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Developing Water Wheel-Integrated Student Worksheets: A Strategy for Enhancing Environmental Care Attitudes

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ABSTRACT

Purpose- This study aims to design and test student worksheets (LKPD) using simple water wheel media, and to cultivate an environmental care attitude among junior high school students.

Methodology- This research is a Research and Development (R&D) with the 4-D model (define, design, develop, disseminate). This research was carried out at SMP IT Ibnu Abbas with 34 students of eighth grade as participants. The data collection is done using the pre-test, post-test, and environmental care attitude questionnaire.

Findings-Validation analysis reveals a predominant average score of 94% (very valid category) towards the suitability of worksheets for instilling the attitude of environmental care and its advantage in the science subject as determined from teacher and student questionnaires. The outcomes showed that there was an effect of simple water wheel media on students' attitude to care for environment and conceptual understanding, average gained N-gain = 0.86 (in the high category).

Significance- This study shows how innovative, hands-on media have the potential to support science education and promote students' sense of responsibility for environmental sustainability.

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INTRODUCTION

The successful process of the curriculum implementation is highly dependent on the quality of curriculum practiced, and this is mainly done by institutions and educators (teachers). Curriculum is one of the most important components of the education system and the process because it determines the purposes, content and methods. It helps direct educational efforts toward the outcomes we want, serves as guidance to teachers designing well-structured lessons, and provides a way to measure students' progress. In addition,

thefy curriculum serves to address inequality in that it makes knowledge and skills more accessible to everyone regardless of race, gender, or socio- economic status. In addition, it also leads to learn the process through what needs to be taught and how it will be delivered in such a way that it becomes a meaningful experience for students in relation to their future needs (Rahma Winta & Ariani, n.d.; Sitorus & Diana, 2020).

The main emphasis would be on the need of quick and proper action of the school and especially the teachers against the reform of education system synopsis from 2013 curriculum to the recent independent curriculum with the rationale of maximizing interest and adaptivity of pupils through the most essential material, competency development and morale-boosting values. This is because the independent curriculum covers the P5 stage (Strengthening Pancasila Student Profiles Project), where the process becomes more major than the learning outcomes. In the sense of P5 stage the four phases includes introduction, contextualization, action and reflection. This big change fundamentally alters the paradigm of teaching and learning from traditional methods (including lectures), no longer suitable for schools and teachers. Therefore, to realize this requires great efforts to change the learning process including learning media as a tool in classroom teaching. Active and enthusiastic classroom atmosphere are the importances of learning media. It is also known that the use of learning media can facilitate students' creativity and independence in learning (Atrasina et al., 2020; Endang Widi et al., 2022).

Instructional media integrated with day to day activities are closely related to science learning. After all, the goal of media is to enable communication between the instructors and the learners. Media also acts to show science, letting students see in detail how a turbine rotates mechanical energy is then converted through the generator into electrical energy. Therefore, instruction media is needed to make the learning process become more effective, for example the use of the miniature waterwheel model. Based on information collected during observations with sixth grade teachers and by researchers in 2012, field findings show the challenges teachers face when teaching science, specifically environmental science on the topic of hydroelectric power plants. This material is often difficult for students to comprehend due to the lack of instructional media to support the subject. Teachers often use a less engaging way of presenting the material where first written content is presented followed by spoken presentation. This monotonous delivery method makes many students feel bored and choose to chat with each other or do something unrelated to the learning (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).

Environmental care attitudes are essential for fostering sustainable behavior and encouraging active participation in environmental conservation efforts. Schools play a pivotal role in developing these attitudes among students, emphasizing the need for innovative approaches to environmental education. Recent studies highlight the importance of active, experiential learning methods in enhancing students' environmental awareness and responsibility (Smith & Peterson, 2021). However, traditional teaching strategies often lack the engagement required to instill meaningful attitudes toward the environment.

The use of hands-on learning media, such as simple water wheel models, has emerged as an effective strategy to enhance students' understanding of environmental concepts. Such tools provide opportunities for students to explore the principles of sustainability through interactive and engaging experiences. Research by Johnson et al. (2022) demonstrates that integrating physical models into environmental education significantly improves students' comprehension and motivation to address environmental challenges. The simple water wheel, as a representation of renewable energy and sustainable water management, is particularly suitable for introducing concepts of conservation and resource efficiency. Incorporating student worksheets (Lembar Kerja Peserta Didik/LKPD) alongside physical learning media offers a structured framework that bridges theoretical knowledge and practical application. Recent findings suggest that combining interactive tools with instructional worksheets fosters not only cognitive understanding but also affective outcomes, such as attitudes and values related to environmental stewardship (Brown et al., 2023).

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. Additionally, this research aims to develop student worksheets (LKPD) integrated with simple water wheel media as an innovative and effective tool for science education. The LKPD is designed to enhance students' conceptual

understanding, foster environmental care attitudes, and provide structured, interactive learning activities that align with educational objectives.

The study also evaluates the effectiveness and validity of the developed LKPD through rigorous validation processes, ensuring its quality in fostering environmental awareness and supporting sustainable education practices. The research contributes to the advancement of environmental education while offering practical solutions for educators to cultivate environmental behaviors in students. The findings are expected to provide valuable insights for both educational practice and policy development.

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. Define Stage Learning needs related to environmental care and water resources were analyzed, highlighting students' challenges and the need to enhance process skills. This formed the basis for developing worksheets (LKPD) with simple water wheel media using the TAI cooperative model. Design Stage Worksheets were designed with cooperative learning principles, clear objectives, and activities to promote environmental awareness. A prototype was created, including instructions, materials, and tasks. Develop Stage The prototype was tested on middle school students using a quasi-experimental design. Feedback was used to refine the worksheets for improved effectiveness. Disseminate Stage The finalized worksheets were implemented in multiple classrooms to evaluate their broader impact and published to support environmental education research.

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 from Class VIII B, while the object of this research was the analysis of students' environmental care attitudes towards the simple water wheel learning media. The selection of 34 respondents was based on purposive random sampling, as Class VIII B was identified to represent the average academic performance and learning behavior of middle school students in the institution. This class was chosen to ensure a balanced representation of learning outcomes and environmental attitudes, providing reliable feedback on the effectiveness of the developed media. The criteria included students' willingness to participate, regular attendance, and their ability to engage actively in the cooperative learning process. This method ensured the respondents were suitable for assessing the study's objectives effectively.

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 Science 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, Strongly Agree, Agree, Somewhat Disagree, and Disagree. 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)

$$Score\ criteria = \frac{number\ of\ score\ obtained}{total\ score} \times 100$$

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

FINDINGS

Design of simple water wheel media

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:

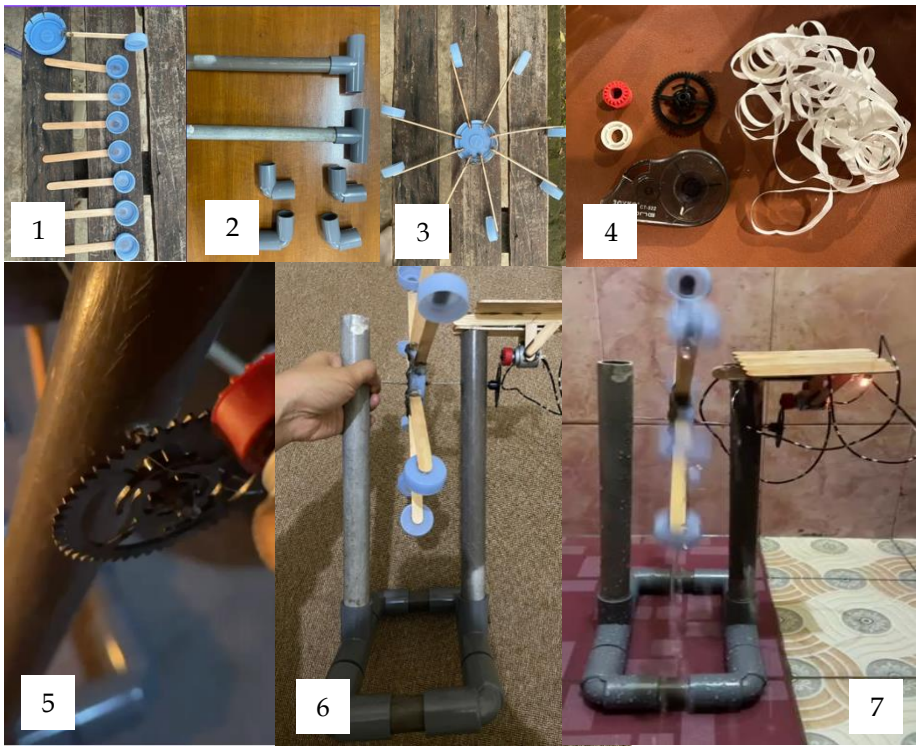

Figure 1. The steps for making a simple waterwheel. 1. (2) propeller from used bottle caps, (3) propeller arrangement, (4) making waterwheel poles from used paralon, (5) Making Gear from used Type X, (6) gear installation, (7) miniature water wheel, (8)use of a water wheel to turn on the lights

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).

Validation results

To ensure the effectiveness and appropriateness of the developed student worksheet, a thorough validation process was conducted. This process aimed to evaluate the worksheet's ability to support the cultivation of environmental care attitudes in middle school students, focusing on both content and construct validity.

Figure 2. Design of student worksheet Simple Water Wheel Media in Cultivating Environmental Care Attitudes

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 4. Validation results

Content Validity	Score	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

Students' environmental care attitudes Result

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 5. 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.

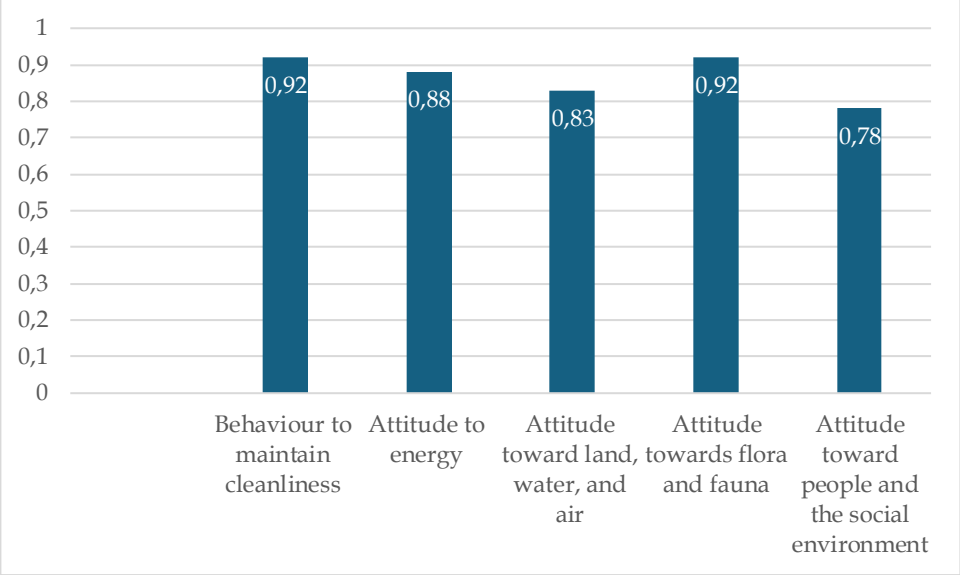

Figure 3. N-Gain result

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.

DISCUSSION

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 6. 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 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.

After completing the implementation process, 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 7. Result of Instructional Effect and Nurturant Effect

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

This study demonstrates that integrating student worksheets with simple water wheel media effectively improves environmental care attitudes in middle school students, as evidenced by an N-Gain increase with an average of 0.86, categorized as high. The results highlight the potential of interactive and hands-on learning tools like the water wheel in fostering environmental awareness and promoting active participation among students. This approach not only strengthens the understanding of environmental concepts but also enhances the development of STEM-based learning. The findings suggest that such affordable and accessible learning media can be incorporated into curriculum development to support environmental education. Educators and policymakers are encouraged to adopt these innovative tools in schools, particularly in resource-limited settings, to promote sustainability education and cultivate a generation of students with a strong commitment to environmental care.

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