introduce the concept of SDGs as an effort to change people's perspectives and attitudes towards the environment [9]. In the context of physics learning, ESD integration not only emphasizes understanding the concept of sustainability, but also demands the development of critical thinking skills and students' environmental awareness. This is increasingly relevant when combined with digital literacy, because students' ability to access, evaluate, and produce digital-based information can enrich the physics learning process that is oriented towards sustainability issues. ESD includes eight key competencies that are important for advancing sustainable development and can be integrated into science education through various methods [10].Thus, digital literacy becomes an important bridge in connecting physics content with the real context of sustainable development, while strengthening ESD competencies that cover eight main dimensions. Education for Sustainable Development (ESD) includes eight key competencies that are important for advancing sustainable development, which can be integrated into science education through various methods [10], [11].

Studies have shown that the implementation of website-based learning media can significantly improve student learning outcomes compared to conventional methods [1][12]. This approach is particularly relevant for the technology-savvy Generation Z, who are accustomed to using digital devices in various aspects of their lives [13]. The implementation of ICT-based learning media, including the internet, has also been shown to significantly improve student learning achievement [14]. Research has shown that ESD-oriented learning can improve students' creative thinking skills in physics education [15]. These findings demonstrate that innovative learning media integrated with ESD and utilizing digital technology are a pressing need for today's students. Students require access not only to easily understood and interactive learning materials, but also to develop critical thinking and creative skills, as well as digital literacy skills that meet the demands of the 21st century. Therefore, this research is based on the need to provide contextual, digital-based, and sustainability-oriented physics learning to address the challenges of today's generation while simultaneously supporting the achievement of sustainable education goals.

Based on the description above, it can be assumed that the learning media used by teachers in the learning process need to utilize digital technology according to the current needs of students. Website become a media that has great potential to be developed and by integrating the ESD concept it is hoped that it can increase students' understanding of sustainable issues so that students will be more motivated to contribute to sustainable practices in the future, both in the workplace and in everyday life. For this reason, research was conducted to determine the "Potential of ESD-Based Learning Media Website ESD-Oriented Physics Learning". The urgency of this research lies in the importance of presenting learning media that are relevant to the development of the digital era while instilling sustainable values, so that Physics learning is not only oriented towards understanding concepts, but also on the formation of critical awareness of global challenges. This research is limited to assessing the potential use of ESD-oriented website-based learning media in the context of Physics learning at the high school level, so that the results of the research are expected to be the basis for further development.

2. Method

The method used is a qualitative descriptive research method by conducting a survey. Implementation of ESD-oriented websites (Education for Sustainable Development) by giving a questionnaire to 22 high school physics teachers in Pemalang Regency and 22 students of SMA Negeri 1 Belik were involved as respondents who were selected randomly. The instruments used were a questionnaire with a Likert scale to determine the perceptions of teachers and students regarding the potential application of ESD-oriented websites in Physics learning, observation sheets to record learning conditions and the use of digital-based media, and document analysis guidelines to examine the learning tools used by teachers.

Data collection techniques were carried out through observation, questionnaires, and document analysis. To ensure the validity of the data, analysis was carried out using triangulation which includes: (1) source triangulation, namely comparing data obtained from teachers and students; (2) technical triangulation, namely combining the results of questionnaires, observations, and document analysis; and (3) time triangulation, namely collecting data at different times to ensure the consistency of the findings. The research instrument has gone through a content validation process *(*content validity) by two expert lecturers in the field of Physics education and one senior Physics teacher as a practitioner. Validity was carried out by assessing the suitability of the questionnaire items, observation sheets, and document analysis guidelines with the research objectives and digital literacy indicators and Education for Sustainable Development (ESD). Suggestions and input from the validator were used to revise and refine the instrument before it was used in data collection. The collected data were then analyzed through the stages of data reduction, data presentation, drawing conclusions, and verification [16].

3. Results and Discussion

3.1 *Results*

Based on the results of the teacher response questionnaire regarding the use of digital media in learning, Figure 1 was obtained. In Figure 1, of the 22 Physics teacher respondents in Pemalang Regency, 13% of teachers were very proficient in using digital media, 73% of teachers were proficient in using digital media, and 14% of teachers were not yet proficient in using digital media. These results indicate that 86% of respondents were in the proficient or very proficient category, which indicates a high level of readiness in adopting digital-based learning media. website.

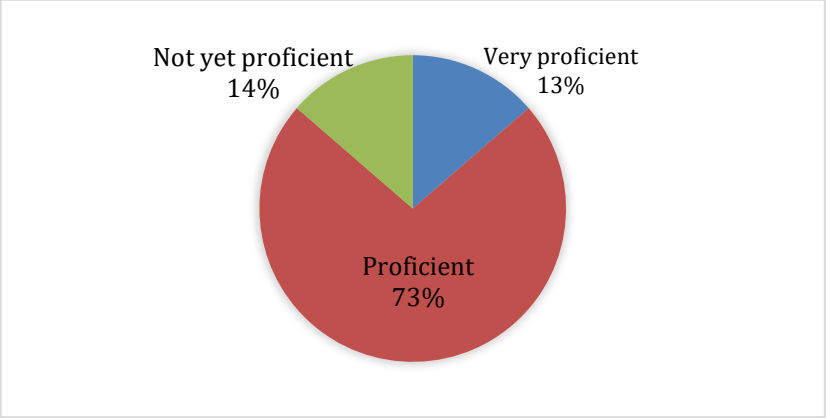

Figure 1. Results of teacher response questionnaires regarding the use of digital media in learning.

These results indicate that 86% of respondents are in the proficient or very proficient category, indicating a high level of readiness to adopt website-based learning media. The implication of this finding is that the majority of teachers already possess adequate basic competencies to support the implementation of digital learning, thus enabling the integration of ESD-oriented website-based media to be effective. However, 14% of teachers are still not proficient in using digital media, which can pose a challenge to

implementing this innovation. This situation indicates the need for support in the form of training, mentoring, and the provision of practical guidance so that all teachers can adapt and have equal skills in utilizing website-based learning technology.

Results of teacher response questionnaire on potential website In learning, Figure 2 was obtained. In Figure 2, of the 22 Physics teacher respondents in Pemalang Regency, 62% of teachers stated that they strongly agreed with the media website in learning, 38% of teachers stated that they agreed with website as media in learning.

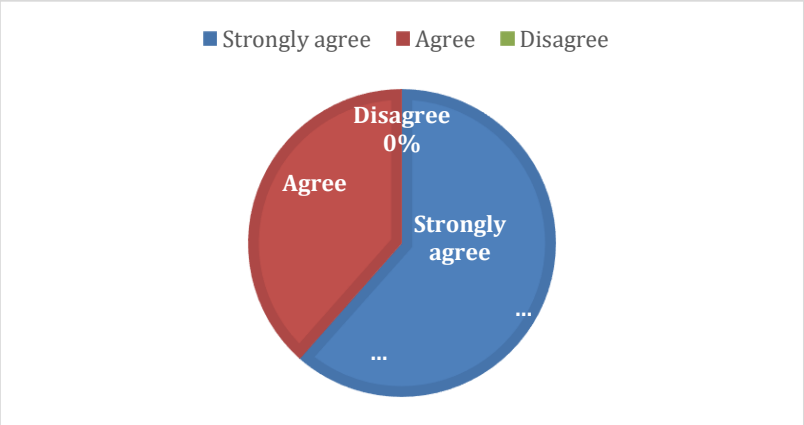

Figure 2. Results of teacher response questionnaire on potential *website* in learning.

The results of the questionnaire regarding the integration of ESD in learning, obtained in Figure 3. This result indicates that there is full support from teachers for the use of digital technology, especially website interactive learning media. In Figure 3, of the 22 Physics teacher respondents in Pemalang Regency, 45% of teachers have integrated ESD into their learning, 41% of teachers have understood the concept of ESD but have not integrated it into their learning, and 14% of teachers have not understood the concept of ESD in their learning. These results indicate a significant opportunity to strengthen the understanding and practice of ESD through the development of ESD-based learning media website.

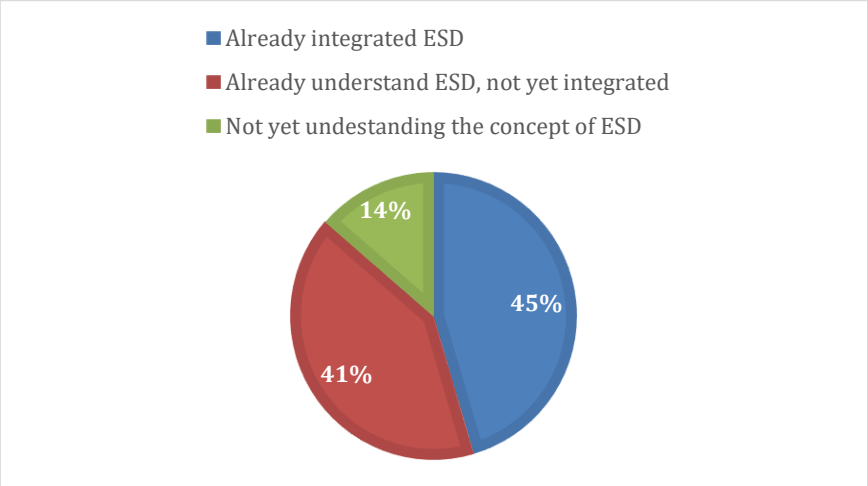

Figure 3. Results of teacher response questionnaires regarding ESD integration in learning.

Based on the student response questionnaire regarding the use of digital media and its potential website. Figure 4 shows that 20 of the 22 students (91%) agreed or strongly agreed that the use of digital media in learning provides benefits. These results indicate that most students have experience and are comfortable with digital-based learning. As many as 91% of students also stated that they agreed or strongly agreed with the potential website as a medium for learning Physics. These results align with

students' experiences, which show that most are accustomed to using digital devices, whether to access information, complete assignments, or communicate during learning activities. This experience strengthens their comfort level in utilizing digital media, so it is natural that the majority of students responded positively to the website's potential as a medium for learning Physics. Thus, the high percentage of student acceptance (91%) not only reflects an enthusiastic attitude but is also supported by their skills and habits in using digital technology in their daily lives. These findings indicate that students are generally open and enthusiastic about using digital platforms that can support their learning process, especially if the media is designed interactively and contextually.

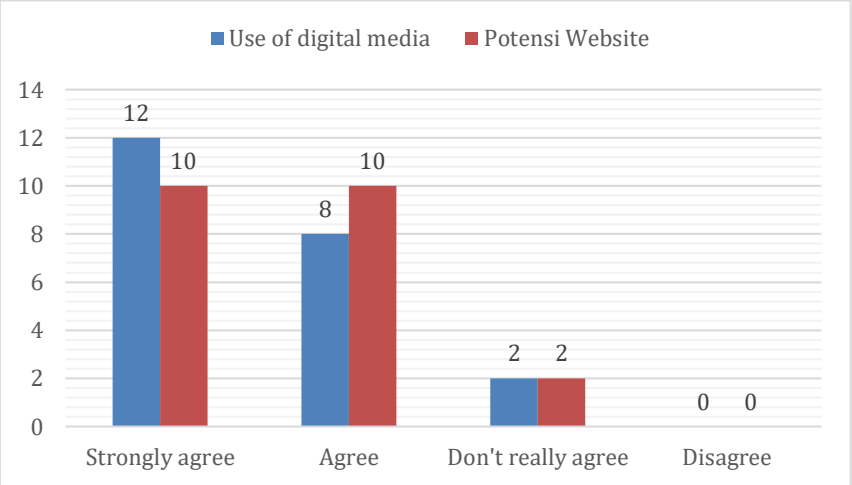

Figure 4. Results of student response questionnaires regarding the use of digital media and the potential of websites.

In addition to the questionnaire data, learning observations were also conducted with two fellow Physics teachers at SMA Negeri 1 Belik. The results showed that the teachers had used digital media in the learning tools they designed and implemented in the classroom. The learning observations also indicated that students had adequate equipment to participate in learning using digital media.

3.2 *Discussion*

There is a moderate influence on the use of learning media based on website on students' cognitive learning outcomes. Research shows that web-based learning media has a moderate positive impact on students' cognitive learning outcomes in productive subjects [17]. This effect is consistent across various levels of education, from primary to higher education [12]. The use of web-based learning media website can be implemented in the productive learning process [18]. Literacy, especially digital literacy, has a crucial role in facing the current era of technology and information [19]. ESD-oriented learning can improve students' creative thinking skills in physics education [15].

Physics teacher respondents in Pemalang Regency, many are accustomed to using digital media in their lessons, but many have not yet integrated ESD into their teaching. The results from the 22 student respondents at SMA Negeri 1 Belik indicate that they responded positively and are familiar with digital media, supported by the devices they already have. This is also supported by classroom observation data, which indicates that teachers have used digital media in their learning process.

The results of the questionnaire show that both teachers and students have positive perceptions and readiness in integrating digital technology, especially website, in ESD-oriented Physics learning. This support is reinforced by recent literature emphasizing the importance of teachers' digital competence, the use of interactive technology in learning, and the integration of sustainability values in education. In addition to questionnaire data, observations of two Physics teachers at SMA Negeri 1 Belik indicate that teachers have begun utilizing digital media, as reflected in the learning tools they have designed and implemented in class. Observations also revealed that most students have adequate devices to participate

in digital-based learning. This finding aligns with the analysis of teachers' learning tool documents, which demonstrate the integration of digital media into learning designs, although sustainability aspects have not yet been explicitly incorporated. However, it is important to note that ESD integration through website-based media also faces several obstacles. Some teachers still have limited digital skills and therefore require training and mentoring to optimally utilize the media. Furthermore, infrastructure limitations such as uneven internet access and the availability of digital devices can pose challenges to implementation. On the other hand, there is still ample potential for development, for example through enriching interactive features, providing contextual materials relevant to sustainability issues, and utilizing collaborative technology that allows students to be more active in constructing knowledge. Thus, the success of ESD integration through the website is not only determined by the readiness of teachers and students, but also by the support of systems, facilities, and sustainable development strategies. Therefore, the development website Interactive and ESD-oriented physics learning is a strategic step to improve the quality of learning in the digital era.

4. Conclusion

Instructional Media website ESD-oriented learning has great potential for application in Physics learning. Both teachers and students are prepared and have a positive outlook on the use of digital media, especially website, in Physics learning. Teachers generally have adequate skills in using digital technology, and students also show enthusiasm for digital-based learning website interactive. In addition, most teachers have become familiar with and begun to integrate the principles Education for Sustainable Development (ESD) into learning. This opens up great opportunities to develop learning media based on website which not only supports the understanding of Physics concepts, but also forms awareness of the importance of sustainability. Thus, the development and utilization of website ESD-oriented learning is a relevant and potential strategy in improving the quality of Physics education in the digital era. The practical implication of these findings is the need for training programs for teachers to improve digital skills as well as content development website interactive and contextual. Follow-up recommendations for media developers include strengthening the integration of ESD values into physics materials and providing features that encourage active student engagement in the learning process.

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