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Validity Analysis of Electronic Student Worksheets Based on Guided Inquiry to Improve Students' Critical Thinking Skills

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ABSTRACT

This research was motivated by the fact that the teaching materials used in physics learning are still largely dominated by conventional textbooks, teacher's books, and Student Worksheets (SWS). The aim of this study is to develop guided inquiry-based Student Worksheets that can enhance students' critical thinking skills in the topics of temperature and heat. The developed Student Worksheets are expected to be not only valid in terms of content and structure but also effective in facilitating a more meaningful learning experience for students. This study employs a Research and Development (R&D) approach. The validation process was carried out by three physics lecturers from the State University of Padang (UNP). The analysis of the validation instrument results showed that the developed Student Worksheets obtained a validation score of 0.95, which falls into the "very valid" category. Therefore, the product developed in this study a guided inquiry-based Student Worksheet is considered valid and suitable for use as an innovative teaching material to improve students' critical thinking skills in understanding the concepts of temperature and heat.

INTRODUCTION

In the 21st century, the development of digital information has become a major feature that marks major changes in various aspects of life. Society is now massively connected through information technology networks, giving rise to a new industrial revolution, especially in the information and communication sector. The digital era has brought significant impacts in various fields, including in the world of education, where 21st century learning must be able to prepare the next generation to be ready to face rapid developments in information and communication technology (Rahayu, Iskandar, and Abidin 2022). In the technological disruption era, education goals have evolved to emphasize students to possess 21st-Century Skills(Novitra et al. 2021).

In this 21st century, everyone is required to be able to adapt and adjust to the sophistication of technology and Human Resources. Competence is needed so that learners have the competence to innovate and create, so that they can create new ideas and results with their innovation and creativity (Ahzari, 2024). Education will continue to develop by the

demands of the 21st century. This is marked by the use of science and technology in all aspects of life. The demand one must have in life in the 21st century is to master a variety of skills one important aspect that must be prepared in facing the challenges of the 21st century is the development of learner skills (Fernando et al. 2021). These skills are known as "The 4Cs," namely critical thinking, creativity, communication, and collaboration (Winarmo, 2024). 4C skills are soft skills that can be used in everyday situations(Sari et al. 2023).

The 21st-century skills help students reason, understand, analyze, and solve problems through critical thinking(Sari et al. 2020). This principle is in line with the educational concept applied by the Ministry of Education and Culture of the Republic of Indonesia in curriculum development, which emphasis the importance of 21st century skills in the national education system. The transformation from the 2013 Curriculum (K13) to the Independent Curriculum is one of the concrete steps in an effort to improve the quality of education and adapt to the demands of the times. The Independent Curriculum is designed to provide learning experiences that are more flexible, support exploration, and adapt to the individual needs of students in facing the challenges of the 21st century (Sartini and Mulyono 2022).

In the context of 21st century education, students need to be trained to think creatively and indicatively and build their own understanding through a scientific process based on student-centred learning. This is confirmed by the Minister of Education, Culture, Research and Technology Regulation Number 12 of 2024 which stipulates the Independent Curriculum as the basic framework and curriculum structure for all levels of education in Indonesia. The Independent Curriculum emphasis student-centred learning, fosters curiosity, and develops critical thinking skills. In this case, the inquiry approach is very relevant because it involves students actively in exploration, discovery, and problem solving. Therefore, the inquiry-based learning model is one of the highly recommended methods in implementing the Independent Curriculum in order to achieve the expected educational goals. The Independent Curriculum aims to provide a more holistic and inclusive approach that emphasis character development, creativity, and critical thinking skills, in addition to academic knowledge (Herdila et al., 2024).

The guided inquiry learning model is one approach that is very effective in improving students' understanding of a concept. This model emphasis the process of actively seeking knowledge, where learners are directed to find their own learning material through scientific methods. In this model, the teacher plays a more active role in guiding students in finding answers to the problems given. The advantages of the guided inquiry learning model are that it can arouse motivation and passion for learning for students to learn more actively, provide opportunities to develop and advance according to their respective abilities and interests, help students to develop readiness and mastery of skills in the cognitive process (Yuzan & Jahro, 2022) . Thus, conclusions can be obtained more quickly and students' understanding of the material becomes deeper (Nurdyansyah and Fahyuni 2016).

In order for guided inquiry-based learning to run optimally, interesting teaching materials are needed and in accordance with current technological developments. Teaching materials used in learning should be designed in such a way as to improve students' critical thinking skills. Students need teaching materials that are relevant to the needs and development of the times. The teacher's ability to design and develop effective teaching materials is an important factor in optimist learning (Dwi Ummu and Herlina Usman 2023). There are various types of teaching materials used in the learning process, both in printed

form such as books, modules, and SWS, as well as non-print teaching materials such as film media, PowerPoint presentations, and E-SWS (Sati and Mutmainnah 2023).

According to Pribadi, Sholeh, and Auliaty (2021), E-SWS is a type of SWS that can be accessed digitally via the internet network. E-SWS is designed in a digital worksheet format that can be filled in directly by students and has the potential to improve their critical thinking skills. Critical thinking ability is a crucial aspect in building 21st century skills, considering the challenges of the glocalization era are increasingly complex and require individuals to be able to solve problems independently (Arman Cahyanto, Lesmono, and Handayani 2022). Critical thinking skills not only help learners in understanding academic concepts, but also equip them with skills that are useful in social and professional life (Sri Adhi Endaryati, St. Y. Slamet, and Kartika Chrysti Suryandari 2023). Ennis (2011) defines critical thinking as reflective and reasonable thinking that focuses on decisions about what to believe or do. Critical thinking includes skills such as analysis, evaluating, and concluding based on logical reasoning and strong evidence. Critical thinking is needed for problem solving in everyday life (Devi, 2022). Previous research shows that E-SWS based on guided inquiry has been proven valid in improving students' critical thinking skills. Aritonang (2023) stated that the development of E-SWS based on guided inquiry can increase the validity of learning based on critical thinking skills. In addition, research by Riski Safitri et al. (2023) found that the developed guided inquiry-based physics E-SWS was declared valid and practical in improving students' critical thinking skills. Therefore, the application of E-SWS based on guided inquiry is an innovative solution in supporting effective learning and in accordance with the demands of the 21st century.

According to research conducted by Hufri, Dwiridal, and Yulia Sari (2021), the teacher's ability to develop technology-based learning scenarios is still not optimal, so that the utilization of digital learning media is not optimal. This is reinforced by the results of a case study conducted at UNP Laboratory Development High School, which shows that physics teachers at the school still tend to rely on conventional teaching materials such as teacher books, student books, and printed SWS. The use of technology in learning is still limited, and teachers have not fully utilized digital media and interactive learning platforms available. This condition is one of the main reasons why technology-based learning cannot be implemented effectively, even though the supporting facilities and infrastructure are already in place.

Therefore, this study aims to develop and test the validity of guided inquiry-based E-SWS products as an alternative teaching material that is more innovative and effective in improving students' critical thinking skills. With the presence of E-SWS based on guided inquiry, it is expected that teachers can more easily integrate digital media in learning, so that students have access to teaching materials that are more interesting, interactive, and able to improve their critical thinking skills. In addition, this research is also expected to be the first step in encouraging teachers to be more active in developing and using technology-based teaching materials, so that physics learning becomes more contextual, interesting, and in accordance with the demands of 21st century learning.

METHODS

This study employs the Research and Development (R&D) method using Sugiyono's development model. This model consists of ten stages: identifying potential and problems, data collection, product design, product validation, product revision, product trials, product revision, trial use, product revision, and mass production. However, this research is limited to the validation stage of the E-SWS. Therefore, the research steps include identifying

potential and problems, data collection, product design, and product validation to assess the validity of the developed E-SWS.

The research process begins with identifying potential and problems, followed by data collection conducted at the UNP Laboratory Development High School. Next, the product design stage involves structuring the E-SWS, including components such as the title, learning instructions, expected competencies, supporting information, guided inquiry-based task steps, evaluation, and bibliography. After the product is designed, it undergoes validation by experts using a per-validated validation instrument. The validation process assesses several aspects, including E-SWS components, material content, visual communication, instructional design, software utilization, guided inquiry model alignment, and its contribution to developing critical thinking skills.

The validity of the product is assessed based on seven key indicators: E-SWS components, material content, visual communication, instructional design, software utilization, alignment with the guided inquiry model, and enhancement of critical thinking skills. Each aspect is evaluated using a Likert scale ranging from 1 to 5, with higher scores indicating a higher level of validity. The validity of the product is determined using Aiken's validity index, and a product is considered valid if it meets the minimum criterion of **≥ 0.92**, as established by Aiken (1985).

The data collection instrument used in this study consists of a validation sheet completed by three physics lecturers from Padang State University (UNP). The validation sheet includes various evaluation aspects such as material content, visual design, instructional feasibility, and the product's effectiveness in enhancing critical thinking skills. Before being used, the validation instrument is tested to ensure its reliability and accuracy. The data obtained from the validation sheet serve as the basis for determining the validity level of the developed product.

The data obtained from the validation process were analyzed using Aiken's validity index to determine the appropriateness and validity of the developed E-SWS. The scores provided by the validators were converted into a scale of 1 to 5 (Sugiyono, 2012) and processed using Aiken's formula to obtain the validity coefficient. The Aiken's V formula is as follows:

$$V = \frac{\Sigma s}{n\,(c-1)} \quad (1)$$

The final calculation results determine whether the E-SWS meets the predetermined validity criteria. If the validity score reaches or exceeds the minimum threshold of 0.92 (Aiken 1985), the product is considered highly valid and suitable for use as an innovative teaching material in guided inquiry-based physics learning.

RESULTS AND DISCUSSION

Result

The main objective of this research is to develop and produce valid guided inquiry-based E-SWS to improve students' critical thinking skills on temperature and heat material. This E-SWS development aims to provide digital teaching materials that are more interactive and in accordance with the needs of technology-based learning. In the potential and problem identification stage, an analysis of the learning conditions at UNP Laboratory Development High School was carried out. Based on the results of observations, this school has great potential in the utilization of technology in the learning process, given the adequate infrastructure and supporting facilities. However, the problem faced is that the utilization of

technology by teachers in learning is still limited. Many teachers have not fully utilized technology optimally, so the use of digital media in learning is still minimal.

The next stage, data collection, was conducted to obtain more information about the learning conditions at the school. The analysis of the collected data revealed that E-SWS had not been fully utilized in the learning process. Most teachers still relied on textbooks, teacher's books, and printed worksheets as the primary teaching materials. This finding highlights the need to develop more innovative digital teaching materials that can enhance students' engagement in learning. To address this issue, at the product design stage, the development of E-SWS was carried out using Canva as the design platform, and the resulting product was made accessible to students through the Live worksheets site.

In designing the E-SWS, its structure was carefully developed to include several key components: title, learning instructions, competencies achieved, supporting information, tasks or work steps based on guided inquiry syntax, evaluation, and bibliography. Each of these components was structured to ensure that the E-SWS effectively supports the learning process and improves students' understanding of physics concepts. Once the development process was completed, the next crucial step was product validation, which aimed to assess whether the E-SWS met the required feasibility standards for use in learning. This validation process involved a thorough evaluation of several essential aspects to determine its suitability for classroom implementation. The key components assessed included E-SWS structure, material substance, visual communication display, learning design, software utilization, guided inquiry model, and critical thinking skills. The feedback obtained from this validation stage was essential for refining the E-SWS before its final implementation.

The first component assessed in the validity instrument is the E-SWS component. The feasibility assessment of the E-SWS focuses on four key aspects: 1) material presentation, 2) language use, 3) usability, and 4) graphic design. The material presentation is analyzed to ensure the clarity and accuracy of the content, verifying its alignment with the learning objectives. The language use is evaluated to assess the readability and appropriateness of the text, ensuring that it is easily understood by students. Usability is measured to determine how effectively the E-SWS supports learning activities and enhances students' conceptual understanding. Lastly, the graphic design is reviewed to confirm that the visual elements contribute to a more engaging and interactive learning experience. The validity analysis results for these components in the developed E-SWS are presented in Figure 1.

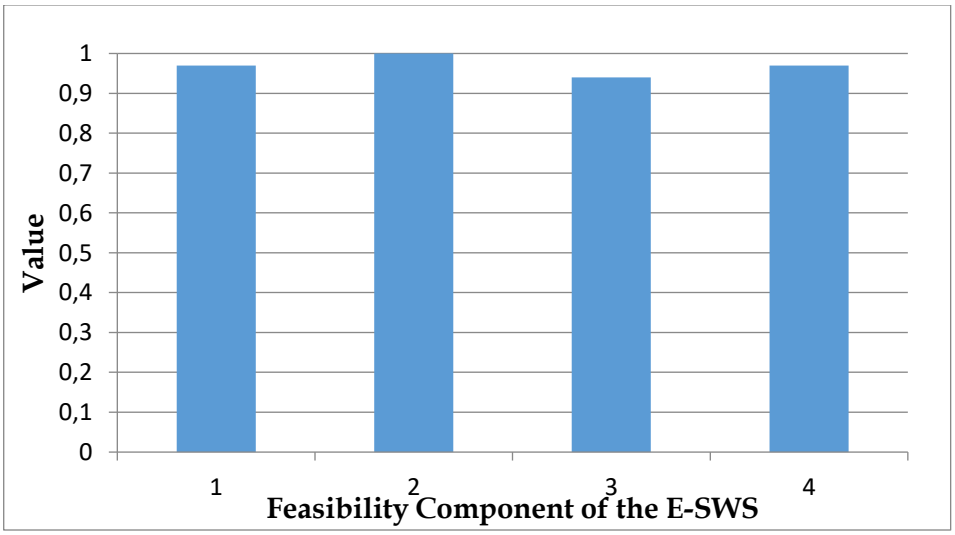


Figure 1. Feasibility Component of the E-SWS

Based on Figure 1, the validity results of the E-SWS, particularly in the feasibility component, show a score range between 0.92 and 1.00. In more detail, the material presentation component received a score of 0.97, placing it in the valid category. The language component achieved the highest score of 1.00, confirming its validity. The usability aspect obtained a score of 0.94, also categorized as valid. Lastly, the graphic design component received a score of 0.97, indicating its valid status. Overall, the average validity score based on the content suitability component is 0.97, classifying it within the valid category.

The second component of the validity instrument is the material substance, which consists of four key aspects: 1) accuracy of content, 2) material coverage, 3) relevance to learning objectives, and 4) readability. This component is essential in ensuring that the information presented in the E-SWS is scientifically accurate, comprehensive, and aligned with the curriculum. Additionally, evaluating readability helps determine whether the language used is clear and understandable for students, allowing for effective learning. The analysis of the validity scores for the material substance component is presented in Figure 2.

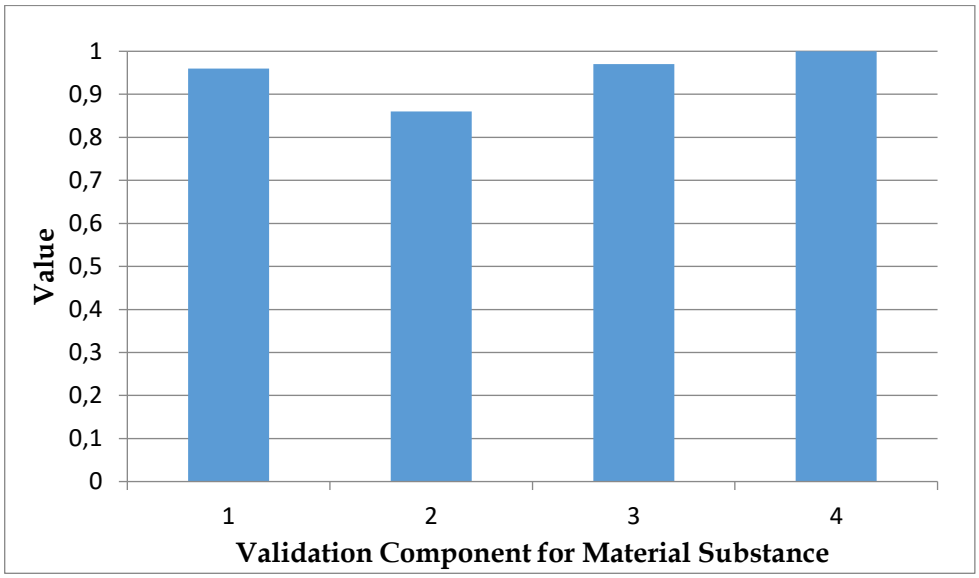


Figure 2. The Validation Component for Material Substance

Based on Figure 2, the validity results of the E-SWS, particularly in the material substance component, show a score range between 0.86 and 1.00. In more detail, the accuracy of the content received a score of 0.96, which falls into the valid category. The material coverage component obtained the lowest score of 0.86, indicating that it requires further improvement to meet validity standards. Meanwhile, the current's aspect, which ensures the relevance and up-to-date nature of the material, scored 0.97, placing it in the valid category. Lastly, the readability aspect achieved the highest score of 1.00, confirming that the text is clear and easily understandable for students. Overall, the average validity score for the material substance component is 0.94, which is categorized as valid.

The third component of the validity instrument is the visual communication display, which plays a crucial role in ensuring that the E-SWS effectively conveys information in a clear, engaging, and accessible manner. This component consists of five key aspects: (1) navigation, (2) font, (3) media, (4) color, and (5) layout. Each of these aspects contributes to the overall effectiveness of the digital learning material by enhancing readability, ease of use, and visual appeal. A well-structured visual communication design not only supports the scientific accuracy and comprehensiveness of the content but also ensures alignment with the curriculum. Additionally, an intuitive and visually appealing interface can significantly

improve students' comprehension and engagement, making the learning experience more interactive and immersive. The analysis of the validity scores for the visual communication display component, as presented in Figure 3, provides insights into the effectiveness of these design elements in supporting the learning process.

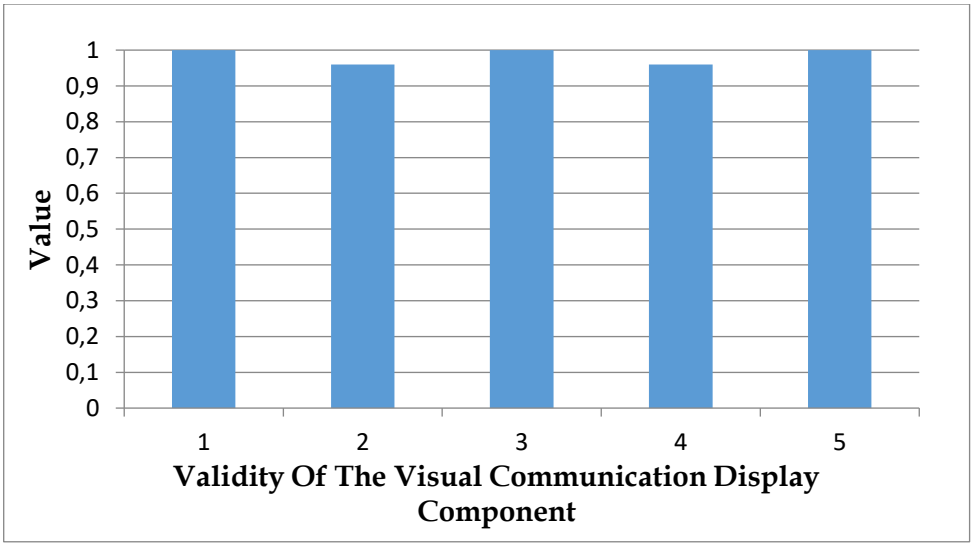


Figure 3. The Validity Of The Visual Communication Display Component

Based on Figure 3, the validity results of the E-SWS, specifically in the visual communication display component, show a score range between 0.96 and 1.00. This indicates that the visual presentation of the worksheet meets high standards in terms of clarity and effectiveness. In more detail, the navigation aspect obtained a perfect score of 1.00, categorizing it as valid, which suggests that users can easily navigate through the content. The font component received a score of 0.96, ensuring that the text is legible and appropriately formatted for readability. Additionally, the media component achieved a score of 1.00, indicating that multimedia elements effectively support the learning process. Furthermore, the color component was rated 0.96, confirming that the color scheme enhances visual appeal without causing distraction. The layout aspect also achieved a score of 1.00, meaning that the arrangement of content is well-structured and organized for ease of understanding. A well-designed layout is essential for ensuring that students can efficiently process the provided information. Overall, the average validity score for the visual communication display component is 0.98, which falls into the valid category. This suggests that the design elements of the E-SWS effectively contribute to an engaging and accessible learning experience.

The fourth component of the validity instrument is learning design, which serves as a critical framework for structuring the E-SWS to ensure clarity, coherence, and alignment with instructional goals. This component comprises eleven key aspects: (1) title, (2) compiler, (3) learning outcomes, (4) learning objectives, (5) learning objective flow, (6) learning achievement indicators, (7) learning instructions, (8) supporting information, (9) tasks and work steps, (10) assessment/evaluation, and (11) references. Each of these elements plays a fundamental role in guiding both students and educators through a well-organized and systematic learning process. A well-structured learning design enhances the effectiveness of content delivery, ensuring that students can easily follow and comprehend the material. Clear learning objectives and structured instructions provide a logical progression of knowledge, facilitating deeper understanding and meaningful engagement with the subject

matter. Additionally, a well-designed E-SWS supports educators in planning and implementing lessons that foster active learning, critical thinking, and student-centered exploration. The validity score analysis for the learning design component, as presented in Figure 4.

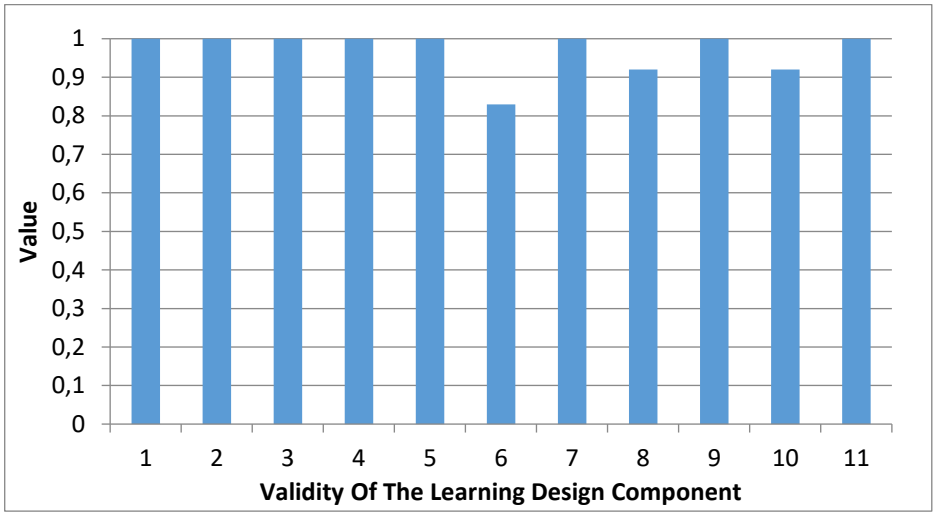


Figure 4. The Validity of the learning design component

Based on Figure 4, the validity results of the E-SWS, particularly in the learning design component, show a score range between 0.83 and 1.00. This component ensures that the learning structure aligns with educational objectives and enhances students' comprehension. In more detail, the title, compiler, learning outcomes, learning objectives, and learning objective flow each received a score of 1.00, indicating their strong validity in guiding the learning process. These elements help provide clear learning targets, ensuring that students understand what they are expected to achieve. However, the achievement indicators of learning objectives received a score of 0.83, which places it in the invalid category. This suggests a need for improvement in defining measurable learning outcomes. The learning instructions scored 0.96, while the supporting information received 0.92, both of which fall into the valid category. Clear learning instructions help students navigate the activities effectively, while supporting information provides additional context for better understanding. Additionally, the tasks and work steps obtained a perfect score of 1.00, ensuring that they are well-structured and aligned with the guided inquiry model. The assessment/evaluation component received a score of 0.92, verifying its validity in measuring student progress. Lastly, the reference aspect also achieved a score of 1.00, confirming that credible sources support the worksheet's content. The overall average validity score for the learning design component is 0.97, classifying it as valid.

The fifth component of the validity instrument is software utilization, which includes three essential aspects: interactivity, supporting software, and originality. Interactivity ensures that students receive immediate feedback, allowing them to correct mistakes and reinforce their understanding in real time. This aspect plays a crucial role in enhancing student engagement and fostering a more dynamic learning experience. Supporting software refers to the technological tools used to create and deliver E-SWS, which must be designed to ensure ease of access, smooth navigation, and overall user-friendliness. The availability of well-integrated supporting software enhances the effectiveness of digital learning by minimizing technical difficulties that may hinder the learning process. Meanwhile, originality assesses the uniqueness and authenticity of digital learning materials, ensuring that they are free from plagiarism and promote creative and innovative content

development. Maintaining originality in educational software is essential to providing high-quality, credible resources that support meaningful learning. To evaluate the effectiveness of software utilization, a validity score analysis was conducted, highlighting the strengths and areas for improvement in this component. The results of this analysis are presented in Figure 5, providing a comprehensive overview of how software utilization contributes to the overall validity of the instrument.

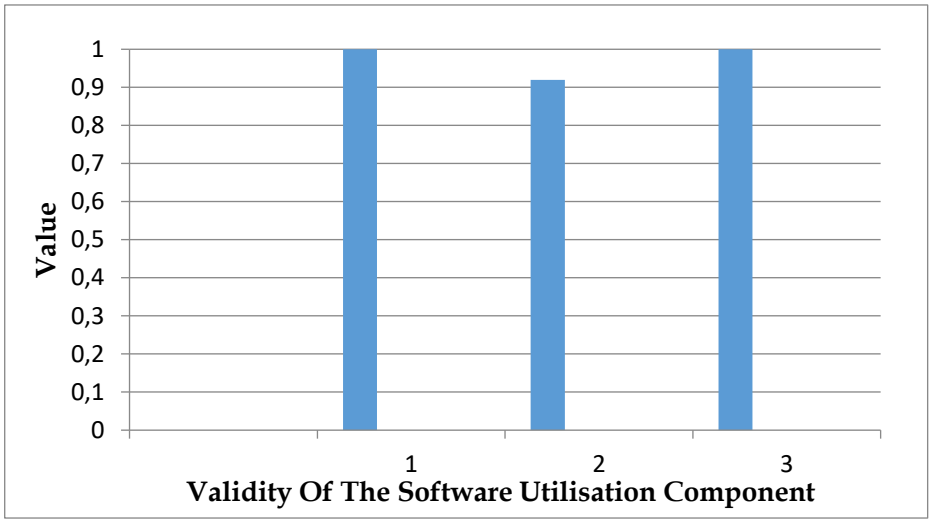


Figure 5. The Validity of the software utilisation component

Based on Figure 5, the validity results of the E-SWS in the software utilization component show a score range between 0.92 and 1.00. This component assesses the effectiveness of the software tools used to deliver the learning material. The interactivity aspect, which refers to system feedback for users, received a perfect score of 1.00, confirming that the E-SWS provides a responsive and engaging user experience. The supporting software component obtained a score of 0.92, indicating that the software used is appropriate and effectively supports the worksheet's interactive features. The originality component, which evaluates the uniqueness of the content and design, also received a perfect score of 1.00. This suggests that the materials were developed without plagiarism and provide innovative ways to enhance student learning. By ensuring interactivity, appropriate software selection, and originality, the E-SWS effectively supports digital learning experiences. These aspects are crucial in maintaining engagement and accessibility for students. The overall average validity score for the software utilization component is 0.96, which is classified as valid, confirming that the digital aspects of the E-SWS contribute positively to the learning process.

The sixth component of the validity instrument is the guided inquiry model, which plays a crucial role in fostering active learning and critical thinking among students. This model is assessed based on seven key aspects: (1) identifying problems and making observations, (2) asking questions, (3) planning investigations, (4) collecting data/information and conducting investigations, (5) analyzing data, (6) drawing conclusions, and (7) communicating results. These steps provide a structured framework that guides students through the inquiry process, enabling them to explore scientific concepts in a meaningful and systematic manner. The guided inquiry model promotes student-centered learning, where learners take an active role in constructing knowledge rather than passively receiving information. By engaging in problem identification, data collection, and analysis, students develop essential problem-solving, analytical, and critical thinking skills. Furthermore, this approach fosters independent and reflective thinking, as

students are encouraged to explore, question, and derive conclusions based on empirical evidence.By following these structured steps, students not only enhance their investigative skills but also improve their ability to communicate scientific findings effectively. This method aligns with the objectives of modern education, which emphasize inquiry-based learning to develop scientific literacy and higher-order thinking skills. The validity score analysis for the guided inquiry model component, as presented in Figure 6.

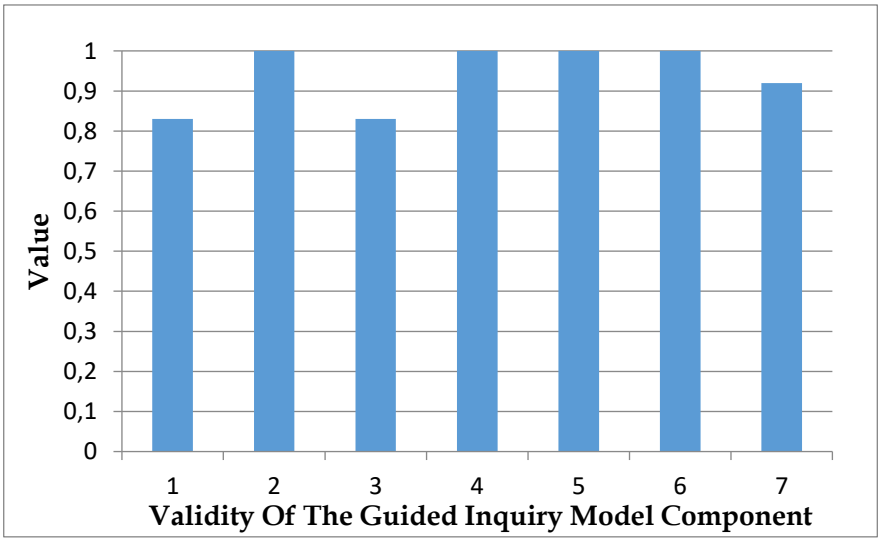


Figure 6. The Validity Of The Guided Inquiry Model Component

Based on Figure 6, the validity results of the E-SWS, particularly in the guided inquiry model component, show a score range between 0.83 and 1.00. The guided inquiry model is crucial for fostering students' investigative and problem-solving skills. However, some aspects require further refinement. In more detail, the identification of problems and making observations received a score of 0.80, indicating room for improvement in providing clearer inquiry-based activities. Similarly, the planning investigations component obtained a score of 0.83, suggesting the need for better-structured investigative guidance. Additionally, the data analysis component received 0.83, signifying that enhancements are needed in supporting students' ability to interpret information effectively. On the other hand, components such as asking questions, collecting data/information and conducting investigations, making conclusions, and learning instructions all received a score of 1.00, categorizing them as valid. This highlights that students are effectively guided in formulating inquiries, gathering information, and drawing conclusions. The communicating results aspect received a score of 0.92, ensuring that students are encouraged to share their findings effectively. Despite a few areas for improvement, the overall average validity score for the guided inquiry model component is 0.94, placing it in the valid category. This confirms that the E-SWS effectively supports an inquiry-based learning approach.

The seventh component of the validity instrument is critical thinking, which is evaluated based on five main aspects: 1) elementary clarification, 2) basic support, 3) inference, 4) advanced clarification, and 5) strategies and tactics. Critical thinking is an essential skill that enables students to analyze information logically and make reasoned judgments. Elementary clarification involves understanding and defining concepts, while basic support focuses on evaluating the credibility of information sources. Inference refers to drawing logical conclusions based on evidence, while advanced clarification enhances deeper analytical reasoning. Strategies and tactics involve applying critical thinking

techniques to solve complex problems effectively. The validity score analysis for the critical thinking component is presented in Figure 7.

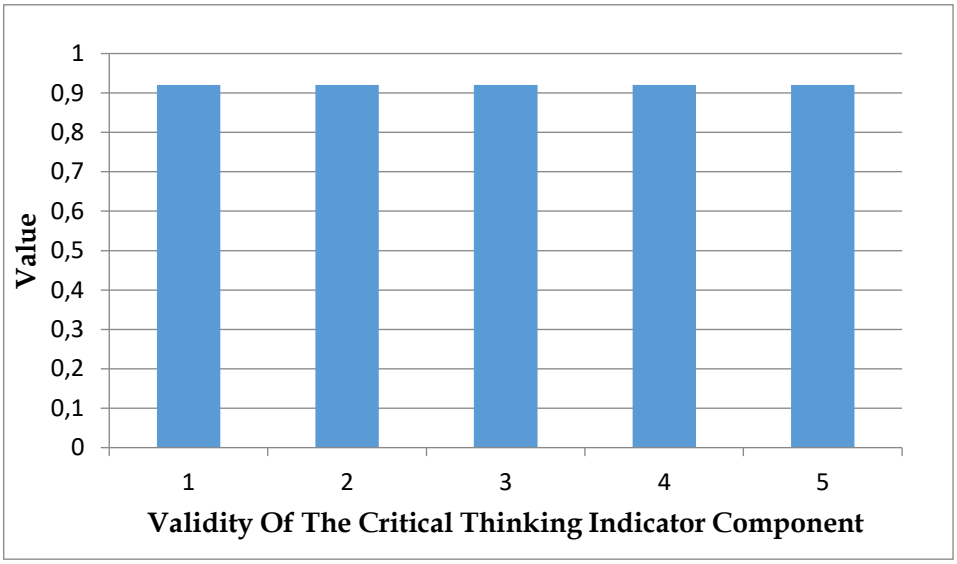


Figure 7. The Validity of the Critical Thinking Indicator Component

Based on Figure 7, the validity results of the E-SWS, specifically in the critical thinking component, demonstrate consistent scores across all aspects. Critical thinking is essential for developing students' analytical and reasoning skills, and the worksheet effectively supports this objective. In more detail, the elementary clarification, basic support, inference, advanced clarification, and strategy and tactics components each received a score of 0.92, indicating that they are all classified as valid. These components ensure that students engage in reasoning processes that encourage deeper understanding and problem-solving abilities. Elementary clarification helps students define concepts and recognize assumptions, while basic support ensures that students rely on credible sources for their arguments. The inference component focuses on drawing logical conclusions based on provided data, enhancing students' ability to interpret information effectively. Additionally, advanced clarification refines students' analytical skills, helping them assess the validity of claims and arguments. The strategy and tactics aspect ensures that students develop structured approaches to solving problems and making decisions. The overall average validity score for the critical thinking component is 0.92, categorizing it as valid. This confirms that the E-SWS successfully enhances students' critical thinking skills in a structured and meaningful way.

To assess the overall quality and effectiveness of the guided inquiry-based E-SWS, the average score of each validation component was calculated. This evaluation encompassed seven key components, namely: (1) E-SWS feasibility, (2) material substance, (3) visual communication display, (4) learning design, (5) software utilization, (6) guided inquiry model, and (7) critical thinking skills. Each of these components plays a vital role in ensuring that the E-SWS meets academic and pedagogical standards, offering an engaging and effective digital learning experience. The assessment process aimed to determine the validity and feasibility of the E-SWS in supporting student learning outcomes, particularly in enhancing critical thinking skills through an inquiry-based approach. A high validity score across these components indicates that the E-SWS is well-structured, scientifically accurate, visually engaging, pedagogically sound, and technologically effective. Furthermore, it confirms that the E-SWS aligns with curriculum objectives, providing a comprehensive and interactive digital learning resource for students. The average validity score for these

components, which serves as a measure of the overall feasibility and effectiveness of the guided inquiry-based E-SWS, is presented in Figure 8.

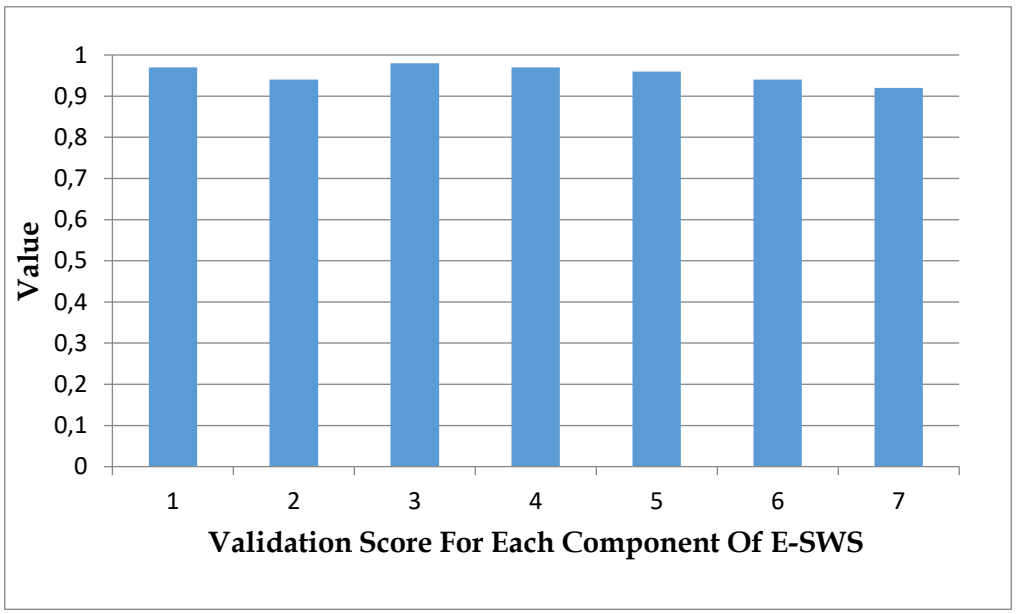
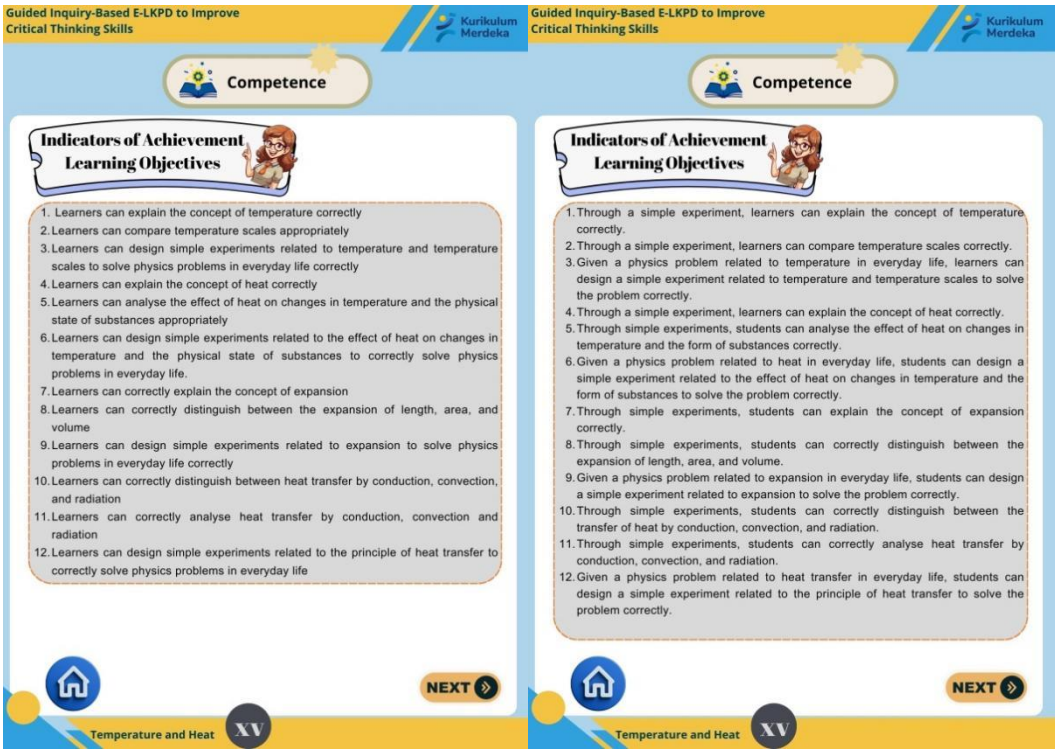


Figure 8. The Validation Score For Each Component Of E-SWS

Based on Figure 8, it can be concluded that the guided inquiry-based E-SWS developed to improve students' critical thinking skills obtained high validity scores on each component. In detail, The feasibility component of the E-SWS scored 0.97%, which is categorized as valid; the material substance component scored 0.94%, which is categorized as valid; the visual communication display component scored 0.98%, which is categorized as valid; the learning design component scored 0.97%, which is categorized as valid; the software utilization component scored 0.97%, which is categorized as valid; the guided inquiry model component scored 0.94%, which is categorized as valid; and the critical thinking ability component scored 0.92%, which is also categorized as valid.

Based on the assessment of all components, the overall average validity score of the guided inquiry-based E-SWS was 0.95, placing it in the valid category. This indicates that the developed E-SWS meets the necessary eligibility standards for use in physics learning, particularly in fostering students' critical thinking skills. The validation process not only confirmed the content accuracy, instructional design, and technological feasibility of the E-SWS but also included constructive feedback from expert validators. These experts provided valuable insights and suggestions to address potential weaknesses in the initial version of the product, ensuring that the E-SWS was refined for optimal classroom implementation. Based on the feedback received, several improvements and revisions were made to enhance the quality and effectiveness of the E-SWS. The visual design was refined to create a more engaging and user-friendly interface, ensuring better accessibility for students. Additionally, the learning materials were restructured systematically to improve content flow, coherence, and readability. Further refinements were made to the guided inquiry-based tasks, where instructions were clarified to ensure that students could follow them with ease and confidence. These modifications aimed not only to enhance the theoretical validity of the E-SWS but also to make it more interactive, practical, and student-centered. By integrating these improvements, the final version of the E-SWS is expected to provide a richer and more engaging learning experience, encouraging students to take an active role in their learning process. With its interactive features and well-structured inquiry-based framework, the E-

SWS has the potential to significantly enhance students' conceptual understanding and critical thinking abilities in physics education.



(a) Before Revision (b) After Revision

Figure 2. Revised Indicators of Achievement of Learning Objectives

Based on Figure 8, the revision made by the researcher is adding conditions to the indicators of achievement of learning objectives adjusted using the ABCD technique. Then, improvements to the E-SWS description by adding an explanation of the guided inquiry syntax. Then add critical thinking indicators in the evaluation section. The next suggestion is that the concept map is separated between temperature and heat. The last suggestion is to add instructions on the evaluation on how to submit the answer.

Discussion

This research focuses on the validity of E-SWS for temperature and heat materials. Product validity was assessed by three experts using seven assessment components. The assessment components are referred to Perpendicular No 8 of 2016, teaching materials used in educational units must meet the standards of content, language, presentation, and graphic feasibility. These standards aim to ensure that teaching materials can be used effectively in the learning process (Peraturan Menteri Pendidikan dan Kebudayaan 2016) and refer to the Directorate of High School Development in 2010, these aspects include material substance, visual appearance, learning design and software utilization. The substance of the material must be in accordance with the curriculum and be able to improve students' understanding, while the visual display plays a role in attracting attention and facilitating the delivery of information. In addition, a good learning design and the use of appropriate software will support interactivity and active involvement of students in learning (Syabrina 2018), and is complemented by an assessment of the syntax of the guided inquiry model, where the guided inquiry model is a learning model that emphasis the

process of students and encourages students to find their own learning material through scientific processes to gather facts and answers to questions or problems given by the teacher (Nurdyansyah and Fahyuni 2016) and critical thinking indicators, where according to Ennis (2011), critical thinking ability is a process that is believed or done. So, humans who have critical abilities will believe more in something produced by reasoning that is obtained by unclear sources.

The first component is the E-SWS component. The results of E-SWS component assessment showed a validity value categorized as "valid". This result shows that E-SWS has fulfilled the criteria of a well-developed E-SWS. The second component is the substance of the material. The assessment results show a validity value categorized as "valid". This result shows that E-SWS has fulfilled the criteria of a well-developed E-SWS. The third component is the visual communication display. The results of E-SWS component assessment show a validity value categorized as "valid". This result shows that E-SWS has fulfilled the criteria of a well-developed E-SWS.

The fourth component is learning design, where an attractive learning design can increase students' motivation in the learning process. The results of the E-SWS component assessment show a validity value categorized as "valid". This result shows that E-SWS has fulfilled the criteria of a well-developed E-SWS. The fifth component is software utilization. The results of the E-SWS component assessment show a validity value categorized as "valid". This result shows that the software used to access E-SWS is easily accessed by students. This is in line with what was stated by Lathifa (2021), E-SWS is a type of SWS that can be accessed via the internet network easily by students. Overall, the validity results for the software utilization component fall into the "valid" category. The sixth component is the guided inquiry learning model. Guided inquiry is a learning in which the teacher provides problems, tools and materials for investigation with students making their own designs for their investigations (Masruhah et al., 2022). According to Nurdyansyah & Fahyuni (2016), the guided inquiry model has 7 syntax's, namely: 1) identifying problems and making observations; 2) asking questions; 3) planning investigations; 4) collecting data/information and carrying out investigations; 5) analysis data; 6) making conclusions; 7) communicating results. The validity results for the guided inquiry model component are classified as "valid", which means that the learning activities in E-SWS are designed in accordance with the guided inquiry model syntax.

The seventh component is the ability to think critically, critical thinking is a reflective thinking ability that focuses on decision-making patterns about what to believe, to do and can be accounted for (Susilawati et al. 2020) . According to Ennis (2011), some indicators of critical thinking are 1) providing simple explanations; 2) building basic skills; 3) conclusions; 4) making further explanations; 5) strategies and tactics. The results of the critical thinking component assessment showed a validity value categorized as "valid". These results indicate that E-SWS can improve students' critical thinking skills. In this study, there were several suggestions given by the liquidators to improve the E-SWS. These suggestions were used to revise E-SWS with the aim of improving its quality.

Based on the results of the research that has been conducted, the validity value of the guided inquiry-based E-SWS developed to improve students' critical thinking skills is 0.95, which is categorized as "valid". These results indicate that the designed E-SWS has met the eligibility standards required for use in physics learning. These findings are in line with research conducted by (Payu, Hermanto, and Yunus 2023), which showed that guided inquiry-based E-SWS that integrate critical thinking skills were also declared valid based on

the validation results obtained. In addition, research conducted by Permata (2020), also strengthened these findings, where the results of their research showed that the guided inquiry-based physics E-SWS that had been developed were not only declared valid, but also practical in improving students' critical thinking skills.

Although the validation results show that this E-SWS is suitable for use in learning, there are some weaknesses that need to be considered. One of the main obstacles found is the dependence on the internet network. Since it is electronic-based, this E-SWS allows learners to access it anytime and anywhere, but optimal use requires a stable internet connection. This can be a challenge, especially for learners in areas with limited internet access

CONCLUSION

Based on the results of the research conducted, the guided inquiry-based E-SWS developed to improve students' critical thinking skills obtained a validation score of 0.95, which is included in the valid category. This value indicates that E-SWS that has been designed meets the eligibility standards set and can be used as teaching materials in physics learning. The validity obtained proves that this guided inquiry-based E-SWS has fulfilled various aspects of assessment, such as material suitability, quality of learning design, visual appearance, effectiveness of the guided inquiry model, and contribution to the development of students' critical thinking skills. With a high level of validity, this E-SWS is suitable to be used as a tool in the physics learning process, especially on temperature and heat materials.

In addition, the success in developing this E-SWS also indicates that the guided inquiry model is able to encourage students to be more active in exploring physics concepts, honing critical thinking skills, and increasing their understanding of the material more deeply. Therefore, the developed guided inquiry-based E-SWS can be an innovative alternative in technology-based physics learning, which not only improves learning effectiveness but also supports 21st century skills that are needed by students.

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