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JURNAL EDUSCIENCE (JES)
p-ISSN : 2303 - 355X | e-ISSN : 2685 - 2217
PUBLISHED BY : LPPM of UNIVERSITAS LABUHANBATU

The Development of Student Worksheets Integrated Simple Water Wheel Media to Improve Environmental Care Attitudes in Middle Schools

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ARTICLE INFO

Keywords:
Environmental Care Attitudes
Student Worksheet
Water wheel

ABSTRACT

This research focuses on developing and testing student worksheets (LKPD) using simple water wheel media to cultivate environmental care attitudes in middle school students. The study employs the Research and Development (R&D) method with the 4-D model (define, design, develop, disseminate), which is widely used for creating and validating educational tools. The research was conducted at SMP IT Ibnu Abbas, involving 34 students from Class VIII B as the main participants. Additional input was provided by the Vice Principal for Curriculum Affairs and the Arts and Culture teacher, who acted as observers. Students participated in pre-tests, learning activities with simple water wheel media, post-tests, and filled out an environmental care attitude questionnaire consisting of ten questions. The tests focused on understanding concepts of pressure and Bernoulli's Law, while the questionnaire measured changes in environmental attitudes. The results were analyzed using quantitative descriptive techniques. Findings showed a significant increase in students' environmental care attitudes and conceptual understanding after using the simple water wheel media. The integration of interactive learning tools proved effective for both science learning and fostering environmental awareness. This research highlights the potential of innovative, hands-on media in supporting science education and developing students' responsibility toward environmental sustainability.

Received 29 June 2024; Received in revised form 18 September 2024; Accepted 12 October 2024
Jurnal Eduscience (JES) Volume 12 No. 1 (2025)
Available online xx October 2025
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INTRODUCTION

The success of the learning process is closely tied to the implementation of a good curriculum by educational institutions, particularly educators (teachers). A curriculum holds a crucial position in the education system and process, as it provides a framework for objectives, content, and methods. It helps steer educational efforts toward desired outcomes, offers guidance for teachers in

designing structured lessons, and provides a means to measure students' progress. Additionally, the curriculum helps address inequality by ensuring equal access to knowledge and skills. It also directs the learning process by defining what should be taught and how it should be delivered, creating experiences that are relevant to students' future needs (Rahma Winta & Ariani, n.d.; Sitorus & Diana, 2020)

The current enhancement of the education system from the 2013 curriculum to the independent curriculum, which focuses on optimizing students' interests and talents through essential materials, competency development, and character-building values, must be promptly and appropriately addressed by schools and teachers. This is because the independent curriculum includes the P5 stage (Strengthening Pancasila Student Profiles Project), which emphasizes the process over the learning outcomes. In the P5 stage, there are four phases: introduction, contextualization, action, and reflection. This fundamental shift directly changes the teaching and learning paradigm from conventional methods (such as lectures), which are no longer relevant for schools and teachers. To achieve this, significant efforts are required to transform the learning process, one of which is the utilization of learning media as tools in classroom instruction. Learning media can foster an active and enthusiastic classroom atmosphere. Furthermore, the use of learning media can stimulate students' creativity and independence in acquiring knowledge(Atrasina et al., 2020; Endang Widi et al., 2022).

Science learning is closely tied to practical activities and the use of instructional media. The purpose of using media is to facilitate communication between educators and students. Media also serves as a means of demonstrating scientific concepts, allowing students to observe in detail how the rotation of a turbine generates mechanical energy, which is then converted through a generator into electrical energy. Thus, the use of instructional media is crucial to make the learning process more effective, such as through the use of a miniature waterwheel model. Field findings, based on the experiences of sixth-grade teachers and researchers' observations, reveal several challenges faced by teachers when delivering science lessons, particularly on the topic of hydroelectric power plants. This material is often difficult for students to understand due to the lack of instructional media supporting the subject. Teachers tend to rely on presenting the material in written form followed by verbal explanations, which are less engaging. With such monotonous delivery methods, many students feel bored and opt to chat with their seatmates or engage in activities unrelated to the lesson (Anistya et al., 2021; Rahmatullah et al., 2024).

A teacher must be innovative in developing instructional media that are engaging, effective, and enjoyable for students, particularly at the middle school level. This helps make learning materials more comprehensible and can enliven the classroom atmosphere, ultimately boosting students' motivation to learn. In science education, which covers a broad range of topics, instructional media are essential. For instance, when teaching about hydroelectric power plants—a topic that explores energy transformations—students need opportunities to engage in hands-on activities and direct observations to deepen their understanding (Hendripides & Hikmah, 2018).

In this digital era, more and more students tend to be glued to technological devices and less involved in conventional learning. One of the challenges faced by teachers is to increase students' interest and motivation to learn. This can lead to poor academic achievements and a lack of understanding of the subject matter presented (Reyna & Meier, 2018). Using engaging and cutting-edge learning materials is one of several attempts to boost students' motivation and interest in their studies. Teachers utilize learning media as a tool to offer instructional content. Students' interest and

motivation can be raised by using the right learning materials to make subjects simple and enjoyable for them to understand (Rasmitadila et al., 2021). Numerous earlier research have emphasized how crucial it is to use engaging and interactive learning materials to boost students' motivation and enthusiasm in studying. According to the study's findings, using engaging educational materials can encourage students' critical thinking, creativity, and engagement with the material . The development of a strong desire and drive to study is essential in junior high school education as it equips pupils to handle future academic and personal problems. As a result, it is critical for teachers to find efficient ways to stimulate students' curiosity and drive to study. The purpose of this study is to investigate and assess how well junior high school students' interest and motivation to learn may be increased by using basic waterwheel media. It is also envisaged that this research would significantly aid in the creation of novel and successful teaching strategies for Indonesian classrooms(Chans & Portuguez Castro, 2021).

Students' awareness and accountability for sustainable activities are fostered via environmental education. Finding creative and interesting ways to foster environmental care attitudes, especially in middle school children, is a challenge (Ogiemwonyi et al., 2020). One approach that has gained attention is the use of simple water wheel media a practical and interactive tool that integrates concepts of science, technology, and environmental conservation into classroom activities (Sulphey et al., 2023; Zheng et al., 2018). The application of simple water wheel media not only provides hands-on learning opportunities but also allows students to directly engage with real-world environmental challenges, such as water resource management and renewable energy. Studies suggest that interactive learning experiences like this can significantly enhance students' understanding and attitudes toward environmental conservation (Aqil et al., 2023; Firmanshah et al., 2023; Kusuma Dewi et al., 2020; Magulod Jr, 2018).

Depending on the pupils' level of comprehension, science learning content is based on phenomena that happen in the surrounding environment. The study of natural phenomena that are typically and rarely directly incorporated into particular natural events, such as natural disasters, local wisdom, local potentials, and indigenous and community activity in a location, constitutes learning content in instructional materials. Additionally, mapping of learning resources that are integrated with the environment, such as mapping local learning potentials, has started to be done (Azhary et al., 2020). Learning outcomes include comprehension of student concepts, creative thinking abilities and attitudes towards environmental care can all be enhanced by actively integrating with the environment (Ardan, 2016; Devitasari et al., 2021; Hanifha et al., 2023; Inggrid Indrayanti, 2021; Kusuma Dewi et al., 2020; Lailatul Munawwaroh et al., 2018; Rohmawatiningsih et al., 2018; Sukri et al., 2020; Syamsussabri & Lasminawati, 2023).

This article investigates the effectiveness of this approach in middle school settings. By combining theoretical and practical aspects, simple water wheel media serve as both an educational device and a symbol of sustainable practices. The goal is to foster a deeper connection between students and their environment while empowering them with knowledge and motivation to take responsible actions.

METHODOLOGY

This study's design makes use of research and development (R&D) studies. R&D research, sometimes referred to as development research, is a research methodology used to design and validate products (Ruhansih, 2017). For the development of this device, researchers employed the 4-

D research approach. Since it is a suggested model for the creation of educational tools, this 4D model was selected for development. Based on product efficacy and testing, the generated product is evaluated for viability. According to (Riani Johan et al., 2023), the 4-D development model comprises four primary phases: define, design, develop, and disseminate. This research uses research and development methods as the main approach. This method was chosen with the aim of producing and testing the effectiveness of a simple water wheel product as a science learning medium. Research and development methods are widely used in the fields of natural sciences and engineering.

The main advantage of the research and development method is its focus on producing products that are useful and measurable in their effectiveness. The subjects of this research were SMP IT IBNU ABBAS with 34 respondents Class VIII B and while the object of this research was the analysis of students' environmental care attitudes towards the simple water wheel learning media.

The Vice Principal for Curriculum Affairs, who served as a resource for the execution of educational and school programs at SMP IT Ibnu Abbas, was one of the research participants. Additionally, the Arts and Culture teacher participated as a resource person and observer during the implementation of the actions. The Class VIII B students at SMP IT Ibnu Abbas served as the main participants directly involved in the learning process.

Students were given a questionnaire with ten questions and four possible replies. The list of questionnaire questions is presented in table 1. Before filling out the environmental care attitude questionnaire, students were given a pre-test and learning using simple waterwheel learning media. After learning, students take a post-test and fill out an interest and motivation questionnaire. The test was given to determine students' abilities in the material on pressure and Bernoulli's Law after using the simple water wheel learning media. There are ten multiple-choice questions on the test that make reference to indications. The data obtained will be analysed using quantitative descriptive data analysis techniques. By using research and development methods, it is hoped that this research can produce products that are useful and effective for science learning.

The research results are presented in tabular and descriptive form. The results of the analysis which include student responses and responses regarding increasing students' environmental care attitudes using simple waterwheel learning media are presented in the table below.

Table 1. Questionnaire Grid of Students' Environmental Care Attitude

Poin	Assesment Aspect	Question Points
1	Behaviour to maintain cleanliness	2
2	Attitude to energy	3
3	Attitude toward land, water, and air	2
4	Attitude towards flora and fauna	1
5	Attitude toward people and the social environment	2

Adapted from (Mamat & Mokhtar, 2018)

$$\text{Score criteria} = \frac{\text{number of scores obtained}}{\text{total score}} x100\%$$

Researchers used expert validators to collect quantitative data via validation questionnaires, and the results were analyzed using formulas related to Table 2 below.

Table 2. Product validity categories

No	Percentage	Validity Category
1	81% ≤ 100%	Very Valid, can be used without improvement
2	61% ≤ 80%	Moderately valid, but needs minor improvements
3	41% ≤ 60%	Less valid, and a major improvement
4	21% ≤ 40%	Invalid, cannot be used
5	0% ≤ 20%	Highly invalid, cannot be used

Researchers have collected effectiveness data during the learning process in the form of pre-test and post-test results. The N-Gain score derived from the following formula was used to examine the data.

Table 3. N-Gain criteria

No	N-Gain Score	Category
1	0.00 < N – Gain < 0.30	Low
2	0.30 ≤ N – Gain ≤ 0.70	Medium
3	N – Gain > 0.70	High

RESULT AND DISCUSSION

The implementation of simple water wheel media in middle school classrooms yielded significant results in fostering environmental care attitudes among students. This section discusses the findings based on observations, surveys, and interviews conducted during the study. The following are the steps for making a simple waterwheel:

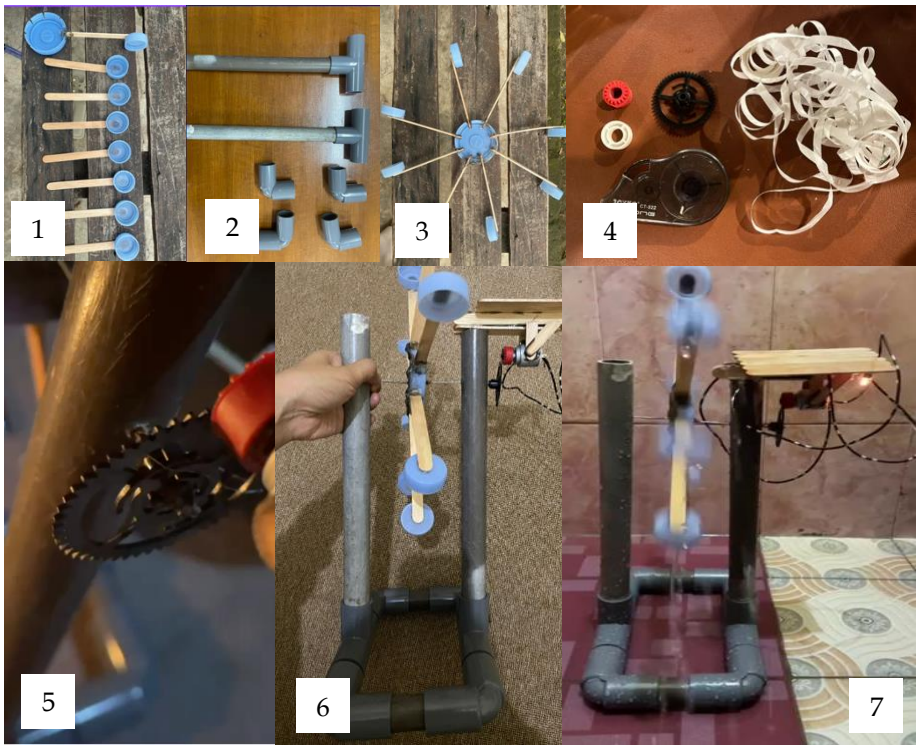
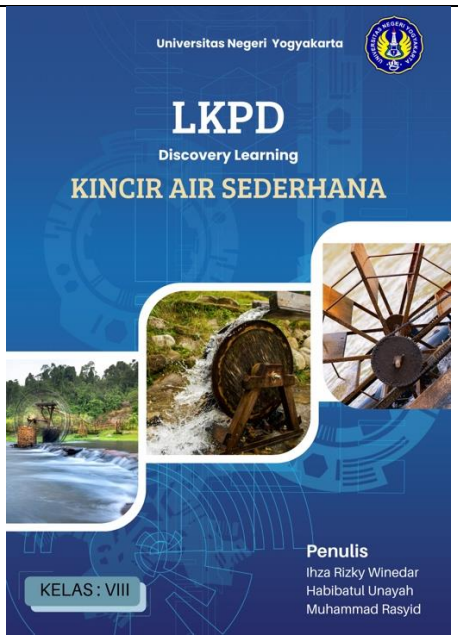


Figure 1. The steps for making a simple waterwheel. 1. (2) propeller from used bottle caps, (3) propeller arrangement, (4) making waterwheel poles from used paralon, (5) Making Gear from used Type X, (6) gear installation, (7) miniature water wheel, (8)use of a water wheel to turn on the lights

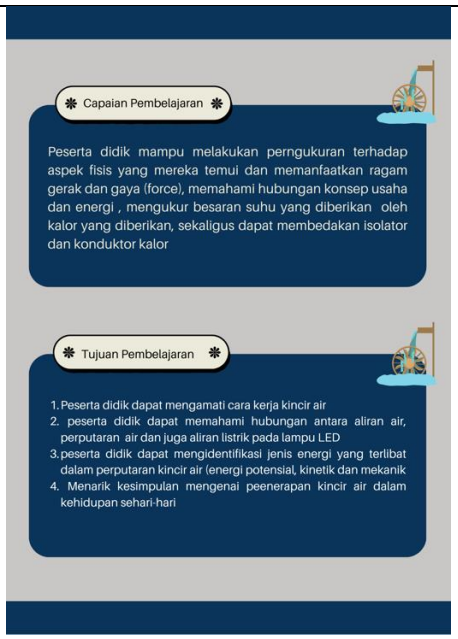
In designing a learning process, teachers prepare a framework for creating a Lesson Plan (RPP), which includes various important aspects of learning. One of the main aspects that teachers need to determine in implementing environmental care attitudes in energy-related lessons is the selection of relevant materials. The materials provided can influence the learning outcomes achieved. In the topic of alternative energy, with the aim of fostering students' environmental care attitudes, the researcher uses a simple waterwheel as a teaching aid.

This medium carries a meaning related to humans, the environment, and water, making it relevant to the aspect of environmental care, particularly emphasizing the importance of maintaining water cleanliness and creating proper sanitation for life. (Furda et al., 2021) The action plan is designed for two meetings using the same learning model, namely Discovery Learning. In addition to materials, the models, methods, and strategies used must be well-planned by teachers to create a learning experience that motivates students to care for their environment through the simple waterwheel medium in the topic of alternative energy (Sulphey et al., 2023).

Table 4. Design of student worksheet Simple Water Wheel Media in Cultivating Environmental Care Attitudes

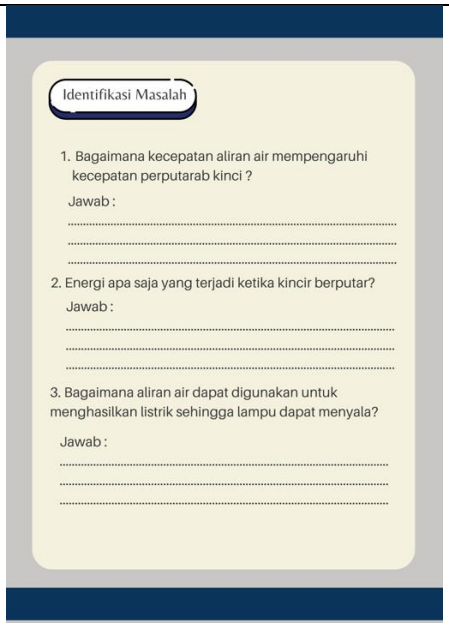


a. student worksheet frontpage

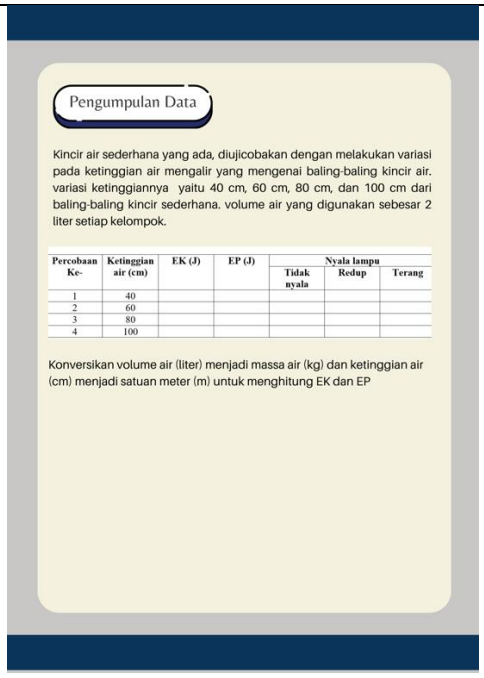


b. Learning outcomes and objectives

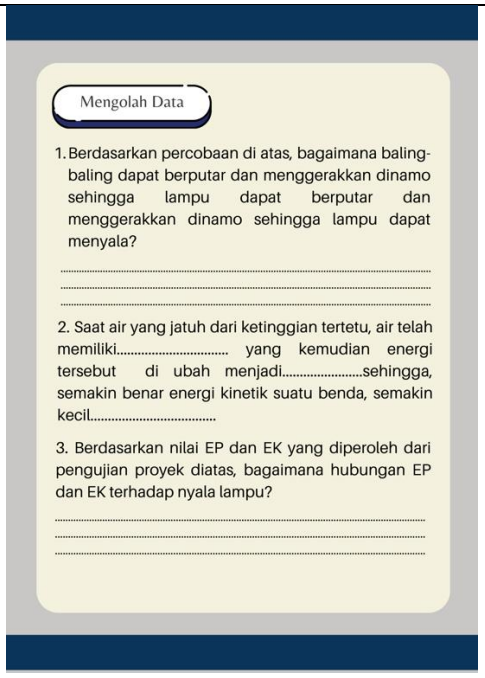
c. Student activity (Stimulation)



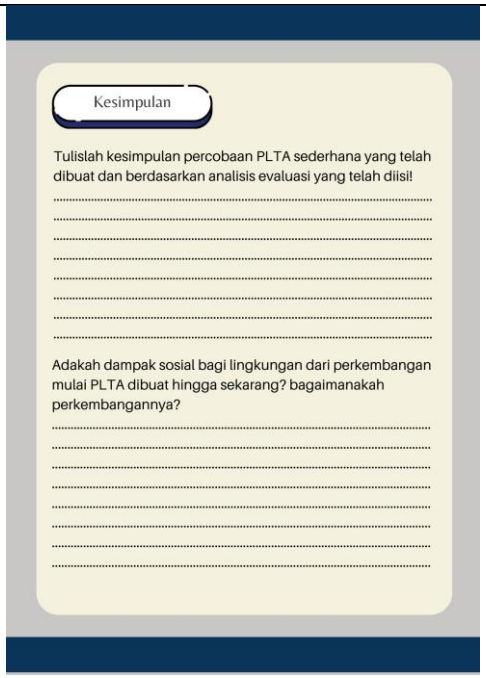
d. Student activity (Prolem statement)



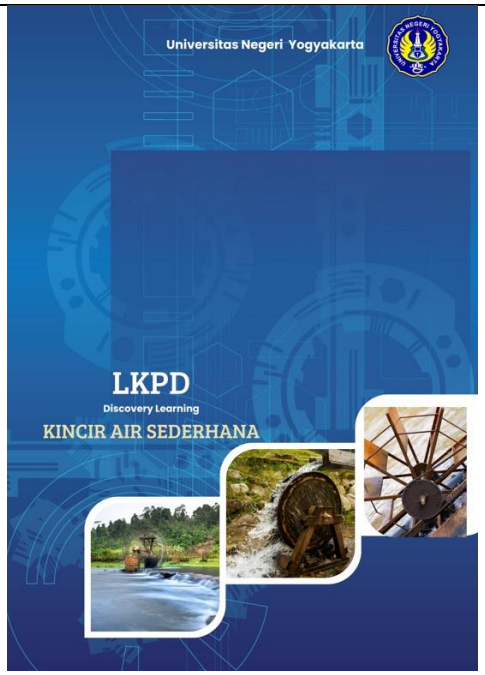
e. Student activity (data collection)



f. Student activity (data processing)



g. Student activity (generalization)



h. Back page of student worksheet

Content validity and construct validity were used to assess the student worksheet Water Wheel Media's suitability for fostering environmental care attitudes in middle schools. The three components of content validity evaluation are language compatibility, presentation suitability, and content suitability. The content's suitability receives a 95% rating with a valid category, the presentation's suitability receives a 93% rating with very valid criteria, and the language's suitability receives an average of 96% rating with very good criteria. With a very valid category, the construct validity result is 93%. An overall average score of 94% very valid was obtained from the validation of the science student worksheet based on Water Wheel Media in Cultivating Environmental Care Attitudes in Middle Schools.

Table 5. Validation results

Content Validity		**Criteria**
Content eligibility	95%	Very Valid
Presentation feasibility	93%	Very Valid
Language feasibility	96%	Very Valid
Construct Validity	93%	Very Valid
Average	**94%**	Very Valid

The N-Gain value derived from the pre-test and post-test administered to the students was used to determine the study's findings. A pre-test was administered to students prior to the implementation of the student worksheet Water Wheel Media's suitability for promoting environmental care attitudes, and a post-test was administered following the implementation of the science module based on Water Wheel Media's suitability to ascertain whether or not student environmental care attitudes had increased. The following is the N-Gain value derived from the pre-test and post-test findings.

Table 6. N-Gain analysis results

No.	Environmental care attitudes Indikator	Average Value		N-gain	Criteria
		Pre-test	Post-test		
1.	Behaviour to maintain cleanliness	1.30	2.87	0.92	High
2.	Attitude to energy	1.13	2.77	0.88	High
3.	Attitude toward land, water, and air	0.55	2.58	0.83	High
4.	Attitude towards flora and fauna	0.81	2.61	0.92	High
5.	Attitude toward people and the social environment	0.94	2.55	0.78	High
	Average	1.23	2.74	0.86	High

Based on the N-Gain analysis results presented in Table 5, it is evident that the use of worksheets (student worksheet) incorporating simple water wheel media has significantly impacted the improvement of students' environmental care attitudes in middle school. The first indicator, behavior to maintain cleanliness, showed a pre-test average score of 1.30, which increased to 2.87 in the post-test. The N-Gain value of 0.92 (categorized as high) indicates a substantial improvement in students' awareness of maintaining cleanliness, such as properly disposing of waste and keeping their learning environment tidy. For the second indicator, attitude toward energy, the pre-test score of 1.13 improved to 2.77 in the post-test, with an N-Gain of 0.88. This highlights a positive shift in students' understanding of energy conservation and renewable energy use, as demonstrated through the application of simple water wheel technology during the activity.

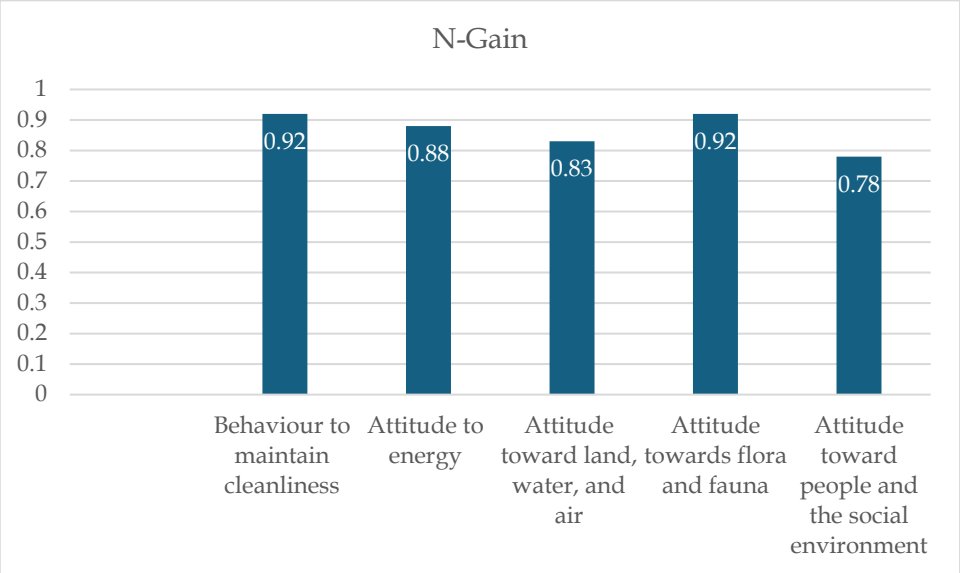


Figure 2. N-Gain result

The third indicator, attitude toward land, water, and air, recorded an increase from 0.55 in the pre-test to 2.58 in the post-test, with an N-Gain value of 0.83. This reflects students' improved

behavior toward preserving natural resources, such as protecting water sources and reducing pollution. The fourth indicator, attitude toward flora and fauna, showed significant progress, with the pre-test score rising from 0.81 to 2.61 in the post-test and an N-Gain value of 0.92. This improvement demonstrates an increased understanding among students about the importance of protecting plants and animals to maintain ecosystem balance.

For the fifth indicator, attitude toward people and the social environment, the pre-test average of 0.94 rose to 2.55 in the post-test, with an N-Gain value of 0.78. This indicates that students became more aware of the importance of social interactions in maintaining a clean and sustainable environment, such as through community activities like mutual cooperation (gotong-royong). Overall, the average pre-test score was 1.23, increasing to 2.74 in the post-test, with an N-Gain value of 0.86, which falls into the high category.

These results confirm that the implementation of student worksheet based on simple water wheel media is highly effective in improving students' environmental care attitudes. The results imply that practical, hands-on learning using innovative media not only enhances students' interest but also provides them with a deeper understanding of environmental preservation. By directly engaging with simple water wheel experiments, students connect scientific concepts with real-life applications, fostering sustainable behaviors and increased environmental responsibility. Furthermore, this approach aligns with the competencies outlined in the Profile of Pancasila Students, particularly in fostering religious values, social responsibility, and environmental awareness. Thus, it can be concluded that the integration of simple, practical, and innovative learning media into science education significantly enhances students' environmental care attitudes and supports the development of a generation that prioritizes sustainability and environmental stewardship.(Hanifha et al., 2023; Mamat & Mokhtar, 2018; Ogiemwonyi et al., 2020; Rahardjanto et al., 2022; Yousuf & Bhutta, 2018)

The stages of learning, which adapt aspects of environmental care attitudes within the framework of Discovery Learning, are as follows:

Table 7. Sintaks and Stpudent's activities in Discovery Learning

Sintaks Discovery Learning	Description of activities
Stimulation	The teacher stimulates the senses participant curiosity educate
Problem Statement	Learners Identify relevant problem with material
Data Collection	Students individually independently collect problem related data
Data Prossecing	Students process data that has been found
Generalization	withdrawal process conclusions based on the findings that have been made presented

The implementation of actions involving the use of a simple waterwheel by the researcher was conducted over two cycles, with two meetings in each cycle. Assisted by a Science teacher from

SMP IT Ibnu Abbas, the researcher carried out observations and reflections on the actions. During the implementation, the researcher, aided by an observer, monitored the learning process and the students' responses using observation sheets prepared by the researcher.

Cycle 1

First Meeting

The first meeting was conducted with an allocated time of 2x40 minutes. The goal was for students to be able to conclude the basic concept of a simple waterwheel based on its supporting elements, linked to environmental phenomena. With the assistance of an arts and culture teacher acting as an observer, the researcher took on the role of teacher in order to keep an eye on the learning process. Both the observer and the researcher considered the instructional acts based on field notes and observation data from the learning process.

The reflection results indicated that the researcher, as the teacher, had not yet maximized efforts and needed to further develop the stimuli provided to students. Consequently, the students had not fully understood the material presented. Additionally, students' motivation and active participation were not optimal, and the character-building values implemented had not shown satisfactory results. Thus, improvements were required for the next meeting. As a solution to the issues identified in the first meeting, the researcher and observer implemented several measures, such as improving classroom management and enhancing the integration of character values into the learning process through dance activities .

Cycle 2

Second Meeting

Two forty-minute meetings were allotted for the second meeting in Cycle 1. On the basis of its supporting components and relationship to environmental phenomena, the researcher assisted students in creating and presenting descriptive writings on the fundamental idea of a basic waterwheel during this session.This was intended to maximize the implementation of character values. Observations were repeated using the same observation sheets as in the first meeting. The results from the observer and the researcher indicated similar findings: students still struggled to fully understand the concept of alternative energy in relation to environmental phenomena. However, the reinforcement provided by the researcher as the teacher was found to be sufficiently relevant to the predetermined learning objectives. Furthermore, additional materials were deemed necessary to provide students with a more comprehensive understanding. On the other hand, students' attitudes toward environmental care had significantly improved and were displayed in an optimal and positive manner.(Inggrid Indrayanti, 2021; Khotimah et al., 2018)

After completing the implementation process in Cycle I and Cycle II, the researcher analyzed the learning process and found that, through dance learning using the implementation of a simple waterwheel as a medium, students achieved both instructional effects and nurturant effects.

Table 8. Result of Instructional Effect and Nurturant Effect

Instructional Effect	Nurturant Effect
Developing the ability to analyze, write, and understand the basic concept of a	Exploring the potential energy of a waterwheel, fostering an appreciation for the

simple waterwheel in relation to environmental phenomena.	environment by utilizing recycled materials, and cultivating motivation and enthusiasm to understand and protect the environment.

Improved Environmental Awareness Students demonstrated a marked improvement in their understanding of environmental concepts, particularly regarding water resource management and renewable energy. Following the intervention, pre-test and post-test scores demonstrated an average increase in knowledge acquisition, confirming earlier research showing that interactive tools improve environmental literacy. Positive Behavioral Changes Behavioral observations indicated that students engaged more actively in classroom discussions and extracurricular activities related to environmental conservation. Students reported participating in water-saving initiatives at home after learning about water wheel mechanics, corroborating research on the role of experiential learning in promoting eco-friendly behaviors. High Engagement and Motivation The hands-on nature of the water wheel media significantly increased student engagement. Teachers reported a improvement in student participation compared to traditional lecture-based methods. Students expressed enthusiasm for interactive activities, reflecting findings on the importance of experiential learning frameworks.(Aqil et al., 2023; Meisarah et al., 2023)

Effectiveness of Experiential Learning The results confirm the effectiveness of experiential learning in enhancing environmental education. The simple water wheel media allowed students to connect theoretical knowledge to practical applications, aligning with studies that emphasize the benefits of tangible, real-world teaching tools. Fostering Personal Connection to the Environment Students developed a personal sense of responsibility for environmental issues through the hands-on approach. This outcome supports theories in environmental education, such as the Model of Environmental Responsibility, which highlight the importance of direct engagement in fostering pro-environmental attitudes (Lahiri, 2011; Sulphey et al., 2023). Challenges and Limitations Despite its success, the implementation faced several challenges. Resource limitations in underfunded schools hindered widespread use. Additionally, some teachers required further training to integrate the water wheel media effectively into the curriculum. Addressing these barriers would enhance the scalability and impact of this approach. Implications for Future Practice The findings suggest that incorporating simple, cost-effective tools like water wheel media into the national curriculum could revolutionize environmental education. Such approaches not only enhance student engagement but also foster lifelong sustainable habits. Future studies should examine the long-term impact of these methods on students' environmental behavior and attitudes (Firmanshah et al., 2023; Liao et al., 2022; Wibowo et al., 2023).

CONCLUSION AND SUGGESTION

The use of simple water wheel media proved to be an effective strategy for cultivating environmental care attitudes among middle school students. By integrating hands-on learning and environmental themes, this approach not only enhanced students' understanding but also motivated them to adopt eco-friendly behaviors. These findings underscore the need for further investment in innovative teaching tools to strengthen environmental education.

REFERENCES