Jurnal Pijar MIPA
https://jurnalfkip.unram.ac.id/index.php/JPM

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

Implementation of Project-Based Simple Science Media in Science Learning: Strengthening Mutual Cooperation, Critical, and Creative Reasoning of Elementary School Students

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Received: April 24, 2026. Accepted: May 14, 2026. Published: July 7, 2027

Abstract: Social studies learning in the Independent Curriculum requires a contextual, participatory, and oriented learning experience that strengthens the Pancasila Student Profile. However, learning practices in elementary schools still tend to be dominated by conventional approaches, so that students' active involvement in understanding science concepts and developing character is not optimal. This study aims to describe the implementation of project-based science media through Volta Drive Connect, analyze student responses, and strengthen the three-dimensional Pancasila Student Profile in science learning. This study used a descriptive qualitative approach with 18 grade IV students of Kakuka National Elementary School. Data was collected through observation, interviews, and documentation. Data analysis uses the interactive model of Miles, Huberman, and Saldana through the stages of data reduction, data presentation, and conclusion drawing and verification. The results showed that implementing Volta Drive Connect encouraged active student involvement throughout the learning process. Indicators of mutual cooperation are evident in the sharing of roles during collaborative assembly, discussion, retrying, and problem-solving activities. The indicators of mutual cooperation were evident in group cooperation (88.9%), role sharing (77.8%), and mutual help (83.3%). Critical reasoning indicators were seen through the ability to ask questions 66.7%, analyze problems 72.2%, and draw conclusions 61.1%. Meanwhile, creative indicators emerged in the ability to generate ideas (72.2%), try alternative solutions (83.3%), and modify the results of work (55.6%). The novelty of this research lies in the use of simple science media that connect the concept of energy to daily life and also show the strengthening of students' character that develops during the learning process. Thus, project-based simple science media can be an alternative to IPAS learning that is contextual and meaningful, and that supports the strengthening of the Pancasila Student Profile.

Keywords: Creative; Critical Reasoning; Mutual Cooperation; Project-Based Learning; Science Media.

Introduction

The Independent Curriculum Policy brings a change in teacher-centered learning towards student-centered, contextual, and meaningful learning [1]. This transformation requires teachers to design learning experiences that are not only oriented to the delivery of material, but also provide space for students to explore, observe, discuss, and build understanding through hands-on experience [2]. However, classroom learning practices are still often dominated by conventional approaches that treat students as passive recipients of information. This condition has an impact on the low involvement of students in the learning process, especially in IPAS learning, which should emphasize the relationship between the concepts of science, the environment, and daily life [3].

Social studies subjects have a strategic position in the Independent Curriculum because they integrate natural and social knowledge through phenomena that are close to students' experiences. Social studies learning aims not only to build conceptual understanding but also to develop thinking skills, caring attitudes, and problem-solving skills through real-world activities [4][5][6].

In the material on energy and its use in daily life, students need concrete learning experiences so that the concept of energy change is not only understood verbally but also observed through practice [7], [8]. Therefore, learning media acts as a bridge between abstract concepts and students' concrete experiences. Especially direct learning activities. Simple science media is relevant because it allows students to learn through hands-on activities that directly involve them in designing, assembling, trying, and reflecting on learning outcomes.

In addition to emphasizing contextual learning, the Independent Curriculum also directs the educational process to strengthen the Pancasila Student Profile [9], [10]. This profile consists of six main dimensions, namely (1) faith, fear of God Almighty, and noble character; (2) global diversity; (3) working together; (4) independent; (5) critical reasoning; and (6) creative [11], [12]. In the context of project-based IPAS learning, the three dimensions that are particularly relevant to develop are mutual cooperation, critical reasoning, and creativity. The mutual cooperation dimension can emerge when students work in groups, divide roles, and help one another complete projects. The critical reasoning dimension develops as students identify problems, analyze errors, ask questions, and seek solutions based on the

How to Cite:
F. N. Saniyyah, N. Nasokah, and A. El-Qorny, "Implementation of Project-Based Simple Science Media in Science Learning: Strengthening Mutual Cooperation, Critical, and Creative Reasoning of Elementary School Students", *J. Pijar.MIPA*, vol. 21, no. 4, pp. 656–663, Jul. 2026. https://doi.org/10.29303/jpm.v21i4.11965

evidence they find during the assembly process. Meanwhile, the creative dimension is evident when students generate ideas, explore alternative solutions, and modify their work in response to the obstacles they face. Thus, simple, project-based science media serve not only as a learning aid but also as a pedagogical stimulus that connects the science learning experience to the formation of students' character.

The Project-Based Learning model can strengthen student involvement in IPAS learning by positioning students as active subjects in the learning process [13]. Through projects, students learn by designing, trying, evaluating, and improving the products or work they create [14]. Theoretically, this approach aligns with constructivism, which emphasizes that knowledge is built through direct experience, social interaction, and reflection on learning activities [15]. Thus, the use of project-based media has a strong conceptual relationship with character building. Media assembly activities require students to collaborate, face real problems, make decisions, and develop creative solutions during learning.

A number of previous studies have shown that Project-Based Learning contributes positively to learning outcomes, motivation, creativity, science process skills, and student engagement in science learning. Pangestu et al.'s research shows that Project-Based Learning affects students' learning outcomes, creativity, and motivation in science learning in elementary schools [16]. However, the study emphasizes the final learning outcomes more than the dynamics of the process by which students build the learning experience. Other research has also integrated project-based learning in science learning, but has tended to use a more structured or module-based approach, so it has not highlighted much student involvement in exploratory activities and in-person media assembly [17]. Thus, there remains a research gap regarding the process aspect, particularly in how simple project-based science media can facilitate hands-on learning while fostering the emergence of the dimensions of mutual cooperation, critical reasoning, and creativity.

Based on these gaps, this study introduces a novel approach by examining the implementation of project-based simple science media, in the form of Volta Drive Connect, in grade IV science learning at Kakuka National Elementary School. This media is designed as a simple science kit that connects energy concepts to students' real experiences through activities that involve assembling and testing their work. Conceptually, this study positions project-based science media as a means of facilitating three main processes: social interaction, problem exploration, and solution creation. Social interaction is the basis for the emergence of mutual cooperation; problem exploration is the basis for the development of critical reasoning; and the creation of solutions is the basis for the growth of creativity. Therefore, this study aims to describe the implementation of project-based simple science media and analyze student responses and strengthen the dimensions of mutual cooperation, critical reasoning, and creativity in the Pancasila Student Profile in social studies learning at Kakuka National Elementary School.

Research Methods

This study uses a descriptive qualitative approach to examine the social studies learning process through the implementation of project-based science media and to analyse student responses during learning. This approach was chosen because the research did not aim to test the effectiveness experimentally but to understand the science learning process at Kakuka National Elementary School [18], [19]. The research was conducted in Grade IV at Kakuka National Elementary School, with 18 students as the main participants. The selection of participants was carried out using purposive sampling, given that grade IV students are studying energy materials and energy changes and are directly involved in project-based science learning using Volta Drive Connect media [20]. In addition to students, grade IV teachers serve as supporting informants to gather information about the learning process, student responses, and class dynamics during the activity.

Data collection is carried out through observation, interviews, and documentation [21]. Data collection was carried out through observation, interviews, and documentation. The data collection procedure is carried out in three stages. The first stage is the preparation stage, namely preparing a project-based science learning plan, preparing Volta Drive Connect media, compiling observation sheets, interview guidelines, and documentation formats, and validating instruments through the supervisor's input. The second stage is the implementation stage, which involves implementing project-based science learning through energy concept introductions, group divisions, media assembly, assembly of results, group discussions, and learning reflections. At this stage, observations are conducted to document student activities, group interactions, problem-solving processes, and the emergence of Pancasila Student Profile indicators. The third stage is the final stage, which is conducting interviews with teachers and several students, collecting learning documentation, and verifying the data from observations, interviews, and documentation [22].

The research instruments include observation sheets and interview guidelines. The observation sheet is prepared based on the indicators of the dimensions of the Pancasila Student Profile, especially mutual cooperation, critical reasoning, and creativity. Indicators of mutual cooperation include group cooperation, role division, and mutual help. Critical reasoning indicators include the ability to ask questions, analyze problems, and draw conclusions. Creative indicators include the ability to generate ideas, explore alternative solutions, and modify work results. Each indicator is observed based on the frequency of its occurrence during the learning process as a basis for qualitative data analysis

The interview guidelines are prepared as open-ended questions for students and teachers. Interviews with students were used to explore learning experiences, understanding of energy concepts, difficulties during media assembly, and their impressions of project-based learning. Interviews with teachers were used to gather information on student involvement, changes in the classroom atmosphere, group cooperation, and the relevance of Volta Drive Connect media to IPAS learning. Documentation is used to complement observation and interview data, in the form of photos of learning activities, student work results, field notes, and learning tools used [22].

Data analysis uses an interactive analysis model from Miles, Huberman, and Saldana that includes data reduction, data presentation, and inference and conclusion [23][24]. At the data reduction stage, the researcher sorts data relevant to media implementation, student responses, and the emergence of the dimensions of mutual cooperation, critical reasoning, and creativity. At the data presentation stage, the findings were compiled in the form of descriptive narratives, interview excerpts, and indicators of the emergence of student behavior. At the conclusion-drawing stage, the researcher interpreted the pattern of findings based on the suitability of the observation, interview, and documentation data [25].

The validity of the data in this study is maintained through triangulation of techniques and sources. Observation data is confirmed through interviews and documentation. Source triangulation is done by comparing information from students and teachers. The instrument's validity is ensured through expert judgment by seeking the supervisor's input on the suitability of the observation indicators and interview questions for the research objectives. Reliability in qualitative research is maintained through consistency in observation, systematic data recording, and re-examination of the fit between field findings and the research focus [26], [27].

Results and Discussion

Implementation of Project-Based Science Media in Science Learning

The science medium used in this study is Volta Drive Connect, a simple science learning kit designed to help students understand the concepts of energy and energy change through hands-on assembly activities. This medium consists of several simple components, such as solar panels, dynamos, connecting cables, wheels, simple car frames, and other supporting materials. The working principle of this medium is the conversion of light energy into electrical energy via solar panels, then into mechanical energy through a dynamo. Thus, the concept of energy, originally abstract, can be made concrete for students through experience [28].

The implementation of IPAS learning through project-based science media is carried out through five main stages, namely: (1) introduction to the concept of energy and energy change, (2) group division, (3) media planning and assembly, (4) trial of assembled results, and (5) reflection and discussion of learning outcomes [29]. These stages show that Volta Drive Connect media functions not only as a visual aid but also as an experiential learning tool. Students not only listen to the teacher's explanations, but are directly involved in the process of designing, trying, evaluating, and improving the group's work.

During the learning process, some groups encountered technical obstacles, such as wiring errors, improper dynamo positioning, or solar panels that did not obtain optimal light. These barriers are an important part of the learning process because they encourage students to discuss, retry, and find solutions collaboratively. In this context, technical errors are not seen as failures, but as learning spaces that allow students to develop critical and creative thinking skills. These findings reinforce the constructivist view that students' knowledge is formed through direct experience, social interaction, and reflection on the processes they experience [15].

Table 1. Project-Based Science Learning Observation Results

Observed Aspects	Description of Observation Results
Student Engagement	Students are actively involved in learning activities, especially when assembling science media in groups.
Group Interaction	Students try to identify assembly errors and discuss solutions
Response to constraints	Students discuss the obstacles that arise during assembly and retry the assembly steps of the science media
The Role of the Teacher	Teachers act as facilitators by providing direction and reinforcement as necessary
Learning Atmosphere	Learning takes place actively, is fun and conducive to two-way interaction

Table 1 presents the results of observations on the project-based science learning process at Kakuka National Elementary School. The results of the observations show that learning occurs more actively, more participatively, and more constructively. Students engage in assembly activities, discuss with group members, ask questions when they encounter difficulties, and try to improve the assembly results. The role of teachers is more as a facilitator who provides direction as necessary, not as the only source of information. This pattern shows that project-based learning through simple science media is able to shift learning activities from a one-way instructional pattern to more exploratory and student-centered learning.

Figure 1. Introduction to the concept of energy and its changes.

Figure 2. Science teaching kit before assembly

Compared with previous studies, these findings have different pressure points. Research by Pangestu et al. [16] shows that Project-Based Learning affects student learning outcomes, creativity, and motivation. However, the study emphasizes the final learning outcomes. Meanwhile, this study shows that the important value of project-based learning lies not only in the final product but also in the learning process students undergo, especially when they encounter problems, discuss, and correct mistakes during media assembly. Thus, the main contribution of this research is to show that simple project-based science media can serve as a space for developing learning experiences and character strengthening.

Student Responses during Hands-on Learning Activities

Students' responses during learning show a positive tendency. Students seemed enthusiastic when they got the opportunity to assemble the media directly. They not only follow instructions, but also show initiative in trying, asking questions, and discussing when the assembly has not worked as it should. This activity shows that the hands-on learning approach can increase student engagement, both cognitively, socially, and emotionally. The results of the interviews reinforce the observational findings. One of the students said it was easier for him to understand the concept of energy because he could see firsthand how the media works, rather than just listening to the teacher's explanation. This statement shows that concrete experiences help students connect energy concepts with real phenomena. The teacher also said that students look more active, happy, and are not just waiting for explanations. They try on their own, discuss, and find solutions when experiencing difficulties.

Analytically, the response showed that the Volta Drive Connect media serves as a learning scaffold, a means that helps students build understanding through real activities. These media not only visualize the concept of energy change, but also create learning situations that demand students to interact, think, and make decisions. In other words, student involvement arises not solely from the use of media but from media designed as projects that demand exploratory activities.

These findings are in line with studies that state that project-based learning can increase student engagement in science learning [30], [31]. However, the study expands on the findings by showing that student involvement is not only seen in the form of general participation, but also in more specific behaviors, such as asking questions, trying alternative solutions, dividing roles, and helping fellow groups. Therefore, the students' responses in this study are understood not only as positive reactions to the media but also as indicators of the emergence of an active and collaborative learning process.

Based on Table 2, the most dominant indicator was mutual cooperation, with a high frequency of occurrence, especially in the aspect of cooperation within the group. Meanwhile, in the critical reasoning dimension, indicators such as asking questions and analyzing began to emerge, although they were not evenly distributed among all students. In the creative dimension, the indicator for trying alternative solutions shows a fairly high tendency relative to the other indicators. However, most indicators have shown a relatively high level of emergence during the learning process. Student activities are not only limited to following instructions, but also involve active thought processes and social interactions. Students were seen engaging in discussions, asking questions, and trying various approaches when facing obstacles during the media assembly.

Table 2. Indicators of the emergence of the Pancasila Student Profile Dimension

Dimensions	Indicator	Students Number	Percentage (%)
Mutual cooperation	Group Cooperation	16	88.9 %
	Role division	14	77.8 %
	Helping each other	15	83.3 %
Critical reasoning	Ask Questions	12	66.7 %
	Analyzing Problems	13	72.2 %
	Drawing conclusions	11	61.1 %
Creative	Generating Ideas	13	72.2 %
	Try alternative solutions	15	83.3 %
	Modifying results	10	55.6%

Implications for Pancasila Student Profiles

Mutual cooperation

The dimension of mutual cooperation is the most dominant dimension that appears during learning. Based on the observation results, indicators of cooperation in groups were observed in 16 students (88.9%), role sharing in 14 students (77.8%), and mutual help in 15 students (83.3%). This data shows that project-based learning provides a powerful space for students to develop social interaction and a sense of shared responsibility. The emergence of mutual cooperation can be seen when students naturally divide tasks; for example, some students assemble frames, connect cables, hold components, or test the results of assemblies. Although the division of tasks is not always formally defined, students take the initiative to assume roles according to their abilities. When one group member has a hard time, the other student is more likely to help without waiting for the teacher's instructions. This shows that mutual cooperation is not only evident in physical joint work but also in care, collective responsibility, and positive interdependence in completing projects [32]. [33], [34].

The dynamics of group work that emerged during learning also showed that students were able to manage differences of opinion through joint discussions before making decisions. This condition demonstrates that project-based learning not only develops technical skills but also essential social skills in collaborative learning [35], [36]. The dimension of mutual cooperation is manifested through the activity of assembling the Volta Drive Connect science media. In this project, students enthusiastically share their understanding and complement each other's knowledge to complete the series together.

Compared to Umbunan's research [37], which shows that Project-Based Learning contributes to increased student cooperation through the achievement of group tasks, this study shows a more procedural aspect. Mutual cooperation in this study is assessed not only by the group's success in producing products, but also by how students build cooperation when facing technical obstacles. Thus, the mutual cooperation dimension develops through role negotiation, mutual assistance, and joint problem-solving during the project. These findings make it clear that simple, project-based science media can strengthen social character. When projects require students to work in groups, they learn that success is determined not only by individual ability but also by the ability to collaborate. Therefore, project-based IPAS learning can be a concrete means to internalize the value of mutual cooperation in the Pancasila Student Profile.

Figure 3. Students are working together to assemble media

Figure 4. Students are discussing with teachers

Critical Reasoning

One of the dimensions of the Pancasila Student Profile is critical reasoning. Critical reasoning is the ability of learners to solve problems by identifying appropriate solutions [38]. Critical reasoning skills enable the ability to analyze and evaluate evidence, identify questions, draw logical conclusions, and understand the implications of arguments [39], [40]. The critical reasoning dimension arises when students encounter problems during the media assembly and testing process. Based on the results of observation, the indicator of asking questions appeared in 12 students or 66.7%, analyzing problems in 13 students or 72.2%, and drawing conclusions in 11 students or 61.1%. This percentage indicates that critical reasoning skills are beginning to develop, though they are not evenly distributed among all students.

Critical reasoning skills can be seen in students' questions, such as why cars don't move, whether solar panels are less exposed to light, or whether cables are installed incorrectly. The question shows that students begin to relate cause and effect to real-world situations they observe. Students not only receive information, but also try to interpret problems and find reasons why the media is not working as expected. Critical reasoning skills can be seen in students' questions, such as why cars don't move, whether solar panels are less exposed to light, or whether cables are installed incorrectly. The question shows that students begin to relate cause and effect to real-world situations they observe. Students not only receive information, but also try to interpret problems and find reasons why the media is not working as expected [41].

Theoretically, this condition suggests that hands-on learning activities can facilitate critical thinking by directly confronting students with concrete problems. Circuit errors, improper component positions, or unsuccessful test results encourage students to observe, analyze, and make evidence-based decisions [42]. Thus, critical reasoning in this study does not arise solely from practice questions but from students' interaction with real problems in the media assembly process.

This finding is consistent with the research [43], which states that Project-Based Learning can improve students' critical thinking skills. However, this study places greater emphasis on the idea that critical reasoning develops through problem identification and re-experimentation during project activities. This means that critical reasoning skills can be seen not only in the final learning outcomes but also in the students' processes as they make guesses, test possible causes of problems, and improve their work. This is an important contribution because social studies learning ideally not only teaches science concepts, but also accustoms students to thinking scientifically and reflectively.

Creative

Creative thinking is a way of thinking that modifies or develops a problem, is open to new ideas, and can see a situation from a different perspective [44] [45][46]. The creative dimension is evident in students' ability to generate ideas, explore alternative solutions, and modify their work. Based on the observation results, the indicator showed that ideas appeared in 13 students (72.2%), tried alternative solutions in 15 students (83.3%), and modified the work results in 10 students (55.6%). This data shows that students' creativity is most evident in their willingness to try alternative solutions, while their ability to modify results still needs strengthening.

The students' creativity is evident when they try to adjust the position of the solar panels, fix the wiring, rearrange the frame, or use simple materials to make the medium more stable. When the first attempt was unsuccessful, some students did not stop immediately, but tried other methods based on the group discussion. This process shows that creativity in learning does not always take the form of an entirely new product, but can be seen in flexible thinking and the ability to find alternative solutions.

Compared with Nugraheni's research [47], which places creativity in the final result as teaching aids, this study shows that creativity can also be observed in the student's exploration process. Creativity lies not only in the final quality of the assembled media, but in how students generate ideas, test alternatives, and improve strategies when faced with obstacles. Thus, project-based learning through Volta Drive Connect provides students with a space to experience the creative process firsthand.

This finding is important because creativity in the Pancasila Student Profile is not only related to the ability to produce works but also to the flexibility of thinking in finding solutions. Project activities that involve trial and error help students learn that problems can be solved in a variety of ways. Therefore, simple, project-based science media can help students develop creativity more naturally through an open, exploratory learning experience.

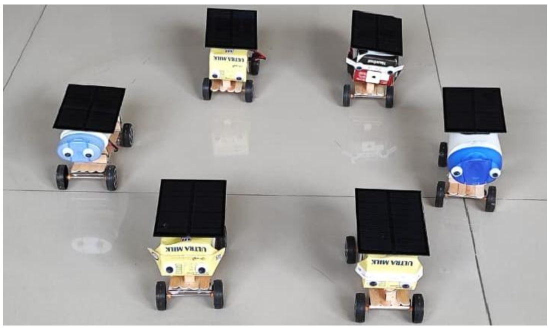

Figure 5. Student work

Overall, the results of the study show that implementing Volta Drive Connect media in IPAS learning not only helps students understand the concepts of energy and energy change but also strengthens the dimensions of mutual cooperation, critical reasoning, and creativity. The three dimensions arise through different mechanisms. Gotong royong develops through group interaction and division of roles. Critical reasoning develops through identifying problems and seeking the causes of errors. Creativity develops through the courage to try alternative solutions and modify the results of work.

The main finding of this study is that the strengthening of the Pancasila Student Profile occurs not only after learning is completed but also during the learning process. Thus, project-based learning through simple science media not only produces learning products but also shapes a social, reflective, and creative learning experience. This is a novelty of the research because most previous studies have emphasized the influence of Project-Based Learning on learning outcomes, motivation, or creativity as the final outcome, while this study shows how the character dimension emerges naturally during the hands-on learning process.

Based on these findings, project-based simple science media can be positioned as an alternative to contextual and participatory science learning. This medium not only bridges abstract concepts with concrete experiences but also provides space for students to collaborate, think critically, and develop creative solutions. Therefore, the use of Volta Drive Connect media is relevant to the direction of the Independent Curriculum, which emphasizes meaningful learning and strengthening the Pancasila Student Profile.

Conclusion

The results of the study show that the implementation of project-based simple science media through Volta Drive Connect in IPAS learning about energy and energy change materials is able to create active, contextual, and student-centered learning. Assembly, testing, discussion, and improvement of media activities provide hands-on learning experiences that help students understand energy concepts more concretely. Student responses during learning show positive tendencies, characterized by enthusiasm, active participation, and group interaction, as well as involvement in the problem-solving process. The study's findings also show that project-based science media strengthen the three-dimensional Pancasila Student Profile, namely mutual cooperation, critical reasoning, and creativity. Practically, the results of this study provide implications for elementary school teachers to utilize project-based simple science media as an alternative to contextual and participatory science learning. Teachers can use similar media to connect abstract concepts to students' real experiences, especially on energy materials, energy changes, styles, environments, or other science topics that require hands-on practice. In addition, teachers need to design project learning with clear stages, starting from concept introduction, group work, assembly or experimentation, trials, discussions, and reflection so that the dimensions of mutual cooperation, critical reasoning, and creativity can develop in a directional manner. This research has several limitations. First, the number of participants was limited to 18 students in a single class, so the findings could not be generalized widely in other elementary school contexts. Second, this study uses a descriptive qualitative approach, so it has not measured the quantitative increase in the dimensions of the Pancasila Student Profile through pre-test and post-test instruments. Third, the implementation of media is carried out on energy materials and energy changes, so its application to other IPAS materials still needs further study.

Author's Contribution

F.N. Saniyyah: contributed to research design, data collection and analysis, and manuscript writing. Nasokah is responsible for data validation, and strengthening theoretical studies. A.E. Qorny: contributed to the review and refinement of the final manuscript.

Acknowledgements

The author would like to express his gratitude to SD Nasional Kakuka for providing permission and support during the research. Appreciation was also conveyed to the principal, class teachers, and all students who had participated in this research activity. The author also expressed his gratitude to Belmawa and the University of Al-Qur'an Sciences (UNSIQ) for their financial support, which enabled this research to be carried out properly.

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