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Validity Analysis of Renewable Energy E-Module Based on Deep Learning Approach and Local Wisdom Assisted by Canva AI to Facilitate Students' Creative Thinking Skills

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ABSTRACT

The rapid development of science and technology in the 21st century requires education to focus not only on mastering concepts but also on developing higher-order competencies, particularly creative thinking skills. However, a preliminary study at SMAN 15 Padang revealed that students' creative thinking skills in physics learning remain low, especially in connecting physics concepts with contextual issues such as renewable energy. Therefore, this study aims to validate a renewable energy e-module based on a deep learning approach and local wisdom assisted by Canva AI to facilitate students' creative thinking skills. The novelty of this study lies in the integration of a deep learning approach, local wisdom, and Canva AI into a renewable energy e-module designed to promote creative thinking in physics learning. This research employed the Research and Development (R&D) method using the 4D model (Define, Design, Develop, and Disseminate), limited to the validation stage. The e-module was evaluated by three physics education experts from the Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, using a four-point Likert scale questionnaire, and the data were analyzed using Aiken's V index. The results of the study showed an overall validity score of 0,95 with a very valid category, comprising material content (0,94), visual communication (0,96), learning design (0,96), software utilization (0,93), implementation of the deep learning approach and local wisdom (0,91), and creative thinking skills (1,00). These findings indicate that the developed e-module is highly valid and suitable for use as an innovative teaching material. Practically, it provides teachers with a technology-assisted learning resource that supports meaningful, contextual, and creativity-oriented physics learning in line with 21st-century educational demands.

Keywords :e-module; deep learning; local wisdom; Canva AI; creative thinking skills; renewable energy

I. INTRODUCTION

The rapid advancement of science, technology, and information has transformed various aspects of human life, including education. In the 21st century, education is expected not only to promote students' mastery of concepts but also to develop competencies that enable them to adapt to increasingly complex global challenges. The emergence of issues such as digital transformation, climate change, energy sustainability, and rapid technological innovation requires individuals who are capable of critical and creative thinking, problem-solving, collaboration, and lifelong learning [1][2]. Consequently, learning should be designed to provide meaningful experiences that encourage students to apply their knowledge in authentic contexts while developing higher-order thinking skills relevant to real-life situations [3].

To address these challenges, 21st-century education emphasizes the development of four essential competencies, commonly known as the 4C is critical thinking, creativity, communication, and collaboration. These competencies are mutually supportive and play an essential role in preparing students to become adaptive, innovative, and responsible citizens capable of responding to social and technological changes [4]. Among these four competencies, creative thinking skills are one that deserves special attention because they play a role in encouraging students to generate new ideas, find alternative solutions to problems, and create innovations that are beneficial to life [5]. Creative thinking is reflected through four key indicators: fluency, flexibility, originality, and elaboration [6]. Fluency relates to the ability to generate many ideas in a given time, flexibility indicates the ability to see a problem from multiple perspectives, originality describes the ability to generate unique and different ideas from the majority, while elaboration is the ability to develop an idea in greater detail and systematically[7]. These indicators collectively demonstrate students' capacity to think creatively when encountering unfamiliar situations and solving contextual problems.

In physics learning, creative thinking skills have a very important role because the characteristics of physics material not only require the ability to understand scientific concepts, but also the ability to apply these concepts in solving various problems encountered in everyday life [2]. However, creative thinking skills do not develop naturally without a properly designed learning process, but need to be facilitated through learning experiences that provide opportunities for students to explore various alternative solutions to problems, express opinions, reflect, and produce innovations [8]. Therefore, the learning process should be able to create a learning environment that encourages students to think divergently, explore various possible solutions to problems, and develop new ideas based on the learning experiences they have gained.

A preliminary study conducted at SMAN 15 Padang revealed that students' creative thinking skills are still relatively low. Most students tend to memorize concepts rather than apply them to contextual problems, thus limiting their ability to generate diverse ideas or propose alternative solutions. As a result, students often focus on finding one correct answer rather than exploring various possible approaches. This finding is consistent with previous research which reported that learning that is still oriented towards memorizing concepts does not provide adequate space for students to develop creativity and high-level thinking skills [9]. This finding indicates the need for a learning approach that actively facilitates students' creative thinking skills while supporting meaningful learning experiences.

The low level of students' creative thinking skills has important implications for physics learning, particularly on the topic of renewable energy. Students who are unable to connect scientific concepts to real-world phenomena tend to view physics as a collection of abstract formulas rather than knowledge that can be applied to solve everyday problems. As a result, learning becomes less meaningful and fails to equip students with the competencies needed to address environmental and energy challenges [10]. This condition highlights the need for innovative teaching materials that not only facilitate conceptual understanding but also encourage students to explore ideas, analyze contextual problems, and develop creative solutions in line with the goals of 21st-century education [11].

Along with the development of digital technology, integrated learning has been shown to increase learning motivation, student engagement, and the quality of interactions between students [12]. Digital technology not only functions as a medium for conveying information but also acts as a learning environment that can encourage active, collaborative, and student-centered learning, one example is the use of electronic modules [13].Compared to conventional printed materials, e-modules provide greater flexibility because they can be accessed through various digital devices and integrate multimedia elements such as images, animations, videos, and interactive activities that enhance the student learning experience [14]. However, the effectiveness of e-modules depends not only on their technological features but also on the learning approach underlying their design. Therefore, e-module development must prioritize meaningful learning experiences that actively engage students in constructing knowledge rather than simply presenting information [15].

One learning approach deemed appropriate to these characteristics is deep learning. This approach encourages students to understand concepts comprehensively, relate new knowledge to prior experiences, reflect on their learning processes, and apply their understanding to authentic situations [16]. In the context of renewable energy, meaningful learning can be further strengthened by integrating local wisdom into the learning process. Local practices, such as the use of the Jirah Water Wheel as a source of mechanical energy, the malamang process utilizing biomass as a heat source, and the utilization of solar energy for drying agricultural products, provide authentic examples that help students connect scientific concepts with their surrounding environment [17].

Developing e-modules that integrate the deep learning approach and local wisdom requires technological support capable of presenting material in an engaging, interactive, and accessible manner. One such platform is Canva AI, an artificial intelligence-based design platform that offers various features to assist in the development of digital teaching materials. Canva AI enables educators to create e-modules with a more communicative and visually appealing interface. Furthermore, Canva AI makes it easy for students to access e-modules through various digital devices, supporting flexible, independent, and learner-centered learning. These characteristics are expected to increase student engagement during the learning process while providing a more meaningful and enjoyable learning experience.

Previous studies have demonstrated the potential of e-modules, deep learning approaches, local wisdom, and AI-assisted learning design in supporting science learning; these aspects are generally studied separately. However, studies integrating deep learning approaches, local wisdom, and Canva AI into a renewable energy e-module specifically designed to facilitate students' creative thinking skills are still limited. To address this gap, this study aims to validate a renewable energy e-module based on deep learning approaches and local wisdom assisted by Canva AI, to facilitate students' creative thinking skills. This integration of pedagogical, contextual, and technological elements is expected to provide a valid and innovative e-module that supports meaningful, student-centered, and contextual physics learning, while contributing to the development of creative thinking skills in accordance with the demands of 21st-century education.

II. METHOD

This research uses a research and development (R&D) method, an approach that combines research and development processes in a structured manner to produce a new product or refine an existing one to meet user needs. The development model adopted in this study is the 4D model which consists of four stages, namely Define, Design, Develop, and Disseminate [18]. This model was chosen because its stages are systematic and easy to follow, allowing the development process to proceed in a directed manner and produce a product that meets feasibility criteria. Furthermore, the 4D model is commonly used in the development of open materials and learning tools, thus aligning with the focus of this research, namely e-module development.

The e-module feasibility assessment instrument was developed with reference to the Guidelines for Developing Information and Communication Technology Based Teaching Materials. The aspects assessed include material substance, visual communication, learning design, software utilization, application of in depth learning approaches, local wisdom, and creative thinking skills.

Data validity was collected through a questionnaire completed by validators. The product validation process involved three physics lecturers from the Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, who were tasked with assessing the e-module's feasibility across various predetermined aspects. The assessment used a four-level Likert scale to measure the degree of validity of the developed e-module, with validator-selected categories presented in Table 1.

Tabel 1. Validator Selection Category

Skala Likers	Skor
Strongly Agree	4
Agree	3
Disagree	2
Strongly Disagree	1

(Source : Ref[19])

The assessment results from each validator were then analyzed using Aiken's V (V) item validity index, with the following formula:

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

$$s = \mathrm{r} - L_0 = \text{.....} (1)$$

The Aiken Index is used to measure the validity of each statement item in the e-module validation instrument. Based on equation (1), V is the rater agreement index regarding the validity of the item, s is the score given by each rater minus the lowest score in the category used, while r is the score of the category selected by the rater, L_0 is the lowest score in the assessment category, n is the number of raters involved, and c indicates the number of assessment categories used. The higher the index value obtained, or the closer it is to 1, the better the

validity of the product being developed. The interpretation categories of the Aiken Index V are presented in Table 2.

Table 2. Aiken's Index Category

Index Range	Category
$V \leq 0,4$	Less
$0,4 < V \leq 0,8$	Valid
$0,8 < V$	Very valid

III. RESULTS AND DISCUSSION

The validity test of the renewable energy e-module based on a deep learning approach and local wisdom assisted by Canva AI to facilitate students' creative thinking skills was conducted by three expert validators from the Physics Department, FMIPA UNP. The assessment covered six components: material substance, visual communication, learning design, software utilization, application of a deep learning approach and local wisdom, and creative thinking skills. First, the results of the analysis of the material substance component aim to measure the suitability of the material content presented in the e-module to suit curriculum demands, scientific developments, and student characteristics. The assessment of this component includes four indicators: truth, material coverage, currentness, and readability. The results of the analysis are presented in Table 3.

Table 3. Results of Material Substance Analysis

Assessment Indicator	**Average**	**Category**
Truth	0,93	Very Valid
Coverage	0,91	Very Valid
Readability	0,94	Very Valid
Currentity	1,00	Very Valid
Overall average	**0,94**	**Very Valid**

Based on Table 3, the four indicators in the material substance component are in the very valid category, with values ranging from 0,91 to 1,00. A truth value of 0,93 indicates that the renewable energy material presented is in accordance with the concepts and principles of physics. A material coverage value of 0,91 indicates that the material has included competencies, learning objectives, and the scope that students need to learn. A current value of 0,94 indicates the relevance of the material to developments in science and technology and actual phenomena of renewable energy utilization, while a readability value of 1,00 indicates that the language used is clear, communicative, and easy to understand. Overall, the material substance component obtained an average of 0,94 with a very valid category, so that the e-module material substance is declared suitable for use as a learning medium.

The second validation assessment relates to the visual communication component. This component is assessed using six indicators: navigation, fonts, media, color, animation, and layout. The analysis results are presented in Table 4.

Table 4. Visual Communication Analysis Results

Assessment Indicator	**Average**	**Category**
Navigation	1,00	Very Valid
Fonts	0,89	Very Valid
Media	1,00	Very Valid
Colors	1,00	Very

Assessment Indicator	Average	Category
	0	Valid
Animation	0,89	Very Valid
Layout	1,00	Very Valid
Overall average	**0,96**	**Very Valid**

Based on Table 4, all visual communication indicators are in the very valid category, with values between 0,89 and 1,00. Navigation, media, color, and layout each obtained a perfect score 1,00, indicating that the access structure, use of multimedia elements, color combinations, and e-module layout have been designed consistently, harmoniously, and systematically so as to make it easier for students to understand the material. The letter and animation indicators each obtained a value of 0,89, indicating that the selection of fonts and the use of animation have been in accordance with learning needs without disturbing the students' learning focus. Overall, the visual communication component obtained an average of 0,96 with a very valid category, so it is considered capable of supporting the presentation of material effectively and attractively.

The third validation assessment relates to the learning design component. This component is assessed through eight indicators: title, learning outcomes, learning objectives, Learning Objective Achievement Indicators, materials, exercises, compilers, and references. The analysis results are presented in Table 5.

Table 5. Learning Design Analysis Results

Assessment Indicator	Average	Category
Title	1,00	Very Valid
Learning Outcomes	1,00	Very Valid
Learning Objectives	0,89	Very Valid
Learning Objective Achievement Indicators	0,89	Very Valid
Materials	0,96	Very Valid
Exercises	0,94	Very Valid
Compiler	1,00	Very Valid
References	1,00	Very Valid
Overall average	**0,96**	**Very Valid**

Based on Table 5, all learning design indicators are in the very valid category, with values between 0,89 and 1,00. The title, learning outcomes, compiler, and reference indicators obtained the highest value 1,00, indicating that the four elements have been clearly structured, according to the curriculum, and supported by relevant and up-to-date reference sources. The learning objectives and Learning Objective Achievement Indicators indicators obtained a value of 0,89, indicating that the formulation of objectives has been directed and the achievement indicators are able to measure learning achievement accurately. The material and exercise indicators each obtained values of 0,96 and 0,94, indicating that the preparation of materials and exercise activities has been systematic and able to measure student understanding. Overall, the learning design components obtained an average of 0,96 in the very valid category.

The fourth validation assessment relates to the software utilization component. This component is assessed using four indicators: interactivity, core software, supporting software, and originality. The analysis results are presented in Table 6.

Table 6. Software Utilization Analysis Results

Assessment Indicator	Average	Category
Interactive	0,78	Valid
Main Software	1,00	Very Valid
Supporting Software	0,94	Very Valid
Originality	1,00	Very Valid
Overall average	**0,93**	**Very Valid**

Based on Table 6, the indicators for the software utilization component are in the valid to very valid category, with values ranging from 0,78 to 1,00. The interactive indicator received the lowest score (0,78) but remains in the valid category, indicating that the e-module has interactive features that support the learning process, although there is still room for improvement. The main software and originality indicators each received a perfect score (1,00), indicating that the use of Canva AI as the main software meets development needs and produces an original product. The supporting software indicator received a score of 0,94, indicating that the supporting software used has been able to optimize the presentation of the material. Overall, the software utilization component received an average score of 0,93, categorized as very valid.

The subsequent validation assessment assessed two main aspects: the implementation of a deep learning approach and the integration of local wisdom into the e-module. The analysis results are presented in Table 7.

Tabel 7. Analysis Results of Deep Learning Approach and Local Wisdom

Assessment Indicator	Average	Category
Deep Learning	0,89	Very Valid
Local Wisdom	0,92	Very Valid
Overall average	**0,91**	**Very Valid**

Based on Table 7, Both aspects were categorized as highly valid. The deep learning approach aspect received a score of 0,89, indicating that the e-module integrated deep learning principles through the stages of understanding, applying, and reflecting on the learning material. The local wisdom aspect received a score of 0,92, indicating that the integrated local wisdom elements were relevant to the renewable energy material and were able to connect physics concepts to the context of local life and culture. Overall, this component received an average score of 0,91, categorized as highly valid.

The sixth validation assessment related to the creative thinking skills component was assessed through four indicators: fluency, flexibility, originality, and elaboration. The results of the analysis are presented in Table 8.

Tabel 8. Results of Creative Thinking Skills Analysis

Assessment Indicator	Average	Category
Fluency	1,00	Very Valid
Flexibility	1,00	Very Valid
Originality	1,00	Very Valid
Elaboration	1,00	Very Valid
Overall average	**1,00**	**Very Valid**

Based on Table 8, All indicators of creative thinking skills, namely fluency, flexibility, originality, and elaboration, received a perfect score of 1,00, categorized as very valid. These results indicate that the developed e-module is able to facilitate students in generating various ideas, providing alternative solutions to problems, putting forward original ideas, and developing ideas in detail through the learning activities presented. Thus, the

e-module is considered to have met the eligibility criteria in supporting the development of students' creative thinking skills.

Validity test results showed that the renewable energy e-module based on a deep learning approach and local wisdom, aided by Canva AI, achieved an overall average score of 0,95, categorized as highly valid. This finding indicates that the developed e-module met the eligibility criteria in terms of material substance, visual communication, learning design, software utilization, implementation of learning approaches, and facilitation of students' creative thinking skills.

Regarding the material substance aspect, the score of 0,94 obtained indicates that the renewable energy material presented aligns with scientific principles, curriculum scope, and students' learning needs. This finding aligns with previous research showing that e-modules with systematically and contextually structured material can improve students' conceptual understanding and learning outcomes in physics [20]. The high validity of the currentness indicator (1,00) also reinforces the view that integrating current issues, such as the energy crisis and sustainable resource use, into teaching materials can increase the relevance of learning to students' real lives.

In terms of visual communication, the 0,96 score indicates that the e-module's appearance, including navigation, colors, media, and layout, has been designed in an attractive and communicative manner. This result is consistent with previous research findings, which found that using Canva as a learning materials development software can produce products with high media validity due to the ease of integrating multimedia elements interactively [21]. A similar finding was found in the development of Canva-assisted learning materials incorporating local wisdom, which received a very valid category in both media and material aspects (with a validity percentage above 90%), thus confirming that AI-based design platforms like Canva contribute significantly to the visual quality of digital learning materials [22].

In terms of learning design, the 0,96 score indicates that the components of the title, learning outcomes, learning objectives, materials, exercises, and references have been systematically structured and interconnected. The highest scores for the title, learning outcomes, compiler, and references indicators indicate that the e-module learning design framework meets the principles of systematic teaching material development as stipulated in the guidelines for developing ICT based teaching materials. This finding is also in line with the results of research on Learning Product Testing Instruments, which shows that the clarity of the learning design structure contributes significantly to a high overall product validity index. [23].

Regarding software utilization, a score of 0,93, categorized as very valid, indicates that the use of Canva AI as the primary software in e-module development resulted in an original and functional product. The slightly lower score for the interactive indicator (0,78), although still categorized as valid, indicates room for improvement in the e-module's interactive features to further optimize student engagement. This finding aligns with the results of research on the development of Canva AI assisted teaching modules on simple machines, which achieved a very acceptable category for material and media validation. It also confirms that Canva AI is a relevant platform for developing artificial intelligence-based teaching materials [24].

In terms of the application of the deep learning approach and local wisdom, an average score of 0,91 indicates that the e-module has successfully integrated the principles of mindful, meaningful, and joyful learning with the context of local wisdom in West Sumatra in a relevant and meaningful manner. This finding supports studies stating that the application of the three pillars of deep learning contributes positively to improving the quality of learning holistically, both from the cognitive, affective, and student engagement aspects [25]. In addition, the high validity of the local wisdom aspect also supports the view that the integration of local cultural and environmental contexts into physics learning can bridge scientific concepts with the realities of students' lives, so that learning becomes more contextual and meaningful.

In terms of creative thinking skills, all four indicators fluency, flexibility, originality, and elaboration earned a perfect score of 1,00, categorized as highly valid. These results indicate that the learning activities designed in the e-module facilitated students' ability to generate diverse ideas, develop alternative problem-solving strategies, and reflect deeply on their understanding. This finding aligns with research on the development of creative thinking-based learning modules for science, which showed that modules specifically designed to facilitate creative thinking indicators received valid to highly valid ratings based on Aiken's V coefficient.

Overall, the validity results for the six assessment components reinforce previous research findings that integrating deep learning approaches, local wisdom, and artificial intelligence-based technology in e-module development can produce teaching materials that are not only valid in terms of material and design, but also contextually relevant and capable of facilitating students' higher-order thinking skills. Therefore, the renewable energy e-module developed in this study could be an alternative, innovative teaching material worthy of implementation in physics learning, particularly to support the achievement of 21st-century competencies.

IV. CONCLUSION

This research aims to develop and determine the validity of a renewable energy e-module based on a deep learning approach and local wisdom, assisted by Canva AI, to facilitate students' creative thinking skills. Based on the results of expert validation involving three physics lecturers, the e-module was declared very valid, with an overall average score of 0,95, comprising six components: material substance (0,94), visual communication (0,96), learning design (0,96), software utilization (0,93), application of the deep learning approach and local wisdom (0,91), and creative thinking skills (1,00). These results indicate that the e-module has met the feasibility criteria in terms of content accuracy, instructional design, visual appeal, technological implementation, contextual relevance, and its capacity to facilitate the four indicators of creative thinking, namely fluency, flexibility, originality, and elaboration. Therefore, the developed e-module is suitable for use as a teaching material in physics learning, particularly on renewable energy topics, and can serve as an innovative alternative that supports more meaningful and contextual learning while addressing the demands of 21st-century competencies. Further research is recommended to test the practicality and effectiveness of this e-module through field trials to empirically confirm its impact on improving students' creative thinking skills.

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