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Development of an Energy-Efficient Flipbook Based on Project-Based Learning (PjBL) to Strengthen the Profile of Pancasila Students and Preserve Local Wisdom in Elementary Schools

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Abstract

Project-Based Learning (PjBL) is a recommended instructional model to strengthen the Pancasila Student Profile and preserve local wisdom. PjBL prioritizes student activities aimed at producing outputs through skills such as inquiry, analysis, creation, and presentation. These outputs are based on real-life experiences. This study employed the ADDIE methodology, encompassing analysis, design, development, implementation, and evaluation phases. Both quantitative and qualitative data were analyzed. The PjBL-based flipbook for elementary school was evaluated as highly valid, receiving validity scores of 85% from content experts, 90% from media experts, and 80% from teachers, all within the highly valid category. Individual tests, small group tests, and field tests showed high validity rates with percentages of 90%, 100%, and 90%, respectively. Based on these assessment findings, it can be concluded that the product demonstrates high validity, practicality, and effectiveness in reinforcing the Pancasila Student Profile and preserving local wisdom.

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INTRODUCTION

According to the Acting Head of the Ministry of Education and Culture's Book Center, a key feature of the *Kurikulum Merdeka* (Independent Curriculum) is project-based learning (PjBL), designed to support character development and align with the Pancasila student profile and literacy competencies. Under this curriculum, schools are granted autonomy to conduct learning projects that are closely tied to their local context (Anggrasari et al., 2021).

Project-based learning is an educational strategy in which students engage in solving real-world problems, gaining knowledge through hands-on experience. This approach suits elementary education because it corresponds to the cognitive development phase of children, who learn best through activities that involve exploration and social interaction. PjBL offers several benefits, such as increased motivation, better resource management skills, active student involvement, enhanced communication, teamwork, and the ability to organize a project (Angin, 2023).

Additionally, PjBL supports the Pancasila Student Profile by creating opportunities for flexible learning structures and interactive activities that connect students to their environment. These projects focus on the development of key competencies aligned with seven themes outlined by the Ministry, including sustainability, local wisdom, democracy, and entrepreneurship (Hastuti et al., 2022).

One significant aspect of the Pancasila Student Profile is integrating local wisdom into education. Local wisdom encompasses knowledge and practices from the local culture that help preserve traditions and foster personal growth in students (Arofah & Wulandari, 2023). Through learning activities like folk stories and cultural traditions, students become more connected to their heritage and are encouraged to develop essential life skills (Fajrin & Wulandari, 2021).

Flipbooks are an effective medium for enhancing the Pancasila Student Profile and preserving local wisdom. They are simple, accessible, and practical (Wulandari et al., 2023). Incorporating visual elements like images and animations into flipbooks can improve engagement by capturing children's attention and enhancing learning(Rahmawati, 2018). Despite their potential, there is a lack of flipbooks designed specifically for elementary schools that address current topics, such as energy conservation, which is crucial from an early age (Widyastuti & Susiana, 2019).

Hence, creating a flipbook on energy conservation based on PjBL principles is essential for strengthening the Pancasila Student Profile and promoting local wisdom in elementary schools.

METHOD

The development of the energy-saving flipbook utilized the ADDIE approach, which is known for its simplicity and systematic design. This model enables flexible adjustments during the development process, ensuring that each stage of creation is evaluated and refined. The ADDIE model is widely recognized for producing reliable and valid learning tools due to its clear structure and focus on continuous improvement.

Studies, such as those by (Wulandari et al., 2023), have demonstrated the effectiveness of the ADDIE model in creating impactful educational products. Research by (Widyastuti & Susiana, 2019) further supports this, showing that students who used materials developed through the ADDIE process performed significantly better compared to those taught with traditional methods. This confirms that following the ADDIE model leads to the creation of high-quality learning materials.

According to (Wulandari et al., 2023), the use of the ADDIE model in developing a Project-Based Learning (PjBL) flipbook for elementary school students has proven effective in improving learning outcomes. In line with this, (Jafnihirda et al., 2023) found that students who learned through the ADDIE model performed better than those taught using conventional methods. This suggests that following the ADDIE model's structured approach plays a key role in producing high-quality and impactful educational products.

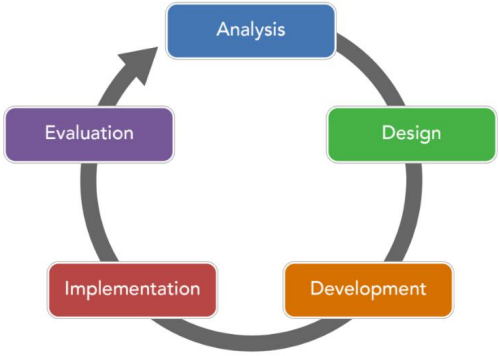

Figure 1. ADDIE Steps

The process of creating an energy-saving flipbook based on PjBL to strengthen the Pancasila Student Profile and preserve local wisdom in elementary schools through the ADDIE model involves several steps: (1) Analysis, which includes sub-processes like (a) analyzing the subject and theme, (b) identifying learning objectives, (c) examining student needs, (d) assessing the learning environment, and (e) reviewing constraints; (2) Design, which consists of (a) organizing the content of the flipbook and (b) preparing a storyboard; (3) Development, which covers (a) gathering materials, (b) creating the flipbook, and (c) obtaining validation from experts (content, media, and teachers); (4) Implementation, which involves (a) preparing the learning environment and (b) conducting a field trial with 40 fourth-grade students; and (5) Evaluation, which occurs throughout the previous stages and includes two types of assessments: (a) formative evaluations through questionnaires for experts and teachers, and (b) summative evaluations during field testing using pretest and posttest evaluations.

The flipbook is designed based on the stages of Project-Based Learning (PjBL) and incorporates the Pancasila Student Profile and elements of local wisdom.

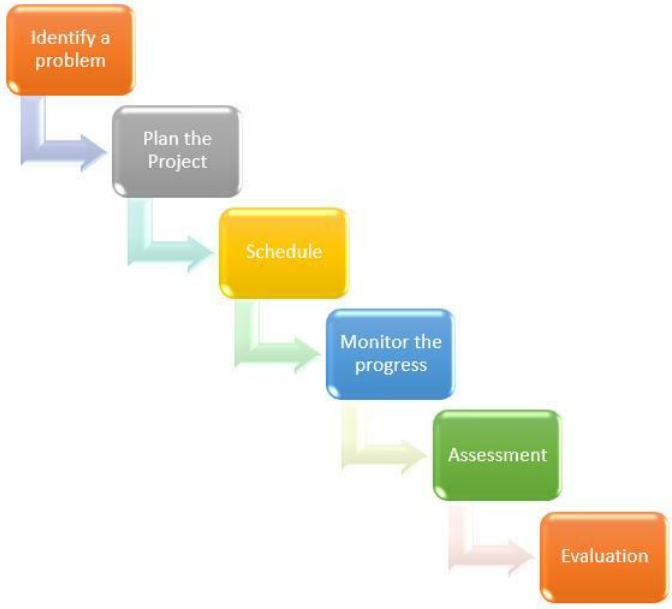

Figure 2. Stages of Project-Based Learning (PjBL)

RESULTS AND DISCUSSION

Results

The development of the Project-Based Learning (PjBL) flipbook, using the ADDIE model, involves several stages as outlined by Wulandari et al., (2023), Jafnihirda et al., (2023), dan (Widyastuti & Susiana, 2019). These stages include: (1) Analysis, which covers the processes of: a) subject and theme analysis, b) learning outcome analysis, c) student needs analysis, d) learning environment analysis, and e) constraint analysis; (2) Design, which consists of: a) mapping the content of the flipbook and b) creating a storyboard; (3) Development, which involves: a) gathering materials, b) creating the flipbook, and c) validating the content with experts (such as content and media experts, and teachers); (4) Implementation, which includes: a) organizing the learning environment and b) conducting a field test with 40 fourth-grade students; and (5) Evaluation, which takes place throughout the four stages and includes two evaluation types: (a)

formative evaluation, involving questionnaires for experts and teachers, and (b) summative evaluation, conducted during field testing using pretest and posttest assessments.

The flipbook product specification comprises five learning projects for fourth-grade students, designed with engaging elements such as vibrant colors, images, and fonts to capture students' attention. It includes 80 slides, covering various sections like a cover page, introduction, user guide, learning materials, projects, and evaluation questions. With a file size of 2.4 MB, the flipbook is available online through links or barcodes on platforms like Canva and Heyzine, requiring an internet connection to access.

Before its release, the flipbook was evaluated by experts who assessed its content and design. The expert review for content validity showed an 85% validity score, confirming the flipbook's alignment with relevant facts, concepts, principles, and PjBL procedures suitable for students. Revisions at this stage involved ensuring proper citation of images, tables, and video links, and enhancing the clarity of material connections to local examples. Educational media experts reviewed the flipbook's design, confirming a 90% validity score, indicating the flipbook met design feasibility standards. Suggestions at this stage included trimming content in some sections, adding sources for images, and adjusting the guidebook cover for better identification.

Teachers also reviewed the flipbook, and their feedback indicated an 80% validity score, confirming that the flipbook successfully captured students' attention and helped them engage with the material. However, suggestions included improving the learning objectives, adding grade-level identification, and adjusting the time allocation for tasks. After expert and teacher reviews, the flipbook was tested with individual students and small groups. The tests showed high validity with individual testing at 90%, small group testing at 100%, and field trials at 90%, confirming the material's clarity and suitability for students. No further revisions were needed.

A hypothesis test was conducted using a t-test to compare the pretest and posttest results. The null hypothesis (H0) stated that there is no significant difference in learning outcomes before and after using the Energy-Saving Flipbook, while the alternative hypothesis (H1) stated there is a significant difference. The paired sample t-test yielded a significance value of 0.000, which is below the 0.05 threshold, leading to the rejection of H0. This suggests a significant improvement in student learning outcomes after using the flipbook. The effectiveness of the flipbook was evaluated using a normalized gain score, which was found to be 0.70, indicating high effectiveness in improving learning outcomes.

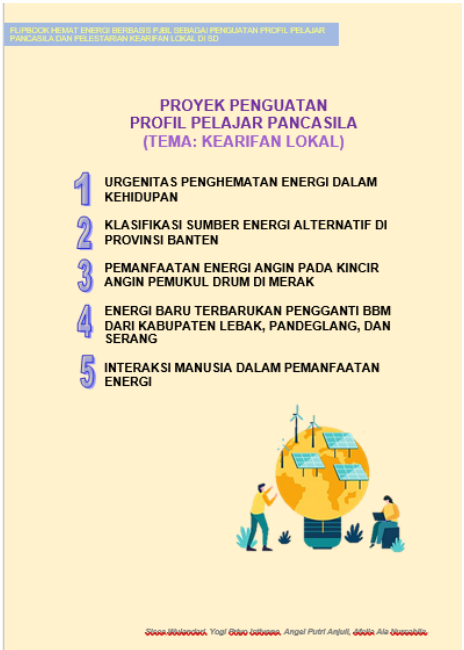

Figure 3. Strengthening the Pancasila Student Profile Project on the Theme of Local Wisdom

Flipbook contains the following 5 themes:

1. Material on The Urgency of Saving Energy in Life

Energy savings are important because they can help conserve natural resources, reduce greenhouse gas emissions, and save costs (Maulida et al., 2024). Here are some of the urgency of saving energy:

a. Environmental protection. Energy savings can help protect the environment from damage caused by excessive energy use.
b. Cost savings. Energy savings can help save on electricity, gasoline and other costs.
c. A sustainable future. Energy savings can help create a sustainable future for future generations.
d. Better air quality. Energy savings can help improve the quality of the air we breathe.

Some examples of activities that can be done to save energy are:
a. Turn off lights when not in use
b. Turn off electronic devices when not in use
c. Turn off the water tap when not in use
d. Use public transportation
e. Dry clothes in the sun
f. Make use of natural light and ventilation
g. Using energy saving mode on electronic equipment
h. Use electric tools that have low power

2. Classification of Alternative Energy Sources in Banten Province

a. The clean energy potential of water

The southern region of Banten is a hilly area that has quite a lot of small-scale hydropower potential. Based on the results of a survey by the Department of Mining and Energy and Mineral Resources (ESDM) of Banten Province, several hydroelectric potentials or what is coolly called microhydro have been identified in Lebak, Pandeglang and Serang Regencies, namely in:
1) Maraya Village, Sajira District, Lebak Regency
2) Hariang Village, Muncang District, Lebak Regency
3) Sobang Village, Muncang District, Lebak Regency
4) Cimanyangrai Village, Gunung Kencana District, Lebak Regency
5) Kramat Jaya Village, Gunung Kencana District, Lebak Regency
6) Sudamanik Village, Cimarga District, Lebak Regency
7) Bojongmanik Village, District Bojongmanik, Lebak Regency
8) Tegalwangi Village, Menes District, Pandegiang Regency
9) Cilentung Village, Cisata District, Pandegiang Regency
10) UjungTebu Village, Ciomas District, Serang Regency
11) Pondokhuru Village, Ciomas District, Serang Regency
12) Tenjoayu Village, Tanara District, Serang Regency
13) Sujung Village, District Tirtayasa, Serang Regency
14) Padarincang Village, Padarincang District, Serang Regency
15) Kaduberem Village, Padarincang District, Serang Regency

The power that can be generated from this Micro Hydro Power Plant (PLTMH) varies from the smallest 39 kilowatts in Sobang, Muncang to the largest 3 megawatts in Ujung Tebu, Ciomas.

b. Solar Energy Power Plant

This energy is quite widely available and can be utilized in Banten Province, which has a mostly hot climate. Utilization and maintenance are relatively easier than other alternative energy sources. This energy source can also be applied to every resident's house.

c. Biomass Energy

Biomass energy in the Banten region is quite abundant, considering the vast area of agricultural land and plantations. Biomass energy includes wood, agricultural, plantation or forest waste, organic components from industry and households, human and animal waste. Biomass can be converted into energy in the form of liquid fuel, gas, heat and electricity. Biomass conversion technology into liquid and gas fuel includes pyrolysis technology (biooil), esterification (biodiesel), fermentation technology (bioethanol), anaerobic digester (biogas) and gasification. Meanwhile, technologies for converting biomass into heat and electrical energy include combustion and gasification technologies.

The potential for biomass (husk) in Banten is found in:

1) Tegal Wangi Village and Alas Wangi Village, Menes District, Pandeglang Regency
2) Cilentung Village and Palembang Village, Cisata District, Pandeglang Regency
3) Palurahan Village, Kaduhejo District, Pandeglang Regency

d. Geothermal Energy or Geothermal

In 2020, electricity needs in Banten Province are estimated at 6,000 megawatts or growing at an average of around 6 percent per year. To meet electricity needs in Banten Province until 2020, an average power increase of 104 megawatts per year is currently required. The additional peak load capacity will continue to increase until 2020, reaching 185 megawatts per year. In response to this phenomenon, the government has issued a policy in the form of accelerating the development of power plants through Minister of Energy and Mineral Resources Regulation Number 02 of 2010, one of which is a project to build a power plant that uses renewable energy (Geothermal) PLTP Rawa Dano in Banten Province with a capacity of 1 x 110 megawatts. Talking about geothermal is actually nothing new in the world of Indonesian electricity, however. Indonesia's geothermal potential is 28 gigawatts. The world geothermal potential capacity that has been installed has only reached 1,189 megawatts, while the roadmap until 2025 is installed at 9,500 megawatts.

In Banten Province, the available geothermal potential is 800 megawatts spread across seven locations and which has been identified by the Ministry of Energy and Mineral Resources, especially the Geological Agency, as having three potential points, namely:

1) Banten Lake Caldera (Mt. Karang, Mt. Pulosari, and Rawa Danau Complex) with a potential of 115 megawatts
2) Mount Endut in Lebak Regency with a speculative potential of 225 megawatts
3) Pramukalan in Lebak Regency with a speculative potential of 225 megawatts

3. Utilization of Wind Energy in Drum Beating Windmills in Merak

Merak is located in the Pulo Merak sub-district, Cilegon City, Banten Province, directly bordering the Sunda Strait. From a topographical perspective, Merak has favorable conditions for wind energy generation, as it is surrounded by mountains, hills, and coastal areas, which contribute to sufficient wind potential.

To assess the feasibility of wind energy utilization in Merak, Banten, a study is required to analyze its implementation and identify the most suitable wind turbines for development in the region. By utilizing wind speed data collected by relevant agencies such as BMKG, LAPAN, and BPPT, along with appropriate wind energy potential calculation formulas, it is possible to determine the viability of wind energy in the Merak, Banten area.

4. New Renewable Energy Substitute for Oil Fuel from Lebak, Pandeglang and Serang Regencies

Biodiesel and solar energy are renewable energy sources that can serve as alternatives to fossil fuels in Banten (Kharisma et al., 2024). In Lebak, Banten, a castor oil refining plant will be

established with a capacity of 250 liters per hour, while in Serang and Pandeglang, a castor bean pressing factory will be built with a capacity of 100 kg per hour. Biodiesel, as a non-fossil fuel, offers a sustainable energy solution.

Solar energy, which is derived from sunlight, also presents a promising renewable energy source. Indonesia has considerable solar energy potential, making it a viable option for energy diversification. Additionally, other renewable energy sources, including water energy, wind energy, geothermal energy, bioenergy, and biomass, contribute to sustainable energy development in the region.

5. Human Interaction in Energy Utilization

Human interaction in energy utilization is the use of energy sources to meet human needs, while maintaining environmental balance (Malihah, 2010). Examples of human interaction in energy utilization:

a. Build solar power plants to reduce greenhouse gas emissions
b. Build a hydroelectric power plant by utilizing river flow
c. Building a wind power plant using an aerogenerator
d. Using renewable energy such as sun, wind and water to reduce negative impacts on the environment
e. Developing biofuels such as bioethanol to reduce dependence on petroleum

Benefits of energy utilization: Meeting human energy needs, improving public health, maintaining the balance of river ecosystems, reducing negative impacts on the environment.

Discussion

In developing the flipbook, five sub-themes were obtained which were in accordance with local wisdom in Banten province. The sub- theme were (1) Material on The Urgency of Saving Energy in Life; (2) Classification of Alternative Energy Sources in Banten Province; (3) Utilization of Wind Energy in Drum Beating Windmills in Merak; (4) New Renewable Energy Substitute for Oil Fuel from Lebak, Pandeglang and Serang Regencies; dan (5) Human Interaction in Energy Utilization.

First sub-theme was Material on The Urgency of Saving Energy in Life. This sub-theme very important because saving energy is not just an individual effort but a collective responsibility. The urgency of energy conservation is driven by the need to protect the environment, conserve resources, reduce costs, improve public health, and ensure long-term sustainability (Maulida et al., 2024). In the face of climate change and finite resources, adopting energy-efficient habits and technologies is crucial for both present and future generations.

Second sub-theme was Classification of Alternative Energy Sources in Banten Province. This sub-theme very important because it equips them with the knowledge and skills necessary to understand the changing energy landscape, make informed decisions, and contribute to building a sustainable future. It also helps students see the interdisciplinary connections between energy, technology, policy, economics, and the environment, making it a fundamental area of study for addressing the challenges of the 21st century.

Third sub-theme was Utilization of Wind Energy in Drum Beating Windmills in Merak. This sub-theme very important because valuable for several reasons, combining education on renewable energy, sustainability, hands-on learning, and fostering creativity. The utilization of wind energy in drum-beating windmills is an engaging and impactful way to introduce them to the concepts of renewable energy, sustainability, and scientific inquiry. By combining hands-on activities with critical thinking, teamwork, and real-world applications, students develop a deeper understanding of energy systems that will benefit them in their studies and future careers. Furthermore, instilling these principles early helps nurture environmentally conscious individuals who are more likely to be active participants in building a sustainable future.

Fourth sub-theme was New Renewable Energy Substitute for Oil Fuel from Lebak, Pandeglang and Serang Regencies. This sub-theme very important because helps the students to equip them with the

knowledge to address both local and global energy challenges. It promotes sustainability, environmental awareness, and economic growth while fostering critical thinking and innovation. Moreover, it prepares students to contribute to the growing movement toward renewable energy adoption, empowering them to take an active role in creating a more sustainable, energy-secure future for their communities and the world (Kharisma et al., 2024).

Fifth sub-theme was Human Interaction in Energy Utilization. This sub-theme very important because essential because it helps them understand their role in energy consumption and its broader impact on the environment, society, and economy. By learning this at a young age, students can develop responsible habits, critical thinking skills, and a commitment to sustainability that will benefit both their immediate surroundings and the world as a whole (Malihah, 2010). Early education in this area prepares them to be informed, conscientious citizens who are equipped to solve future energy challenges and contribute to a more sustainable future.

This development study addresses several key challenges in elementary education, such as low literacy rates, difficulties in implementing Project-Based Learning (PjBL), limited instructional time, and underutilized innovative teaching methods. Technology offers a promising solution, and one approach is the creation of flipbooks. These digital tools have proven to be effective in enhancing student interest in reading (Sugara et al., 2023). Furthermore, flipbooks are an accessible medium in today's digital age, allowing for efficient use of limited classroom time (Budiarti et al., 2022). Research supports the idea that digital media like flipbooks can foster greater literacy through interactive and engaging content, as well as increase student participation in the learning process (Wulandari et al., 2023).

A unique feature of the developed flipbook is its inclusion of project-based tasks. By providing challenging activities, it aims to motivate students to engage with topics they might otherwise find dull or difficult (Lakapu et al., 2023) This strategy promotes student independence and creativity (Jafnihirda et al., 2023). The flipbook aligns with the principles of Project-Based Learning (PjBL), which offers inquiry-driven tasks that deepen students' understanding of subjects. These tasks also promote collaboration, allowing students to work together to solve real-world problems, such as energy conservation issues relevant to their community. By integrating collaborative learning, students enhance their social skills and critical thinking abilities (Intansari et al., 2023). Thus, the flipbook connects theoretical knowledge to practical applications, enriching the students' educational experience.

CONCLUSION

The Energy-Saving Flipbook, designed using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), was created to support the Pancasila Student Profile and preserve local wisdom. It was assessed by content experts, media experts, and teachers, and received high validity ratings—85%, 90%, and 80%, respectively. The flipbook also demonstrated excellent validity during individual and group testing, with results of 90%, 100%, and 90%. Observations during testing showed high enthusiasm from students, with many reporting greater engagement and improved understanding of PjBL concepts and local wisdom values. These findings suggest that the flipbook is highly valid, practical, and effective in supporting educational goals.

Based on the results of this study, several recommendations are made:

1. Since the flipbook was developed based on the learning outcomes of students in Tangerang Regency, it is advisable to adapt the content for schools with different student demographics. For instance, in regions with diverse cultures, the flipbook content can be tailored with local examples to increase its relevance and clarity. Schools with limited technological access may benefit from an offline version or simplified materials to ensure all students can access the content effectively.

2. This study developed the PjBL flipbook using platforms like Canva and Heyzine. Future iterations of the product could explore other media types, such as e-learning platforms, instructional videos, educational games, or additional interactive tools to provide schools with a wider variety of learning resources.
3. This study's effectiveness was measured using a t-test, but further research is necessary to assess the media's suitability and its impact on student learning outcomes. A quasi-experimental design involving comparison groups could offer more in-depth insights into the flipbook's effectiveness.

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