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Development of an Energy Teaching Kit to Foster Computational Thinking Skills of Primary Students in the Renewable Energy Subject

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Abstract

This research aimed to develop the Energy Teaching Kit as a learning medium to enhance elementary students' computational thinking skills in science learning. The study employed a Research and Development (R&D) design, utilizing the ADDIE model, which comprises the stages of Analysis, Design, Development, Implementation, and Evaluation. The participants were elementary school students from both public and private schools in Madiun City. Data were collected through tests and questionnaires during the implementation phase. The results indicate that the developed medium achieved a validity score of 86%, demonstrating that its content, structure, and functionality meet expert criteria. The practicality level reached 87.05%, indicating that the medium is easy to use and has been positively received by teachers and students. Its effectiveness is supported by an N-gain score of 52.76%, indicating a moderate level of improvement in students' computational thinking skills. Overall, these findings confirm that the Energy Teaching Kit is valid, practical, and effective for classroom use. Future research may examine its integration with digital sensors, its scalability across different grade levels, and the support it provides for teacher professional development to optimize implementation.

Keywords Computational Thinking; Energy Teaching Kit; Renewable Energy; Sciences

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1. INTRODUCTION

The Government of Indonesia, through the Ministry of Energy and Mineral Resources (EMR), encourages the use of renewable energy, as Indonesia aims to reduce emissions and achieve Net Zero Emissions (carbon neutrality) by 2060 (Evitasari & Komarulzaman, 2023). Humans need to reduce carbon emissions (Antón et al., 2011; Aziziankohan, 2017; Chen & Wang, 2012; Gonzalez-Asenjo et al., 2023; Jiang et al., 2018; Munsamy & Telukdarie, 2022). One way to reduce energy consumption is by increasing energy efficiency at home (Facchini et al., 2016). Therefore, it is necessary to educate the general public about renewable energy. To date, socialization efforts related to the use of renewable energy, particularly solar panels, have been targeted at adult community members (Hai, 2019; Irfan et al., 2021; Kapoor & Dwivedi, 2020). In fact, introducing renewable energy sources to school students early can increase their interest and curiosity in learning, utilizing, and even developing them later (Uddin, 2024). In addition, students currently in elementary school will become leaders in Golden Indonesia by 2045, when they will be responsible for implementing regulations and policies.

Renewable energies that are environmentally friendly and are currently being intensively developed include microhydro, solar panels, and windmills (Ali et al., 2021; Laksana et al., 2022)The most cost-effective alternative sources of electrical energy to build are solar panels. In addition to its relatively cheap cost compared to others, Indonesia benefits from its geographical location along the equator, so that it gets sunlight all year round with an average solar radiation intensity of 4,8 kWh/m^2 (Kinasti et al., 2019; Maghfiroh et al., 2022; Pratama et al., 2023; Yuniahastuti et al., 2023).

In the learning process, learning media that function as teaching aids are needed, which also affect the climate, conditions, and learning environment that are arranged and managed by teachers (Garba et al., 2015; Güzel & Berberoğlu, 2005; Lusa et al., 2024). Learning media makes it easy for students to understand a concept of knowledge (Suarsana et al., 2019). In addition to the use of media, learning requires skills that support the current era. The current era is a digital era where all aspects, including education and teaching, utilize digital technology. Students in Indonesia are the next generation of the nation who can create something in the future. One of the skills needed is Computational Thinking (CT).

CT is a fundamental ability that a person has, which is the same basic ability as the ability to read, write, and perform arithmetic calculations (Hu, 2011; Maharani et al., 2019; Zhong et al., 2016). In addition, CT is everyone's basic ability to learn, which is an important preparation for the future to educate young people (Cho & Lee, 2017) Because CT will be applied in the world of work later (Buteau et al., 2017; Gadanidis, 2017). According (Wing, 2010)Learning to use CT as a foundational skill throughout the school curriculum will enable students to develop abstract, algorithmic, and logical thinking. To teach CT, teachers need a variety of different approaches (Guzdial, 2008) and based on the needs of the student (Stevens et al., 2013).

Previous studies on CT have focused partly on students (Barr et al., 2011; Lee et al., 2020; Sung et al., 2017; Yadav et al., 2017). For example, exploratory investigations by Lewandowski et al. demonstrate how CT exposure enhances students' problem-solving approaches. Some researchers propose that CT can serve as an effective vehicle for subjects such as science and math concepts (Blikstein & Wilensky, 2009; Kynigos, 2007; Sengupta et al., 2013). (Werner et al., 2014) Tested new performance assessments from a student's perspective to measure CT in high school. Research on the integration of CT in education is still scarce (Koning et al., 2011; Voogt et al., 2015). Many studies focus on computational thinking, which primarily addresses definitional issues and the tools that drove its development (Grover & Pea, 2013). While computer science education researchers have recently contributed a significant amount of work to the growing knowledge base on CT teaching and learning, existing studies have rarely focused on teacher perspectives (Portelance & Bers, 2015) and learning media. There are a few studies that systematically and comprehensively examine the effect of CT on pre-service and in-service teachers (Yadav et al., 2014). CT is also needed in all learning materials, including natural learning. In the elementary school curriculum, materials related to renewable energy are determined, which are also related to students' CT (Drikakis & Dbouk, 2022).

The “Kurikulum Merdeka” currently implemented in Indonesia focuses on a project-based approach and emphasizes student-centered learning. Based on the curriculum, renewable energy learning is ideally practicum-based, with learning media that illustrate the implementation of renewable energy in daily life (Ang et al., 2022). However, according to preliminary studies in the field, most elementary schools in Madiun City still lack adequate facilities for carrying out the learning process of renewable energy materials, resulting in students becoming less enthusiastic because the learning is less contextual or does not involve direct practice. Therefore, this study designed an “energy teaching kit” as a learning medium for students to learn and easily understand the application of renewable energy. The novelty of this study lies in the fact that the media developed can be used by teachers to enhance students' computational thinking through problem-solving, in contrast to previous renewable energy media that only demonstrated and did not capture the students' computational thinking process.

However, despite the growing body of literature on computational thinking, research that integrates CT into elementary science learning—particularly in the context of renewable energy—remains limited. Existing studies predominantly focus on programming activities, assessment models, or theoretical discussions of CT. At the same time, systematic investigations that embed CT within hands-on, inquiry-based renewable energy learning at the primary school level are still scarce. In addition, studies exploring learning media that simultaneously support science understanding and CT development in real classroom settings in Indonesia are notably lacking. This gap highlights the need for innovative instructional tools that contextualize renewable energy concepts while fostering students' computational thinking. Therefore, the present study addresses this gap by developing the Energy Teaching Kit as a science learning medium designed to integrate CT within renewable energy learning in elementary schools.

The energy teaching kit is a learning media to introduce renewable energy that is designed to be used in accordance with the Kurikulum Merdeka so that it can help students understand the working principles of power plants using renewable energy, as recommended in hands-on and context-based science learning (Çetin & Günay, 2018; Rahmawati & Ridwan, 2020). The kit consists of *a solar kit* and *a wind turbine kit*, accompanied by a kit module that contains procedures for using the kit. This aligns with studies emphasizing the importance of experiment-based renewable energy kits in supporting conceptual understanding in elementary science (Tsai, 2020; Zengin et al., 2021). *The wind turbine kit* consists of a fan that functions as an input to the wind speed on the turbine, a turbine (propeller) connected to the generator then connected to an LED light as a load and an indicator of the presence of an electric current generated which is then displayed on the LCD, similar to low-cost educational turbine kits developed in prior research (Adeyemi & Oke, 2022). LEDs are installed in miniature houses as an illustration of wind energy for home needs. *The solar kit* consists of solar cells placed on the roof of a miniature house, then connected to a battery as an energy store and LED lights as an indicator of the presence of electric current generated, reflecting the approach used in previous studies employing photovoltaic kits for science education (Alami, 2021; Dewi & Hartono, 2021) as well as the amount of power displayed on the LCD.

This media aims to make students know the concept of generating electrical energy that can be produced from solar and wind heat, so that it is hoped that later they will be able to apply it in the real world when they grow up to be able to realize the ideals of the state of Indonesia "zero carbon". The implementation of electrical energy generated by solar panels and wind turbines can be used to power streetlights and small water pumps. In addition to being operated by children, this media is also equipped with a screen display that indicates the electrical energy produced by solar panels and wind turbines. Students can be invited to place media in the sun to demonstrate that solar panels are capable of generating electricity, and they can also prove that wind turbines work by blowing directly on windmills. The innovations developed in the Energy Kit are based on experimentation and testing. Students can conduct experiments using renewable energy props directly with module guidance. Through these experiments, students are not only limited to understanding the working principles, but can also analyze the phenomena that occur and solve them scientifically.

Renewable energy teaching kits have been widely commercialized, but the prices offered are high enough to make them unaffordable for schools. Many prototypes have been developed regarding renewable energy, but these prototypes still have shortcomings, namely, they are still limited in their demonstration capabilities. The innovations developed in this energy teaching kit are based on experiments and feature an LCD screen that displays the amount of power produced. Students can conduct experiments using energy teaching kits directly, accompanied by module guides/manuals. Through these experiments, students are not only limited to understanding the principles of work, but can also analyze the phenomena that occur and solve them scientifically. In addition, teachers are equipped with maintenance and repair methods in case this kit is damaged in the future, so it is hoped that this kit can be used for a long period of time. Therefore, the purpose of this study is to develop and test an affordable, experiment-based renewable energy teaching kit that effectively supports students' conceptual understanding and scientific analysis skills, while also providing teachers with a sustainable, easy-to-maintain instructional tool that aligns with classroom needs.

2. METHODS

Research Design

The type of research employed is development research, also known as R&D (Research and Development), utilizing the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model. The stages of research carried out are as follows:

Analysis

In the early stages of the research, the researcher analyzed needs, learning materials, the environment, and problem identification through interviews with primary school teachers in Madiun City.

a. Design

At this stage, the researcher designed a product in the form of an energy teaching kit learning media. This stage includes product design planning, learning objectives, materials, instructions for use, and evaluation.

b. Development

Researchers create media based on concepts and designs that have been designed. The energy teaching kit developed has an output in the form of a concrete object that can be used as a learning medium/teaching aid. Before being implemented, the product will be validated by experts, namely material experts, media design experts, and practitioner experts.

Implementation

At this stage, researchers implement or apply the media that have been developed to determine the feasibility and readability of the energy teaching kit, which has been refined through limited trials and field tests.

Evaluation

This stage involves analyzing the validity and practicality of the energy teaching kit in relation to renewable energy materials. Evaluate research results and follow-up planning after research.

Subject

This study involved four elementary schools in Madiun City—SDN 03 Kanigoro, SDN 05 Madiun Lor, SD Islam Siti Hajar, and SD Muhammadiyah Madiun—representing both public and private institutions. The schools were selected using purposive sampling based on the availability of science teachers and their readiness to implement project-based learning. The research subjects consisted of four Grade IV classes with a total of 162 students. The student characteristics considered in this study included their initial understanding of energy concepts, prior experience with science laboratory activities, and their level of exposure to tasks involving computational thinking (CT).

Instrument

The instruments used in this study consisted of observation sheets, interview guidelines, student response questionnaires, and learning outcome test sheets.

Observation Sheet

The observation sheet was used during the analysis stage to identify classroom conditions, available science learning facilities, and the extent to which learning activities supported hands-on investigation. The indicators observed included the availability of practicum tools, students' engagement during science activities, teachers' use of experimental methods, and the alignment of classroom practices with project-based learning elements in the Kurikulum Merdeka.

Interview Guidelines

Interviews were conducted with teachers to obtain more detailed information regarding learning needs and challenges. The indicators explored in this instrument covered teachers' perceptions of students' difficulties in understanding energy concepts, the types and limitations of media currently used in science lessons, teachers' readiness to implement experimental activities, and their expectations regarding media features that could enhance students' computational thinking.

Student Response Questionnaire

The questionnaire was administered after students completed learning activities using the Energy Teaching Kit to assess the practicality and attractiveness of the media. Indicators measured through the questionnaire included the clarity of instructions provided in the module, the ease of operating both the solar and wind turbine kits, students' interest and engagement throughout the learning process, their perception of the media's usefulness in understanding renewable energy concepts, and the level of comfort and safety experienced while using the tools.

Learning Outcome Test Sheet

The learning outcome test was used to evaluate the effectiveness of the developed media through pre-test and post-test administration. The indicators embedded in the test items were aligned with computational thinking skills, reflecting students' ability to decompose problems related to energy generation, recognize patterns in the relationship between energy inputs and the power displayed on the LCD, abstract relevant information from experimental observations, and apply algorithmic thinking by following or constructing systematic procedures during experiments.

Data Collection

The data collection techniques in this research are observation, interviews, questionnaires, and learning outcome tests. Observations and interviews are conducted at the analysis stage, specifically, to perform an in-depth analysis of learning needs. Observations were conducted in the school environment, and interviews were held with teachers to gather data on the needs of both teachers and students in the science learning context. The instruments used were observation sheets and interview guidelines.

The questionnaire is used to measure students' responses to the media developed. This questionnaire is distributed and completed by students after they receive instruction using the Media Energy Teaching Kit. Experts have previously validated the questionnaire used in this study.

The last data is the results of learning tests taken to measure the effectiveness of the developed media. In this study, tests are carried out before and after students use the media. The instrument used is a learning outcome test sheet. The questions in it are complex problem-solving problems that can measure students' CT. Experts also validate the test sheet before use.

Data Analysis

Analysis of the Validity of Learning Media

The validators of science teaching materials in this study are science teachers or lecturers. The components evaluated are display quality, content, language, and media interactivity, which are then accumulated using the following formula.

$$\text{validityvalidit}=\frac{\text{scores obtained}}{\text{maximum scores}}\text{x}100\% \quad (1)$$

The combined validity formula of the 2 validators is as follows.

$$v=\frac{vah_1+vah_2}{2} \quad (2)$$

V : Combined validity

vah_1 : Validity value of validator 1

vah_2 : Validity value of validator 2

Based on Table 1, the validity categories are as follows.

Table 1. Validity Category

No	Validity value	Validity Category
1.	85,1% - 100%	Highly valid or used without revision
2.	70,1% - 85%	Quite valid, or can be used with minor revisions
3.	50,1% - 70%	Less valid or recommended not to be used because it needs major revision
4.	0,1% - 50%	Invalid or unusable

Analysis of the Practicality of Learning Media

The practicality formula used is as follows.

$$Vp=\frac{TSEp}{S\text{-}Max}\times 100\% \quad (3)$$

Information:

Vp : Validity of Practicality

TSEp : Total Empirical Score of Practicality

S-Max : Expected Max Score

Based on Table 2, the practicality criteria are as follows.

Table 2. Practicality Criteria

Practicality value	Practicality Criteria
85,1% - 100%	Very practical or used without revision
70,1% - 85%	Quite practical, or can be used with minor revisions
50,1% - 70%	Less practical or recommended not to be used because it needs major revisions
0,1% - 50%	Impractical or unusable

The validity of the media was analyzed using Aiken's V formula involving X expert validators, and the resulting scores were categorized based on the criteria proposed by Akbar. These criteria were selected because they are widely applied in media development research in Indonesia, provide clear interpretive boundaries for validity levels, and are well-suited for evaluating the content, construct, and visual feasibility of instructional media. Practicality was assessed using percentage scores derived from teacher and student questionnaires, which were also interpreted using Akbar's (Categorization. This categorization offers appropriate percentage thresholds for evaluating classroom applicability and has been extensively used in studies assessing learning tools and instructional materials, thereby enabling meaningful comparison with prior research. Based on Figure 1, the flow of research procedures used is as follows:

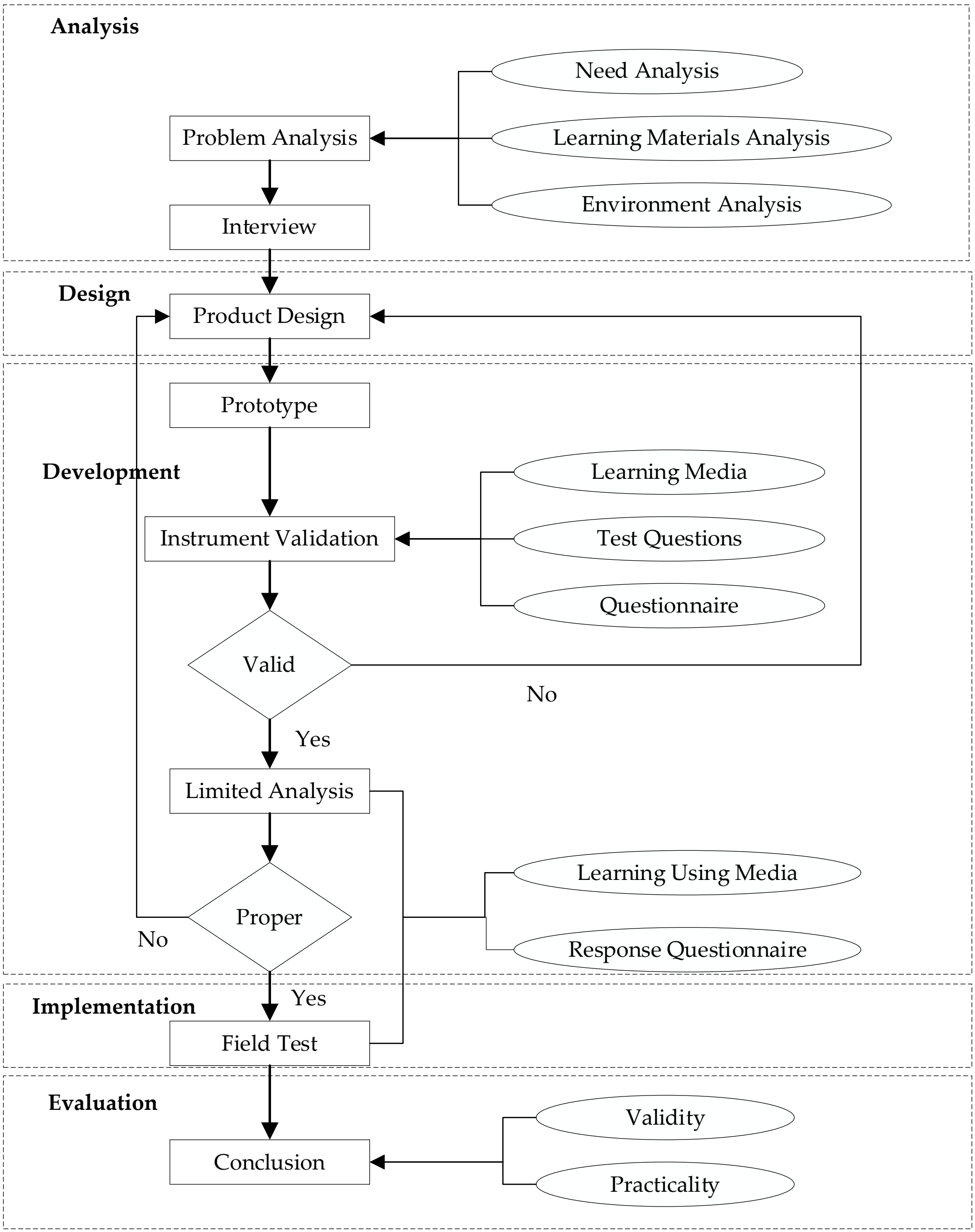

Figure 1. Research Procedure

3. FINDINGS AND DISCUSSIONS

Findings

Based on the research and development that has been carried out, the following results are obtained:

Analysis

At this stage, a Focus Group Discussion (FGD) was conducted with grade 4 teachers throughout the city of Madiun to determine the needs in schools regarding learning media, particularly in renewable energy materials or concepts.

a. Needs Analysis

The results of the FGD conducted with grade 4 teachers throughout Madiun City indicate an urgent need for science learning materials, particularly those related to renewable energy, in primary schools. The majority of teachers stated that the current learning media are still limited, lack variety, and often fail to attract students' interest. The need for concrete, relevant, and interactive learning media is urgent. In addition, obstacles such as limited access to technology, minimal preparation time, and lack of training are also inhibiting factors in the effective use of learning media. Based on the results of the FGD, it can be concluded that the development of innovative and engaging learning media is crucial for enhancing students' understanding of the concept of renewable energy.

b. Analysis of Learning Materials

The results of the analysis of renewable energy materials in elementary schools show several important things. First, students' understanding of the concept of renewable energy still needs improvement, particularly in aspects such as the difference between renewable and non-renewable energy, as well as the energy conversion process. Second, the dominant learning method remains teacher-centered, with limited variation in the use of learning media. Third, the lack of interactive and concrete learning media is an obstacle to attracting student interest. This highlights the need for more innovative and relevant learning media to integrate into students' daily lives. Thus, the development of an "Energy Teaching Kit" specifically designed for renewable energy materials can be an effective solution to overcome this problem.

c. Environmental Analysis

The lack of renewable energy learning media in elementary schools is a complex challenge. Several key factors contribute to this condition, including limited school budgets, inadequate infrastructure, a lack of teacher training, and the limited availability of educational materials on the market. Additionally, the low awareness of the importance of renewable energy and the lack of curriculum support are also significant obstacles.

This condition has a direct impact on the quality of students' learning, as they struggle to understand the concept of renewable energy in depth and are less motivated to learn. To overcome this problem, a comprehensive effort is needed. One important step is to increase teachers' access to quality training, enabling them to develop creative and innovative learning materials. Additionally, cooperation is necessary among schools, the government, and the private sector to provide the necessary resources, including budgets, infrastructure, and high-quality learning materials.

Design

At this stage, the initial design is prepared, and the research instrument is designed.

a. Initial Design

The development of this media energy kit began with an initial design that was drawn manually, after which it was continued to create an image design in SketchUp. The media energy kit, designed to be as easy as possible to operate by elementary school students, contains miniature renewable energy sources, including solar panels installed on the roof of the house and miniature rice fields equipped with wind turbines. In addition to being operated by children, this media is also equipped with a screen display that indicates the electrical energy produced by solar panels and wind turbines. The initial design is presented in Figures 2 and 3 below.

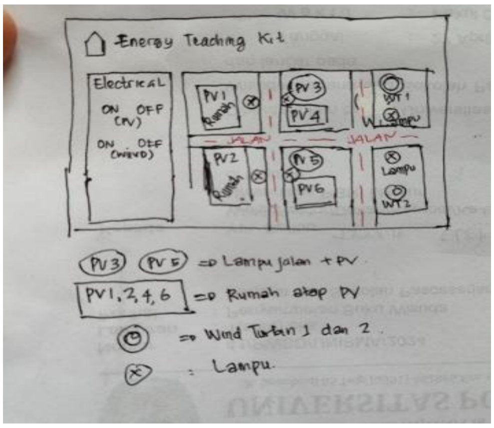

Figure 2. Manual Design

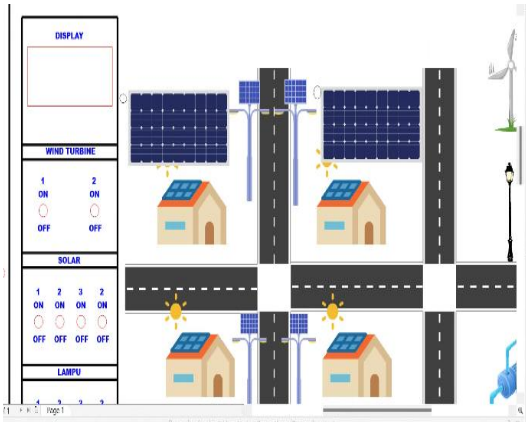

Figure 3. Design on Sketchcup

b. Research Instrument

Media Validation Sheet

This validation sheet contains 12 statements that are used to assess the feasibility of the Energy Teaching Kit on renewable energy materials. These statements include aspects of content, language, activities, as well as implementation and measurement. Each statement is graded on a 5-point Likert scale: 5 (very good), 4 (good), 3 (moderately good), 2 (not good), and 1 (very bad). At the end of the validation sheet, validators can provide suggestions for improvements to this learning tool.

Student Response Questionnaire

The student response questionnaire consists of 15 statements used to assess several aspects, including interest, material, and language, when students use the media. The statement consists of 8 positive statements and seven negative statements. Students can put a check mark on the strongly agree, agree, or disagree columns.

Student Response Questionnaire Validation Sheet

The validation sheet for the student response questionnaire, which has been prepared, contains nine statements. The statements on the validation sheet contain aspects of instructions, content, and language, with assessments ranging from 5 (very good) to 1 (very bad). At the end of the sheet, validators can provide suggestions for the developed device.

1.1.2. Development

The results of developing the energy teaching kit media and the validation of the instrument will be explained in this chapter.

a. Media Development Results

The energy teaching kit is a learning medium designed to introduce renewable energy, in accordance with the "Kurikulum Merdeka", to help students understand the working principles of power plants that utilize renewable energy. The kit consists of a solar kit and a wind turbine kit, accompanied by a kit module that contains procedures for using the kit.

The wind turbine kit consists of a fan that serves as an input for measuring wind speed, a turbine (propeller) connected to the generator, and an LED light as a load and indicator of the generated electric current, which is then displayed on the LCD. LEDs are installed in miniature houses as an illustration of wind energy for home needs. The solar kit consists of solar cells placed on the roof of a miniature house, which are then connected to a battery as an energy store and LED lights as an indicator of the electric current generated. This current can be used to meet household needs, and the amount of power is displayed on an LCD. The media developed can be seen in the following Figure 4.

Figure 4. Energy Teaching Kit (View Top)

b. The Result of Media Validation and Research Instrument

The validation of the learning media aims to determine if the Energy teaching kit developed is indeed valid, ensuring the research carried out has validity. If the validation results show that the results are not valid, it is mandatory to carry out product revisions in accordance with the suggestions given by the validator and revalidate the revised or improved instruments. The validators of the learning tools appointed in the study consisted of three experts, namely learning media experts, and two experts on renewable energy. The results of the validation of the instrument sheet and the validated media design are presented below.

Learning Media Validation

Learning Media validation was used to determine the accuracy of the energy teaching kit as a teaching medium for grade IV renewable energy learning in elementary schools in Madiun City. The results of media validation are presented in Table 3.

Table 1. Energy Teaching Kit Validation

Result	Validator		
	I	II	III
Total Score obtained	51	52	52
Maximum Total Score	60	60	60
Validation Percentage	85	87	87
Combined Percentage		86	

Based on Table 3 above, the results of media validation have a validity of 86%.

Student Response Questionnaire Validation

The validation of the student response questionnaire was made to determine the level of accuracy of the response questionnaire for elementary school students in Madiun. The results of the validation of the student response questionnaire are presented in Table 4.

Table 2. Student Response Questionnaire Validation

Result	**Validator**		
	I	**II**	**II**
Total Score obtained	39	41	40
Maximum Total Score	45	45	45
Validation Percentage	86.67	91.11	88.89
Combined Percentage		88.89	

Based on Table 4, the results of the validation of the student response questionnaire have a validity of 88.89%.

Implementation

The results of the research at the implementation stage include limited tests and field tests. The two tests were carried out on different subjects and at different times.

a. Limited Test

A limited trial was conducted in the research and development of the "Energy Teaching Kit" to improve Computational Thinking in primary school students at SD Negeri 03 Kanigoro, Madiun. The trial involved 24 4th graders, who were randomly selected. The implementation of the limited trial will take place on Monday, August 26, 2024, from 08:00 to 10:00. The "Energy Teaching Kit" is used as a learning media in science subjects with an energy topic, where research instruments, such as student response questionnaires, are also employed.

The implementation of the limited trial lasted for 4 hours of lessons. The trial began with the researcher giving a presentation on the learning outcomes and objectives, followed by an explanation of the use of the "Energy Teaching Kit." Students were divided into four heterogeneous groups (a mixture of men and women). Each group was given the task of learning the concept of energy and conducting experiments using the components of the kit. Each group was asked to discuss the results of their experiment and present them to the class. After the discussion and presentation session was over, students were asked to fill out a response questionnaire and answer a test to assess the effectiveness and practicality of the "Energy Teaching Kit" in helping them understand energy materials and develop computational thinking. The results of the practicality of this limited trial were obtained through the analysis of student response questionnaires. Most students responded positively to the use of the "Energy Teaching Kit," with high ratings on aspects of interest, ease of use, and increased understanding of energy concepts. The results of the comprehensive analysis of the practicality of the learning tools are presented in Table 5.

Table 5. Practicality of the Energy Teaching Kit in a Limited Test

Practicality of Energy Teaching Kit	
Combined T-Sep	1246
Combined S-Max	1440
Combined Percentage	86,6

Based on Table 5, it shows that the "Energy Teaching Kit" learning media used to improve Computational Thinking in grade 4 students of SD Negeri 03 Kanigoro achieves a practicality percentage of 86.6%. According to (Akbar, 2011)The percentage of 86.6% falls within the category of very practical or can be used without revision. Therefore, it can be concluded that the students' response to the limited trial of the "Energy Teaching Kit" was very positive. This shows that the learning media developed meet practical criteria and are suitable for further use in further learning.

b. Field Test

Field tests were conducted as part of the research on the development of the "Energy Teaching Kit" learning media to improve Computational Thinking in elementary school students at three schools in Madiun City: SD Negeri 05 Madiun Lor, SD Islam Siti Hajar, and SD Muhammadiyah Madiun. This trial involved a total of 162 students from grade 4 in the three schools. The field test implementation took place from Tuesday to Thursday, September 5, 2023, from 07:30 to 11:30, using the "Energy Teaching Kit" learning media and research instruments, including student response questionnaires.

The field test was conducted over 5 hours of lessons. The activity began with the researcher explaining the learning outcomes and objectives of using the "Energy Teaching Kit." Furthermore, students were divided into four heterogeneous groups (a mixture of men and women) to discuss material on energy and conduct experiments provided in the kit. Each group presented the results of their experiments and discussions to the class. After the discussion and presentation activities are completed, students are asked to fill out a response questionnaire to evaluate the practicality and effectiveness of the "Energy Teaching Kit."

The results of this field test demonstrate the practicality of learning media, as evidenced by the analysis of student response questionnaires. Most students responded positively to the use of the "Energy Teaching Kit," particularly in terms of its ability to attract interest in learning, ease of use, and relevance of the material. The complete results of the analysis of this learning tool's practicality are presented in Table 6.

Table 6. Practicality of Energy Teaching Kit in Field Tests

Practicality of Energy Teaching Kit	
Combined T-Sep	8461
Combined S-Max	9720
Combined Percentage	87,05

Based on Table 6, the "Energy Teaching Kit" learning media used to improve Computational Thinking in primary school students in Madiun City achieved a practicality percentage of 87.05%. According to (Akbar, 2011) The percentage of 87.05% falls within the category of very practical or can be used without revision. Thus, it can be concluded that the students' response to the use of the "Energy Teaching Kit" in the field test is very positive. This shows that the learning media developed meet practical criteria and are feasible for application in elementary learning.

Discussion

The "Energy Teaching Kit" learning media developed in this study has been validated by several experts. Based on the combined validation results from the validators, the "Energy Teaching Kit" achieved a validity percentage of 86%. According to (Akbar, 2013b) This percentage falls within a valid category, so this media is considered feasible for use in learning without the need for significant revision.

This research also demonstrates that the "Energy Teaching Kit" can make a positive contribution to improving students' understanding of energy concepts and Computational Thinking. The learning methods employed in this media enable students to explore energy concepts through an interactive and real-life-based approach. In line with (Puspitarini & Hanif, 2019)Learning with media helps increase students' understanding and exploratory power in translating abstract concepts into concrete pictures of learning materials.

The implementation of the "Energy Teaching Kit" brings a breath of fresh air to the world of education in primary schools in Madiun. As an innovation, this learning media introduces a more interactive approach than traditional methods, which tend to be one-way. By utilizing the "Energy Teaching Kit," students are not only recipients of information but also active participants in the learning process. They are encouraged to engage in group discussions, collaborate, and exchange ideas, ultimately enriching their learning experience. This approach is aligned with the principles of 21st-century learning, where critical, creative, collaborative, and communicative thinking skills are strongly emphasized (Adamson & Darling-Hammond, 2015; Anwar & Umam, 2020; Thornhill-Miller et al., 2023). Student-centered learning places the role of teachers as facilitators who direct students in the process of knowledge exploration. Interaction between teachers and students is a key component in this approach, where teachers play a crucial role in motivating, providing direction, and supporting the development of student understanding through constructive dialogue.

The results of limited tests and field tests on the use of the "Energy Teaching Kit" learning media were very positive. This media has proven to be effective and practical to improve Computational Thinking in primary school students. From the results of a limited test conducted at SD Negeri 03 Kanigoro, this learning media obtained a practicality percentage of 86.6%. According to Akbar (2011), this percentage falls into the very practical category, meaning that the media can be used without requiring revision. This indicates that the "Energy Teaching Kit" has met the practical criteria and is ready to be applied on a wider scale.

The practicality of this learning media is also supported by the results of a field test involving 162 students from three schools in Madiun City. The percentage of practicality obtained from field tests is 87.05%, which is also included in the very practical category according to (Akbar, 2011)This figure shows that most students responded positively to the use of the "Energy Teaching Kit," particularly in terms of its ability to attract interest in learning, ease of use, and relevance of the material.

One of the key factors that contributed to the success of the "Energy Teaching Kit" in the trial was its interactive and group-based learning approach. This learning model offers students opportunities to actively engage in the learning process, particularly in understanding the concept of energy through hands-on experiments. This approach is in line with the 21st-century learning concept, which focuses on the development of critical, creative, collaborative, and communicative (Thornhill-Miller et al., 2023) Thinking skills. Additionally, group-based learning helps students develop social skills and teamwork skills, which are important aspects of Computational Thinking.

The use of this media also has a positive impact on increasing students' understanding of energy materials. Through experiments and group discussions, students can explore the concept of energy in a more in-depth and applied way. They not only learn about the theory, but also gain hands-on experience in applying energy concepts through the kit components provided (Fromm et al., 2021; Hattie, 2008). This makes learning more contextual and meaningful for students, ultimately increasing their interest in the material and understanding of the subject matter.

Although the test results are limited and the field tests show high practicality, some notes for improvement are still necessary. For example, some students may still need simpler guidance on using the kit or additional examples of energy applications that are more relevant to their daily lives. These notes are the basis for further improvement before this learning medium is applied more widely. Overall, based on the results of limited tests and field tests, the "Energy Teaching Kit" demonstrates great potential as a practical and effective learning medium for improving the Computational Thinking skills of elementary school students. This medium is not only relevant in the context of energy learning, but it also supports the development of 21st-century skills that students need to face the challenges of the future.

4. CONCLUSION

The findings suggest that the Energy Teaching Kit (ETK) is a valid and practical tool for promoting elementary students' computational thinking in the context of renewable energy. The media validity reached 86%, with student response validity at 88.89%. Practicality was categorized as very high, as shown by scores of 86.6% in the limited trial and 87.05% in the field implementation. These results imply that ETK can effectively support hands-on, concept-driven learning and aligns well with classroom needs, if teachers receive adequate guidance for its implementation. Future research may focus on comparing ETK with alternative instructional approaches, examining factors that influence its effectiveness, such as student characteristics and teacher roles, and expanding the kit to include additional energy topics. Refinement of assessment tools for measuring computational thinking is also recommended to strengthen evidence of the kit's impact.

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