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DEVELOPMENT OF INTERACTIVE LEARNING MEDIA IN SCIENCE LEARNING BASED ON SOCIO-SCIENTIFIC ISSUES (SSI) TO IMPROVE DIGITAL LITERACY OF JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT

This study aims to produce interactive learning media based on socio-scientific issues on ecology and biodiversity material that is valid, practical and effective in improving digital literacy of junior high school students. This research uses the ADDIE development model with data collection techniques, namely observation, interviews, validation sheets, media use implementation sheets, digital literacy assessment rubrics, student response questionnaires and documentation. The results of the validation data analysis obtained a validity value of 92% with a highly valid category covering aspects of content validation, language and graphics. The results of the analysis of the practicability data obtained a value of 94% with a very practically category. The results of the effectiveness analysis based on digital literacy indicators obtained an n-gain of 0.50 in the medium category. The results of the effectiveness analysis were seen from the student questionnaire, which obtained a score of 85% in the very good category. Thus, the developed SSI-based interactive learning media products was considered to be valid, practical and effective to be applied in science learning for the improvement of digital literacy skills of junior high school students.

A. INTRODUCTION

Natural Sciences is a series of concepts that encompass processes, products, attitudes, and applications related to natural events or phenomena around us. Science learning emphasises the essence of science, which aims to shape students' scientific character so that they can assess information logically based on the data obtained (Qoidah et al., 2024). However, with the development of technology and the increasing diversity of information that needs to be analysed for accuracy and utilised as needed, digital literacy skills are essential for students to use information effectively in their learning process. Digital literacy is defined as an individual's ability to search for, understand, process, and utilise information from digital sources to meet specific needs (Putra et al., 2022).

Digital literacy is essential to develop, considering that 21st-century learning requires competencies in information and communication technology. Digital literacy can help students choose information that is relevant to science learning. Students can develop a critical mindset towards information, enabling them to distinguish credible information from less reliable sources and effectively address problems (Hasliyah et al., 2022). According to the research by Cynthia and Sihotang (2023), digital literacy is an effective tool for addressing the challenges of the information and technology era, where students are not only required to be active learners but also need to have the ability to process information from various digital learning sources.

Digital literacy in Indonesia has not yet reached a satisfactory level, according to a survey by the Ministry of Communication and Information Technology, which indicates that Indonesia's digital literacy index in 2021 was 3.49 on a scale of 1-5 (Katadata Insight Center, 2020). The low level of digital literacy among students is also supported by research from Erlianti dan Ardoni (2019) which shows that the level of digital literacy at SMP Negeri 4 Palembayan in West Sumatra is still categorised as low, based on the number of students who use gadgets only for social media and gaming purposes. In addition, the research by Pambudi and Windasari

(2022) revealed that the level of digital literacy among students in Blitar Regency is categorised as low, with an overall score of 2.61 measured from aspects including internet searching, understanding navigation cues on the web, and content evaluation.

Internal and external factors cause students' low digital literacy. Internal factors that affect students' digital literacy include intelligence, attitude, motivation, physical condition and health. External factors affecting students' digital literacy include inadequate infrastructure, low-quality education, school and family environments that prioritise learning outcomes over other aspects, and a lack of innovation in learning methods (Depari et al., 2022). Low digital literacy is often attributed to students' passive behaviour during learning (Sonia dan Yuliani, 2023). Meanwhile, interviews conducted at SMP Negeri 7 Jember revealed that seventh-grade students in class VII H lacked skills in technology utilisation, learning motivation, and interest in science reading. Additionally, teachers primarily used textbooks, workbooks, PowerPoint presentations, and YouTube videos as teaching aids.

Based on these issues, interactive science learning media innovations can be developed to improve students' digital literacy. The media is developed using a socio-scientific issues approach, considering that science learning is inseparable from the social science issues that exist in everyday life (Rifa'i dan Subiantoto, 2022). Socio-scientific Issues are social science issues that have no definite solution but tend to have problem-solving approaches from various perspectives (Zeidler, 2011). Information analysis skills can be developed through SSI-based learning by placing existing problems in the surrounding environment as the context for learning (Zeidler, 2011). Information analysis skills can be developed through SSI-based learning by placing existing problems in the surrounding environment as the context for learning (Nur et al., 2023). This finding aligns with those of Laksono et al. (2023), who stated that integrating learning media with SSI can enhance students' analytical skills, opinion-forming skills, problem-solving skills, and decision-making skills by scientific principles.

Meanwhile, discussions regarding the relationship between SSI and students' digital literacy are still being studied by the author and other researchers. The development of learning media is aligned with the concept of the independent curriculum, utilising Google Sites. SSI learning media is designed to be simple, user-friendly, and integrated with activities that foster digital literacy. The objective of this research is to develop valid, practical, and effective interactive science learning media based on a scientific approach to learning.

B. METHODS

This research uses development research (research and development) with the ADDIE development model by Branch (2009), namely: analyze, design, development, implementation, and evaluation (figure 1). The research subjects consisted of 30 students in class VII H at SMP Negeri 7 Jember. The technique used was purposive sampling with the criteria that students had devices such as smartphones and had internet access at school. Data collection consisted of primary and secondary data. The primary data consisted of validity, practicality, and effectiveness data. Secondary data consisted of interview results and documentation. The data analysis method in this study consisted of three parts, including analysis of the validity, practicality, and effectiveness of the product.

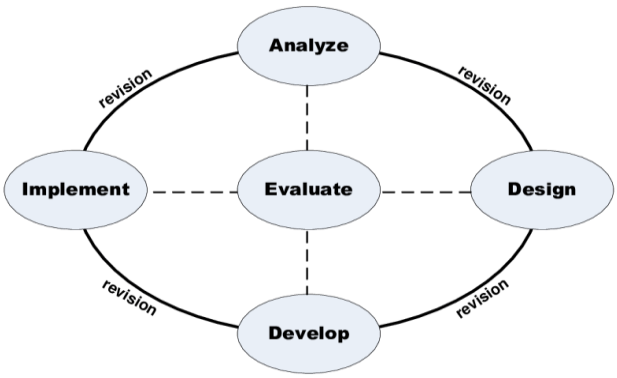

Figure 1. ADDIE Development Model
(Source: Branch, 2009)

Media validity calculations were analysed during the analysis, design, and development stages. Product testing was conducted during the development stage. The product validity percentage can be calculated as follows.

$$V = \frac{T_x \text{ (the sum total of expert ratings)}}{T_{xi} \text{ (the sum of all ideal values)}} \times 100\% \qquad (1)$$

The validity results can be compared with the validity level category based on the validity criteria table as follows.

Table 1. Criteria of Validity

No	Criteria of Validity	Category
1.	85% < V ≤ 100%	Highly valid
2.	70% < V ≤ 85%	Valid
3.	50% < V ≤ 70%	Less valid
4.	V ≤ 50%	Invalid

Nesri dan Kristanto, 2020

The practicality of a product can be analysed at the media implementation stage to measure how practical the media is. The percentage of product practicality can be calculated using the following formula.

$$P = \frac{T_{Se\ (sum\ of\ empirical\ practicality\ scores)}}{T_{Sh\ (maximum\ sum\ of\ scores)}} \times 100\% \qquad (2)$$

The practicality level category is based on the practicality criteria table as follows.

Table 2. Practicality criteria

No	Practicality criteria	Category
1.	85% < V ≤ 100%	Highly practical
2.	70% < V ≤ 85%	practical
3.	50% < V ≤ 70%	Less practical
4.	V ≤ 50%	Not practical

Nesri dan Kristanto, 2020

The level of media effectiveness in improving digital literacy can be determined in the evaluation and development model stages. Product effectiveness analysis can be carried out using the average N-gain score calculation, as described by Wahyuni *et al*., (2022) as follows.

$$N\text{-gain} = \frac{S_{post\text{-}test\ average} - S_{pre\text{-}test\ average}}{S_{maximum} - S_{pre\text{-}test\ average}} \times 100\% \qquad (3)$$

The known N-gain score can be compared with the n-gain category table as follows.

Table 3. N-Gain Category

Low	Medium	High
(g) < 0,3	0,3 ≤ (g) < 0,7	0,7 ≥ (g)

In addition to product effectiveness data based on N-gain, effectiveness analysis was also carried out using a response questionnaire using the following formula.

$$RS = \frac{Sum\ of\ students\ who\ voted}{The\ total\ number\ of\ students} \times 100\% \qquad (4)$$

The categories of student responses are presented in the following table.

Table 4. Student Response Criteria

No	Student Response Criteria	Category
1.	85% ≥ RS	Very good
2.	70% ≤ RS < 85%	good
3.	50% ≤ RS < 70%	Less good
4.	RS < 50%	Not good

C. RESULTS AND DISCUSSION

The results of this study are interactive learning media based on socio-scientific issues using Google Sites tools. Before testing the validity, effectiveness, and practicality, an analysis and design stage was carried out first. The analysis stage included material analysis, student characteristic analysis, and environmental analysis. The design stage continued with the inclusion of material, student activities, and tests into interactive learning media based on socio-scientific issues. The design results of the media are shown in Figure 2. The appearance of the learning media is as follows.

Figure 2. Display of learning media

The finished learning media is uploaded on the google sites platform to generate links: https://tinyurl.com/yc6wnhkn which allows users to view and utilize the learning media anytime and anywhere through devices connected to the internet. The learning media that has been completed will be tested for validity, practicality, and effectiveness which can be described as follows.

1. Product validity

The validity of a product can be determined by validating it, specifically interactive learning media based on SSI, using Google Sites. The aspects assessed by the validator include content suitability, linguistic suitability, and suitability of presentation and graphics. Content suitability encompasses assessment criteria such as the material's alignment with the curriculum and its relevance to learning outcomes. The linguistic aspect is assessed by

considering the use of standard language and sentence structure. Similarly, the graphical aspect is assessed by considering the presentation of the material, ease of access to the media, and the suitability of the illustrations to the material. The results of assessing these three aspects will produce a product validity analysis to determine the suitability of the product for testing in the learning process (Depdiknas, 2008).

Product validation was conducted by three validators, comprising two science education lecturers from Jember University and one science teacher from SMP Negeri 7 Jember. The three validators assessed the validity form, which aims to evaluate the quality and suitability of the learning media for learning needs, such as the curriculum, integration of social science issues with the material, activities related to digital literacy indicators, and the sources of images included in the learning media.

Based on the data in Table 5, the validity of SSI-based interactive learning media is demonstrated, indicating that it meets valid criteria. These criteria were established based on an average score of 92% across three aspects: content feasibility, language feasibility, and presentation and graphics feasibility. This score indicates that the interactive learning media developed is suitable or valid for use in learning. In line with Surjono (2017), interactive learning media can be suitable if the material aligns with learning objectives, uses appropriate language, is presented accurately, offers easy navigation, and provides quality feedback or is responsive to students.

Learning media can be interactive if they can store and present access to information in various forms, including text, images, audio, and video. Additionally, interactive learning media should incorporate interaction between students' active responses and educators' feedback. Usually, interactive learning media involve the utilisation of technology in the form of software to create student involvement in the learning process, making learning more interesting, compelling, and memorable for students (Amatullah dan Ab, 2022). The use of technology-based learning media can create a fun and interactive learning atmosphere. The advantages of technology-based interactive media include the ability to increase student motivation and involvement during learning (Suryadi, 2020).

The characteristic that distinguishes SSI-based interactive learning media from other learning media is the presentation of material that combines social-science issues (SSI) and activities that train students' digital literacy. This encourages students to think critically and wisely in choosing valid information. The selection of SSI in learning can make learning more relevant to students, improve the ability to evaluate information, and enhance scientific literacy (Afrilya *et al.,* 2022). The process of digital literacy consists of managing information from various digital sources, including analysing and evaluating, reflecting, creating, acting, and accessing information. (Nurcahyo, 2020). The product validity results are explained in more detail in the following Table 5. Validity of SSI-based learning media

Table 5. Validity of SSI-based learning media

No	Aspect	Validator Percentage (%)			Percent %	Category
		1	2	3		
1.	Content eligibility	92	97	94	94	Highly valid
2.	Language eligibility	88	88	100	92	Highly valid
3.	Presentation and graphic eligibility	91	88	90	89	Highly valid
	Total	90	91	95	92	Highly valid

2. Product practicality

The practicality of the product can be determined by examining whether it contains materials that can be utilised, is user-friendly for both teachers and students, and aligns with the developer's intentions and objectives. Curriculum and operational consistency are important considerations in determining the practicality of the product. If both of these are consistent, then the product can be considered practical (Nieveen, 1999). The results of the product practicality analysis conducted at the implementation stage, through product trials, are presented in the following table.

Table 6. Practicality of SSI-based learning media

Assessment activities	Encounter (%)						Percentage (%)	Category
	1	2	3	4	5	6		

Open learning media	96	100	100	100	92	93	97	Highly practical
Accessing materials and activities in the media	96	96	100	96	92	96	96	Highly practical
Analyze information on activities in the media	96	96	96	92	92	90	93	Highly practical
Discuss the results of analyzing activities in the media	92	92	100	83	92	93	92	Highly practical
Assignment	97	92	94	91	97	96	94	Highly practical
Total							95	Highly practical

The results of implementing learning using SSI-based interactive learning media showed an average percentage of 85%, meeting efficient criteria. These results criteria are based on the average outcomes of the learning implementation over six meetings, which included assessment activities such as opening learning media, accessing materials and student activities, analysing information on activities in the media, discussing the results of activity analysis, and assignments. Media can be said to be practical if it has been implemented in the field, are easy to use, and provide benefits in the learning process (Benda *et al*., 2022).

3. Product effectiveness

The effectiveness of SSI-based interactive learning media in enhancing students' digital literacy can be assessed through pre-test and post-test instruments that include questions with digital literacy indicators. The pre-test was conducted prior to the learning process to determine the students' initial digital literacy scores, with an average score of 41.25. The pre-test results indicate that students' digital literacy scores were still low before the use of interactive learning media based on SSI during the learning process. The lack of learning media use during the learning process tends to make students less interested or prone to boredom when participating in the learning process (Purniasih *et al*., 2024).

Meanwhile, the post-test scores obtained after learning with SSI-based interactive media using Google Sites yielded an average post-test score of 70.5. According to Nurcahyo (2020), the use of learning media can increase interactivity and hone students' digital literacy skills. The use of learning media can provide students with opportunities to explore information from digital learning sources.

Further analysis of the effectiveness of SSI-based learning media in improving students' digital literacy can be obtained through the calculation of the N-gain value. The results of the N-gain calculation analysis obtained an average score of 0.50, indicating that the use of SSI-based learning media is moderate in improving students' digital literacy. These results align with the research by Setianingsih *et al*., (2024), which states that moderate increases in N-gain occur when students are provided with information and guidance on how to use the media effectively in learning during its use. Additionally, the effective use of technology by teachers also contributes to the improvement of digital literacy.

Table 7. Practicality of SSI-based learning media

Total number of student	*Pre-test*	*Post-test*	*N-gain*	criteria
30	41,25	70,5	0,50	medium

The improvement of students' digital literacy is influenced by several factors, including collaboration, analysis, evaluation, and questioning skills (Naufal, 2021). Distractions from other platforms, such as social media, students' lack of interest in reading, and their tendency to be passive during learning, tend to affect students' digital literacy. Additionally, students' moderate digital literacy is attributed to varying cognitive abilities, leading them to use technology for less beneficial purposes rather than accessing knowledge. The lack of integration in media use is one factor contributing to the moderate improvement in digital literacy. The overall effectiveness of media across each indicator is evident in the table below.

Table 8. Effectiveness of Digital Literacy for Each Indicator

Digital literacy indicators	Activities	N	Value	*N-gain*	Category
Access	*Pre-test*	30	36,3	0,28	Low
	Post-test		54,4		
	Pre-test		32	0,10	Low

Analyze and Evaluate	*Post-test*	39		
Act	*Pre-test*	30	0,26	Low
	Post-test	48,7		
Create	*Pre-test*	31	0,52	Medium
	Post-test	67		
Reflect	*Pre-test*	43	0,52	Medium
	Post-test	73		

(Hobbs, 2017)

The analysis results for the access indicator obtained an N-gain score of 0.28, which is classified as low. One of the contributing factors is the lack of explicit instructions on how to use the media, which prevents students from understanding how to use it effectively. The lack of guidance in identifying and selecting appropriate information sources within the media also affects students' ability to access information according to their learning needs. As stated by Anggia et al., (2022), students' access to and ability to act upon learning media are important insights or requirements for students to become skilled in using learning media. Information analysis is also a key factor in improving students' digital literacy skills.

Low n-gain scores were also found in the indicator of analysing and evaluating information, with an N-gain score of 0.10. These low n-gain scores indicate that activities in SSI-based interactive learning media have not fully encouraged students to analyse and evaluate information in depth. Some students follow the steps in the media procedure without engaging in the process of analysing and reflecting on the digital information presented. Additionally, there is a need to strengthen students' ability to read comprehensively and understand the content of information, as some students only access the title or summary in line with the opinion of Yusniati *et al.,* (2023), who stated that students' dependence on the internet without having good information processing skills impacts their digital literacy. This results in students tending to passively accept information without verifying the sources they need to answer problems.

Low n-gain scores were also found in the action indicator, with an average N-gain score of 0.21. Low n-gain scores indicate that the learning media did not fully facilitate students to actively discuss and summarise information. The complexity of information in the media may be one of the challenges, especially if the activities within the media are not accompanied by guidance. Additionally, the learning strategies used have not fully encouraged students' active involvement in discussing key points that need to be summarised and presented. In line with the statement by Anggia *et al.,* (2022), it is essential for students to consistently collaborate in managing information contained in the media or originating from other sources, enabling them to produce high-quality information. This collaboration also plays a role in enhancing students' digital literacy skills, including the ability to evaluate, sort, and convey information accurately and responsibly.

The results of the indicators of creation and reflection contained in the learning media showed a moderate increase. The indicators of creation and reflection improved students' digital literacy, with an N-gain score of 0.52, classified as moderate. These results indicate that students have fairly good abilities in creating, compiling accurate and precise information, and paying attention to ethics. The increase in the N-gain score for the creation indicator is due to the learning media training students to create questions and digital posters, which contain reflective activities by providing solutions to environmental problems included in the media. In line with Anggia *et al.,* (2022), who stated that activities involving the creation of digital media can influence students' digital literacy skills. Additionally, improvements in students' digital literacy are influenced by several factors, such as collaboration skills, analysis, evaluation, and questioning (Naufal, 2021).

In addition, digital literacy is not only about being able to operate technological features, but also training students' ability to understand content and critically evaluate readings contained in digital learning resources (Cynthia dan Sihotang, 2023). The implementation of the independent curriculum, which is currently related to digital competence, requires students to have good digital literacy in order to utilize technology more wisely. In addition, it is important for both teachers and students to have the awareness that digital literacy can be an effective strategy to face the digitalization era as it is now (Dewi dan Sunarni, 2024).

The effectiveness of SSI-based interactive learning media is also reviewed from students'

responses to the learning media that has been used. The results of student responses were obtained through a student response questionnaire consisting of 12 questions, namely 6 positive questions and 6 negative questions. The purpose of analyzing student responses is to find out student responses after using interactive learning media. The results of the student response questionnaire analysis can be seen in the following table.

Table 9. Student response results

Aspect	Total questions	Percent (%)	Categori
Interest	12	83	Excellent
Satisfaction		85	Excellent
Motivation		86	Excellent
Total		92	85

The results of student responses to the use of learning media show an average of 92% and are included in the excellent category. Technology-based learning media can improve students' literacy activities, attract students' attention, and be effective in the learning process (Prasetyo dan Patmisari, 2024). Positive responses indicate the attractiveness of the technology in increasing engagement and interest in learning and accelerating concept understanding (Wahyuni *et al*., 2023).

D. CONCLUSIONS AND SUGGESTIONS

The results of the validity analysis of SSI-based interactive learning media on ecology and biodiversity material with an average of 92% indicate that the learning media that has been developed has met the valid criteria. Therefore, learning media can be said to be feasible as a science learning tool in junior high school. The practicality of SSI-based learning media obtained based on the learning implementation sheet for 6 meetings obtained an average of 95% so that it was classified as very practical when used in learning. The results of the analysis of the effectiveness of SSI-based learning media in terms of pre-test and post-test results obtained an average N-gain score of 0.52 with a moderate category and obtained an average N-gain score indicator with a moderate category and the results of student responses are very good so that learning media can be said to be effective when used in learning.

The results of the analysis of the validity, practicality, and effectiveness of SSI-based interactive learning media obtained an average score of 92% for product validity. These results indicate that the learning media developed meet the validity criteria. Meanwhile, the practicality of SSI-based learning media, as assessed over six sessions, yielded an average score of 94%, indicating that it is a convenient learning medium. However, the analysis of the effectiveness of learning media based on pre-test and post-test results yielded an average N-gain score of 0.50, categorised as moderate, suggesting that the development of SSI-based learning media could be further explored to enhance its effectiveness in improving students' digital literacy.

The limitation of this study is that the use of learning media was conducted over a relatively short period, so the long-term effects of its use have not been thoroughly analysed. In future research, learning media can be developed by adding usage guidelines and interactive activities that include digital literacy indicators. Recommendations for other researchers include conducting reflections at each session to enhance the effectiveness of learning media in improving students' digital literacy.

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