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Validity Analysis of Ethno-STEM Integrated E-SWS Development to Facilitate Students' Knowledge and Creative Thinking Skills

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ABSTRACT

Knowledge and creative thinking skills are essential components of 21st-century learning. However, field observations indicate that students' knowledge and creative thinking abilities remain relatively low. One contributing factor is the use of teaching materials that are not contextualized and fail to connect scientific concepts with local culture and everyday life. A proposed solution to address this issue is the development of Ethno-STEM integrated E-LKPD an innovative teaching material that combines elements of local culture with approaches from science, technology, engineering, and mathematics (STEM). This study aims to develop and assess the validity of an Ethno-STEM integrated Electronic Student Worksheet (E-SWS) to support students' knowledge and creative thinking skills on the topic of heat. The research employs the Research and Development (R&D) method, using the Hannafin & Peck model, which consists of four stages: needs analysis, design, development, and implementation. Validation was conducted by three physics lecturers from Padang State University (UNP), using an instrument covering eight main components: content substance, visual communication design, instructional de-sign, software utilization, Ethno-STEM integration, knowledge development, and creative thinking enhancement. The validation results indicated a high level of validity across all aspects, with an average score of 0.87, placing the E-SWS in the "valid" category. The E-SWS was designed using Canva and delivered through Liveworksheet, providing students with an interactive and innovative learning experience. The integration of Ethno-STEM, which merges local cultural elements with STEM concepts, creates a contextual learning environment that enhances relevance and engagement. Therefore, the E-SWS developed in this study is appropriate for use as a creative, innovative, and contextual teaching resource, aligned with the Merdeka Curriculum and the demands of 21st-century education.

Keywords: E-SWS; Ethnoscience; STEM; Knowledge Ability; Creative Thinking.

I. INTRODUCTION

The 21st century is a century of rapid development of science and technology around the world. This development makes all aspects of life experience development, including in the world of education. In 21st century education, technology is no longer a complement but has become the main component used in the teaching and learning process. Educators and learners are required to understand, use and interact with digital technology, thus requiring certain abilities to deal with it [1]. The utilization of technology in education is expected to help students and educators in carrying out learning activities, so that technology really becomes an intermediary to achieve learning goals [2].

The development of science and technology in the 21st century has certainly triggered an increase in global competition. To be able to compete in the 21st century, it is necessary to prepare human resources that are adaptive to this competition. In the 21st century, new skills are needed, called 21st century skills. 21st century skills are known as 4C skills, namely *critical thinking, creativity, communication,* and *collaboration* skills [3]. These 21st century skills can be trained through education. 21st century skills are skills that combine cognitive, interpersonal, and intrapersonal aspects that support the learning process and transfer of knowledge in depth and face 21st century competition. 21st century skills develop students into critical, skilled individuals who are literate in technology and information [4].

The curriculum is an important component in the education system. The curriculum is designed to optimize the learning process. In 2021, the Ministry of Education, Culture, Research and Technology introduced the

Merdeka Curriculum as part of efforts to reform the education system in Indonesia. The independent curriculum aims to create learning that is fun and according to student interests, so that the quality of education in Indonesia improves [5]. This curriculum requires students to be more independent in acquiring knowledge, both inside and outside school. The independent curriculum is a curriculum that is expected to provide a learning process to prepare skills for the 21st century [6]. The independent curriculum is the main foundation for improving 21st century skills, one of which is creative thinking skills [7].

Knowledge and creative thinking skills are very important competencies in facing the challenges of the 21st century and are in line with the development direction of the Merdeka Curriculum. In the current era of globalization and digitalization, students are not only required to master knowledge conceptually, but also to be able to apply it in real life creatively and innovatively. The Merdeka Curriculum is here to answer these needs through learning that is student-centered, flexible, and oriented towards developing the Pancasila learner profile. Various studies have shown that the learning approaches used in the Merdeka Curriculum are able to improve students' creative thinking, collaborative, and communication skills [8]. In the context of education, creative thinking skills are very important to pay attention to, as they help students to develop the problem-solving, adaptation, and innovation skills needed in future lives and careers [9]. Therefore, strengthening the ability of knowledge and creative thinking in the learning process is very important to prepare young generations who are adaptive, innovative, and ready to face the changing times.

The problems found in this study after conducting a needs analysis at SMA Negeri 6 Padang were three real conditions that became the main problem. First, teachers still experience high difficulties in utilizing technology, especially in making E-SWS and applying the Ethno-STEM approach, with an average percentage of difficulty of 60% and 61.33% respectively. Second, the learning outcomes of Phase F students in class XI are low, as seen from the average odd semester final exam score of 54, which is caused by the lack of application of student-centered learning and the lack of interesting methods used by teachers. Third, students' creative thinking skills are also still low, based on the results of the discourse test designed according to the indicators of creative thinking skills in the aspects of fluency and elaboration, with an average score of only 39.75. This result is not in line with 21st century learning that supports the development of 21st century skills such as creative thinking [10].

The solution given to this condition is to develop an Ethno-STEM integrated E-SWS that is designed contextually and interactively. This development aims to assist teachers in utilizing learning technology and facilitate the application of the Ethno-STEM approach that is relevant to local culture. This Ethno-STEM E-SWS can connect modern science knowledge with local wisdom, so that learning becomes more contextual and meaningful for students. Previous research mentioned that E-SWS Etno-STEM can improve students' 21st century knowledge and skills, namely creative thinking skills [11]. Different from previous research, the E-SWS developed in this study specifically adapts the Minangkabau cultural context and is focused on improving students' knowledge and creative thinking skills.

E-SWS is a teaching material that is packaged so that students can learn the material independently. E-SWS is an electronic sheet that aims to help students carry out learning activities in order to master understanding and skills [12]. E-SWS plays a big role in the learning process. Its use can make learning activities more enjoyable, provide opportunities for students to practice, and increase learning motivation. E-SWS can increase student activity and can assist teachers in directing students to discover concepts through their own activities. E-SWS encourages students' active involvement in every stage of learning [13].

Ethnoscience is science that is obtained by studying the local wisdom of a community. This approach emphasizes the importance of linking scientific knowledge with traditional practices that live in society, so that students can understand that science is not a foreign concept, but part of their daily lives [14]. Ethnoscience is an approach that connects science applications in people's lives so that science and culture become connected in the formation of student character [15]. Integrating ethnoscience in learning can improve students' understanding of science concepts. In addition, ethnoscience encourages the development of creativity, the ability to think beyond conventional boundaries, and the ability to create solutions to various problems [16].

STEM is one of the innovative learning approaches that developed in the 21st century. STEM is identified as modern science learning which consists of four disciplines namely *Science, Technology, Engineering, and Mathematics*. STEM provides contextualized learning experiences and is oriented towards real problem solving [17]. The application of STEM in learning can stimulate learners to actively participate and be able to integrate various disciplines in solving various challenges they face [18].

This study aims to develop and test the validity of Ethno-STEM integrated E-SWS products as one of the more innovative and effective teaching materials in facilitating students' knowledge and creative thinking skills. The presence of this ethno-STEM integrated E-SWS, it is hoped 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 knowledge and creative 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 in

the learning process, so that physics learning becomes more contextual, interesting, and in accordance with the demands of 21st century learning.

II. METHOD

This research adopts the Research and Development (R&D) approach. R&D is a method used to develop or validate educational and instructional products [19]. The development model employed in this study is the Hannafin & Peck model, which consists of three main phases: needs analysis, design, and development/implementation. However, in this study, the research was limited to the development phase only.

The first phase is the needs analysis. In this phase, an analysis was conducted to provide a strong foundation for developing the E-SWS. The needs analysis was carried out at SMA Negeri 6 Padang and included three aspects: the analysis of ICT utilization challenges, Ethno-STEM integration, and students' knowledge and creative thinking abilities. The ICT utilization and Ethno-STEM integration analyses were conducted by distributing questionnaire sheets to three physics teachers at SMA Negeri 6 Padang. Students' knowledge was assessed through the analysis of learning outcomes, obtained from the odd semester final examination scores of Phase F students at the same school. Meanwhile, students' creative thinking skills were analyzed by administering a creative thinking test instrument to Phase F students in grade XI.

The second phase is the design phase. During this phase, the E-SWS was prepared based on the structure and guidelines for developing digital teaching materials. The design included components such as title, usage instructions, learning instructions, Ethno-STEM explanation, expected competencies, supporting information, Ethno-STEM integrated activities/work steps, practice questions, evaluation, and references. These elements were structured to produce a high-quality E-SWS. The final phase of the Hannafin & Peck model is the development and implementation phase. In this study, the focus was only on the development and validation of the E-SWS. The final phase of the Hannafin & Peck model is the development and implementation phase. In this study, the focus was only on the development and validation of the E-SWS.

Product validation is a crucial step in the product development process. The validation was conducted based on seven key indicators: content quality, visual communication design, instructional design, software usability, Ethno-STEM integration, students' knowledge mastery, and students' creative thinking skills. Each aspect was evaluated using a 4-point Likert scale, where higher scores indicated a higher degree of validity. The overall product validity was determined using Aiken's V validity index, with a product considered valid if it achieved a minimum index value of ≥ 0.61, as established by Azwar [20].

The data collection instrument used in this study was an extended validation sheet, which was completed by three physics lecturers (validators) from Padang State University (UNP). The data obtained from the validation process were analyzed using the Aiken's V index to assess the feasibility and validity of the developed E-SWS. The validators' scores were converted to a 1-to-4 scale and processed using Aiken's V formula to obtain the validity coefficient. The formula used for calculating Aiken's V is as follows [21]:

$$V=\frac{\sum S}{n(c-1)} \quad (1)$$

Determination of the feasibility of E-SWS is done through the calculation of the final validity value. This value indicates the extent to which the E-SWS meets the predetermined validity criteria based on the results of the experts' assessment. If the validity value obtained reaches or exceeds the minimum threshold of 0.61, then the E-SWS is considered valid. This validity is an important indicator that the product is suitable for use in the learning process. Thus, E-SWS that has met the validity criteria can be utilized as innovative teaching materials in physics learning integrated with the Ethno-STEM approach.

III. RESULTS AND DISCUSSION

Result

This research aims to develop and produce a valid ethno-stem integrated E-SWS. This section presents the results of the validation analysis of ethno-stem integrated E-SWS designed to facilitate students' knowledge and creative thinking skills. The validity of E-SWS was assessed from the aspects of material substance, visual communication display, learning design, software utilization, ethno-stem integration, knowledge ability, and students' creative thinking skills. The assessment was conducted by three Physics lecturers at Padang State University (UNP). The purpose of this analysis is to see the extent to which E-SWS meets the validity criteria in

the context of science learning, as well as the feasibility of E-SWS in innovative and contextual learning. The first component assessed in the validity instrument is material substance, which is a fundamental aspect in the development of E-LKPD. The assessment of material substance covers four main aspects, namely material truth (TR), material coverage (MC), information currency (CR), and readability (RD), which can be seen in Figure 1.

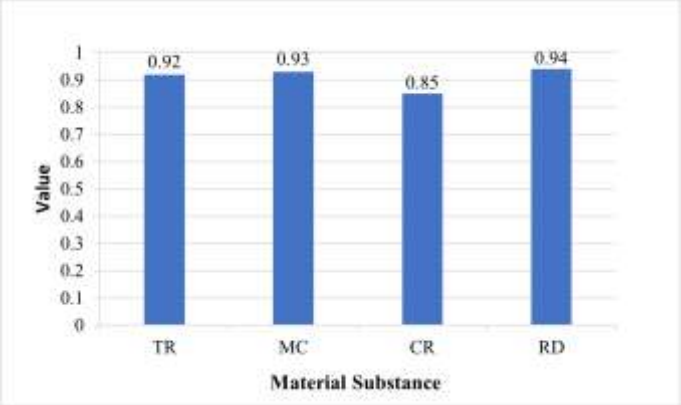

Fig. 1. Components of material substance

Based on Figure 1, the results of the validity of E-SWS, especially in the material substance component, show a range of scores between 0.80 to 1.00. In more detail, the truth aspect obtained a score of 0.92 so that it entered the valid category. The material coverage component scored 0.93 with a valid category. The current aspect scored 0.85 which is categorized as valid. Finally, the readability aspect scored 0.94, categorized as valid. Overall, the average validity score for the material substance component is 0.91 which is categorized as valid, meaning that the content of the material is in accordance with scientific concepts and the latest information developments. These results indicate that E-SWS is suitable for use as teaching material because the substance of the material presented has met the content eligibility standards.

The second component of the validity instrument is the visual communication display, which plays an important role in ensuring that the E-SWS is effective in conveying information in a clear, attractive and accessible manner. This component consists of six main aspects: 1) navigation (NV), 2) font (LT), 3) media (MD), 4) color (CL), 5) video (VD), and 6) layout (LY). Each of these aspects contributes to the overall effectiveness of the learning materials presented by improving readability, ease of use, and visual appeal. Analysis of the validity scores for the visual communication display component as presented in Figure 2.

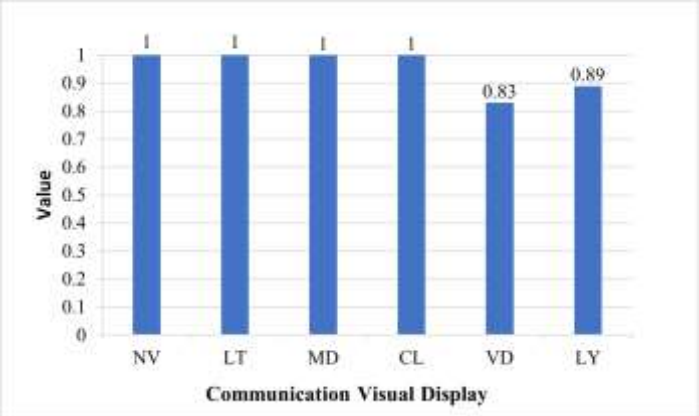

Fig. 2. Visual communication display

Based on Figure 2, the results of the validity of E-SWS, especially the visual communication display component, show a range of scores between 0.80 to 1.00. In more detail, the navigation aspect obtained a score of 1.00 with a valid category, this score indicates that users can easily navigate the content. The font aspect scored 1.00 with a valid category, ensuring that the text presented in the E-SWS is formatted appropriately so that it is easy to read. The media aspect scored 1.00 in the valid category, indicating that the multimedia elements effectively support the learning process. The color aspect scored 1.00 in the valid category, confirming that the color scheme enhances visual appeal without causing distraction. The video aspect scored 0.83 in the valid category. Finally, the layout aspect scored 0.89 in the valid category. Overall, the average validity score for

the visual communication display component is 0.95 which is categorized as valid, indicating that E-SWS can create a fun and meaningful digital learning experience.

The third component of the validity instrument is the learning design which has an important function as a framework for compiling the E-SWS to ensure clarity, coherence, and alignment with the learning objectives. The learning design component consists of eight main aspects: 1) title (TL), 2) learning outcomes (LC), 3) learning objectives (LJ), 4) materials (MT), 5) tasks/worksheets (WS), 6) practice questions (PQ), 7) evaluation (EF), and 8) references (RF). Each of these aspects plays a fundamental role in guiding students and teachers through a well-structured and systematic learning process. The validity score analysis for the learning design component is as presented in Figure 3.

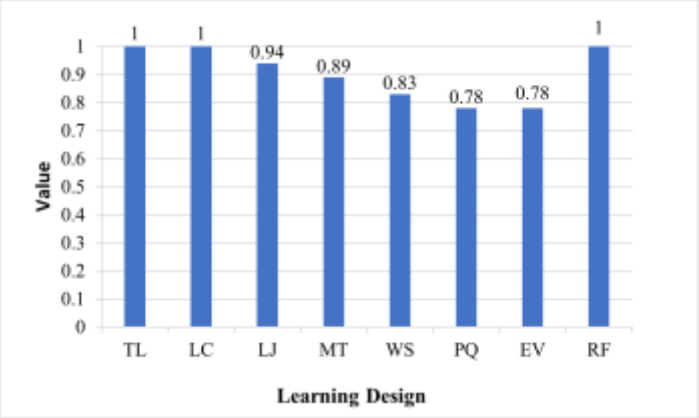

Fig. 3. Components of learning design

Based on Figure 3, the E-SWS validity results on the learning design component show a score range between 0.70 to 1.00. This component ensures that the learning structure is in line with the learning objectives. In more detail, the title aspect scored 1.00 with the valid category. The learning outcomes aspect scored 1 with a valid category. The learning objectives (LJ) aspect scored 0.94 with a valid category. The material aspect scored 0.89 with the valid category. The task/worksheet aspect scored 0.83 with a valid category, which indicates that the tasks and worksheets are well structured and aligned with ethno-stem integration. The exercise aspect scored 0.78 in the valid category. The evaluation aspect scored 0.78, indicating its validity in measuring student progress. Finally, the reference aspect scored 1.00 in the valid category which confirms that credible sources support the E-SWS. Overall, the average validity score of the learning design component is 0.90 categorizing it as valid, which indicates a well-structured learning design can increase the effectiveness of content delivery and make it easier for students to follow and understand the material. Clear learning objectives and systematic instructions help form a logical flow of knowledge. A well-designed E-SWS supports educators to plan and implement lessons that encourage active learning, thus improving students' knowledge and creative thinking skills.

The fourth component of the validity instrument is *software* utilization which includes three important aspects: 1) interactivity (IT), 2) supporting software (SS), and 3) originality (OG). Each aspect plays an important role in increasing student engagement and encouraging a more dynamic learning experience. Supporting software refers to the technological tools used to create and deliver E-SWS that should be designed to ensure ease of access, smooth navigation, and overall user-friendliness. Meanwhile, originality guarantees new and inventive content and evaluates the distinctiveness and originality of digital learning resources. The validity score analysis for the *software* utilization component is as presented in Figure 4.

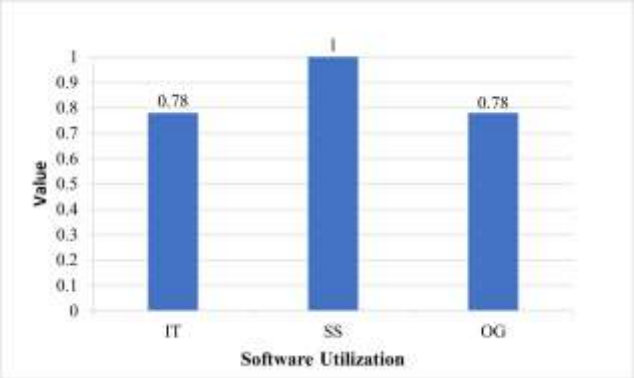

Fig. 4. Components of *software* utilization

Based on Figure 4, the validity results of E-SWS on the software utilization component show a score range between 0.70 to 1.00. This component assesses the effectiveness of the software used to deliver learning materials. The interativity aspect obtained a score of 0.78 which was included in the valid category in providing feedback to users. The supporting software aspect scored 1.00 in the valid category, indicating that the software used is appropriate and effective with interactive features on the worksheet. The originality aspect scored 0.78 in the valid category, which shows that the E-SWS is well developed and offers innovative ways to improve learning. The overall average validity score for the software utilization component is 0.85 classifying it in the valid category. This result makes the E-SWS effectively support the digital learning experience.

The fifth component of the validity instrument is ethno-stem integration. This component has 5 important aspects which are the merging of two learning approaches: 1) ethnoscience (ES), 2) *science* (SC), 3) *technology* (TC), 4) *engineering (*EG), and 5) *mathematics* (MM). This aspect provides a structured worksheet framework that guides students through the ethno-stem process, to explore scientific concepts in a meaningful and systematic way. Analysis of the validity scores for the ethno-stem integration component as presented in Figure 5.

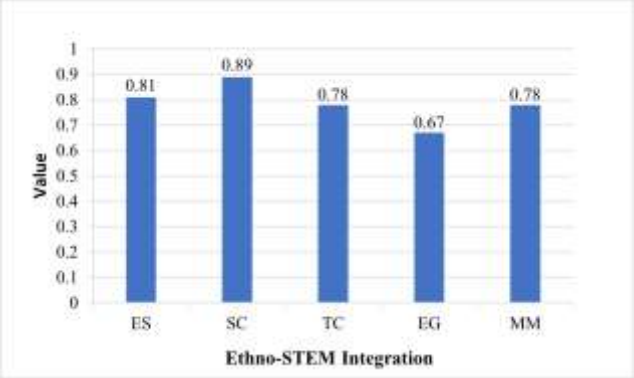

Fig. 5. Components of ethno-stem integration

Based on Figure 5, the results of the validity of E-SWS on the ethno-stem integration component show an average score range between 0.60 to 0.89. The ethnoscience aspect obtained a score of 0.81 with a valid category, which shows that E-SWS is integrated with local culture so that learning has a new atmosphere, not boring, and fun. The *science* aspect scored 0.89 with a valid category, indicating that the E-SWS can increase the understanding of concepts scientifically for students. The *technology* aspect scored 0.78 with a valid category, indicating that E-SWS encourages the use of technology in the learning process by students. The *engineering* aspect scored 0.67 in the valid category, which shows that this aspect can encourage students to think engineering and design a product. *The mathematics* aspect scored 0.78 in the valid category, which refers to training students' basic math skills. The overall average score for the ethno-stem integration component is 0.79 which classifies it in the valid category. These results show that E-SWS is able to connect between local culture and the disciplines of science, technology, engineering, and mathematics in a contextual and meaningful learning unit.

The sixth component of the validity instrument is knowledge capability. This knowledge capability aims to assess the extent to which the E-SWS is able to facilitate and measure learners' knowledge comprehensively. This knowledge capability is evaluated based on four aspects of knowledge dimensions: 1) factual (FC), 2)

conceptual (CP), 3) procedural (PR), and 4) metacognitive (MV). These four dimensions provide a comprehensive picture of the students' knowledge structure that is expected to be formed through the use of E-SWS. The validity score analysis for the knowledge ability component as presented in Figure 6.

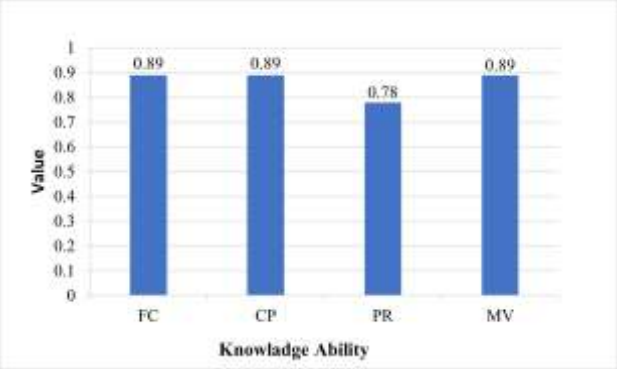

Fig. 6. Components of knowledge ability

Based on Figure 6, the results of the validity of E-SWS on the knowledge ability component show an average score range between 0.70 to 0.89. The factual aspect obtained a score of 0.89 with a valid category, which indicates that the E-SWS. The conceptual aspect scored 0.89 with a valid category, which shows that the conceptual aspect of the E-SWS is well facilitated, because the material and activities provided encourage deep understanding. The procedural aspect scored 0.78 in the valid category, which shows that E-SWS can develop students' procedural knowledge to create a step to solve a problem. Finally, the metacognitive aspect scored 0.89 in the valid category, which shows that E-SWS encourages students to reflect on their understanding. The overall average score of the knowledge ability component is 0.86 which classifies it in the valid category. These results indicate that the E-SWS has been comprehensively designed to develop all dimensions of knowledge that students need.

The seventh component of this validity instrument is creative thinking skills which are evaluated based on four main aspects: 1) fluency (FL), 2) flexibility (FX), 3) novelty (OR), and 4) elaboration (EB). Creative thinking skills are one of the 21st century skills that are very important to be developed in the learning process. In this context, the E-SWS is designed not only to deliver the material, but also to facilitate the development of students' creative thinking skills. Analysis of the validity scores for the creative thinking component as presented in Figure 7.

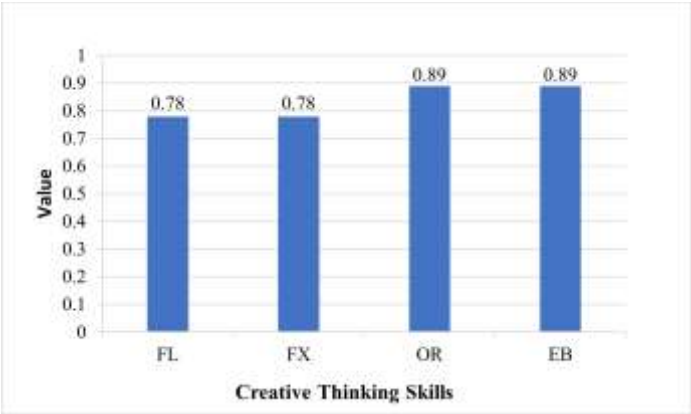

Fig. 7. Components of creative thinking skills

Based on Figure 7, the results of the validity of E-SWS on the creative thinking skills component show an average score range between 0.70 to 0.89. The fluency aspect obtained a score of 0.78 in the valid category, which shows that E-SWS facilitates students to express many ideas and have fluency in providing answers in responding to a problem. The flexibility aspect scored 0.78 in the valid category, which shows that E-SWS facilitates students to see a problem in various perspectives and different ways of solving. The novelty aspect scored 0.89 in the valid category, indicating that E-SWS facilitates students to generate new unique ideas by providing space for students to design a tool or produce a new solution. Finally, the elaboration aspect scored 0.89 with a valid category, indicating that the E-SWS facilitates students to develop and detail ideas or solutions in depth. The overall average score of the creative thinking skills component is 0.83 which classifies it in the

valid category, indicating that the E-SWS encourages active interaction and provides space for exploration to significantly improve the dimensions of student creativity.

The validity assessment of ethno-STEM integrated E-SWS was conducted to determine its quality and feasibility as digital teaching materials. This assessment includes seven main components, namely: 1) material substance (MS), 2) visual communication display (VC), 3) learning design (LD), 4) software utilization (SU), 5) ethno-STEM integration (ES), 6) knowledge ability (KA), and 7) creative thinking skills (CT). Each component has an important role in ensuring that the E-SWS meets academic and pedagogical standards, and is able to provide an interesting and meaningful learning experience. Evaluation is conducted to ensure that the E-SWS can improve learning outcomes, especially in the mastery of knowledge and the development of creative thinking skills. The average validity score of each component is presented in Figure 8.

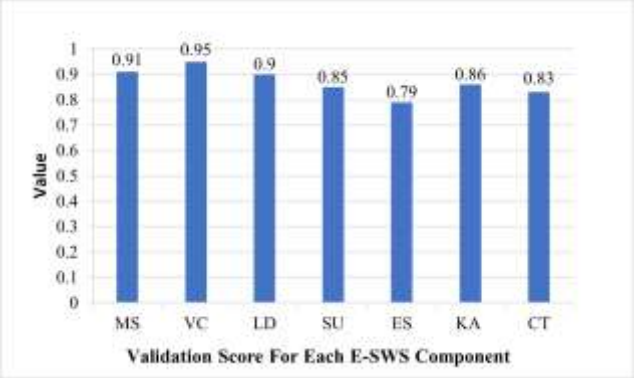

Fig. 8. Validation value of each E-SWS component

Based on Figure 8, it can be concluded that the Ethno-STEM integrated E-SWS developed to facilitate students' knowledge and creative thinking skills obtained high validation scores on each component. In detail, the material substance component scored 0.91. The visual communication display component scored 0.95. The learning design component scored 0.90. The *software* utilization component scored 0.85. The ethno-stem integration component scored 0.79. The knowledge ability component scored 0.86. Finally, the creative thinking component scored 0.83. All scores are in the valid category. Based on the assessment of all components, the average overall validity score of the ethno-stem integrated E-SWS is 0.87 which classifies it in the valid category. This shows that the developed E-SWS meets the feasibility standards that can be used in physics learning, especially to improve students' knowledge and creative thinking skills.

The validation process not only included assessment of the material substance, visual appearance, learning design, software utilization, ethno-STEM integration, knowledge ability, and students' creative thinking, but also included constructive feedback from experts. The validators provided comments, suggestions and insights that helped to identify and correct deficiencies in early versions of the product. This ensured that the E-SWS was refined before being implemented in learning. Based on the feedback, a number of revisions were made to improve the quality of the E-SWS, one of which is shown in Figure 9.

(a) Before revision (b) After revision

Fig. 9. Cover Revision

Based on Figure 9, researchers made revisions based on input from validators. Initially, the writing on the cover looked disproportionate. Based on the validator's input, the researcher made revisions to the color of the

writing, and the layout was adjusted so that it looked proportional, harmonious, and did not interfere with readability. The addition of the UNP and Tut Wuri Handayani logos was also made to fill the empty space and strengthen the institution's identity.

Feedback from validators regarding the ethno-stem worksheet. In the initial version, the STEM principles on the worksheet were only in the form of questions. The validator's input was to present the real content of the STEM principles with related ethnoscience. In the science principle, simple experiments are presented. The technology principle also presents technology related to ethnoscience. In the engineering principle, it does not yet contain procedures that encourage students to create. Another input given by the validator is to replace the ethnoscience examples used in the worksheet. The ethnoscience that was originally used was the batangeh tradition (steam bath) replaced with gulo saka cooking. This replacement is because the batangeh tradition is not suitable as an example of the application of the principle of heat transfer in local culture. The next suggestion is to add indicators of knowledge and creative thinking skills on worksheets and practice questions. The last suggestion is to tidy up the formula numbers and picture numbers.

Discussion

This research was conducted at SMA Negeri 6 Padang. This research focuses on developing E-SWS products to facilitate students' knowledge and creative thinking skills. The development model used is the Hannafin & Peck model which consists of three phases, namely needs analysis, design, development and implementation. Researchers only conducted up to the development stage and focused on product validity. Product validity was assessed by three Physics lecturers at Padang State University (UNP) using seven assessment components. The assessment components refer to the guidelines for developing ICT-based teaching materials by the Ministry of National Education in 2010. The components include material substance, visual communication display, learning design, software utilization [22]. The substance of the material is organized according to the curriculum and designed to improve student skills. Visual communication displays that attract attention and facilitate the delivery of information. Systematic learning design and appropriate software utilization encourage interactivity. This supports student engagement in the learning process. It is complemented by an ethno-STEM approach. Ethno-STEM is a learning approach that integrates science, technology, engineering and math with local cultural values. Etno-STEM can be interpreted as a process of developing scientific science concepts using local wisdom [23]. Indicators of knowledge ability measured are based on the principle of knowledge ability based on the revision of Bloom's taxonomy, namely factual, conceptual, procedural, and metacognitive [24]. Creative thinking indicators measured are according to Harisuddin namely fluency, flexibility, novelty, and elaboration [25].

The development of Ethno-STEM integrated E-SWS in this study is very relevant in the context of 21st century learning which demands increased knowledge and creative thinking skills of students. The application of ethno-STEM allows students to understand science concepts in the context of local culture, so that learning becomes more meaningful and contextualized [26]. The E-SWS design is developed through digital platforms such as Canva and *Liveworksheet* to support interactive online learning, this is in line with the direction of education digitization policy according to Permendikbudristek No. 16 of 2022 [27]. In addition, this approach is also supported by the constructivism-based learning model, as proposed by Hannafin & Peck which emphasizes the importance of learning design that is flexible, responsive, and able to facilitate active student participation.

Based on the results of the analysis and research that has been done, the ethno-STEM integrated E-SWS shows a high level of validity with an average score of 0.87, which is in the very valid category. A product is declared valid if it has an Aiken's V value above 0.61, so this E-SWS is suitable for use in learning. The developed E-SWS not only fulfills the aspects of substance and interactivity, but also successfully integrates local cultural values into science learning through the ethno-STEM approach. This integration proves that the combination of local wisdom, science, and digital technology can create contextual and meaningful learning, while supporting the strengthening of 21st century skills. Therefore, this ethno-STEM-based E-SWS deserves further development as a learning innovation that is relevant to the needs of today's students.

The limitation in this research lies in the scope that is still limited to the E-SWS product development stage and has not yet included the implementation stage in the classroom. The research was only conducted at SMA Negeri 6 Padang and involved three validators from UNP Physics lecturers, so it does not represent the diversity of other school contexts. The assessment focused on the validity aspect only, without testing the effectiveness of the product in improving student learning outcomes empirically. In addition, the involvement of students and teachers in the product evaluation process has not been carried out, so direct feedback from end users has not been obtained. Therefore, further research is needed that includes testing the practicality and effectiveness of ethno-STEM integrated E-SWS in real learning.

IV. CONCLUSION

Ethno-STEM integrated E-SWS proved to be feasible and effective to facilitate students' knowledge and creative thinking skills. The validation results show a score of 0.87 which is included in the valid category. The score obtained indicates that E-SWS has met the eligibility standards to be applied in the learning process. The validity obtained proves that E-SWS has met various aspects of assessment, such as material substance, material coverage, learning design, software utilization, ethno stem integration, knowledge ability, and students' creative thinking skills. The use of digital technology such as Canva and *Liveworksheet* strengthens the overall attractiveness and efficiency of learning that encourages active student engagement. The use of two learning approaches namely ethnoscience and stem in this E-SWS provides added value in providing a new atmosphere in the learning process and encouraging students' knowledge and creative thinking skills. The Hannafin & Peck model used in this development ensures that the process is systematic and based on needs analysis. Revisions based on expert feedback also improved the structure and content of the product, making it more mature and applicable. Although the development focused on one topic and a specific local cultural context, the results show great potential in supporting learning innovation in the 21st century era. Therefore, this product is worth considering as a creative, relevant and contextual learning alternative, in line with Merdeka Curriculum and the needs of 21st century education.

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