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The Effectiveness of the Eco Rocket Media-Assisted Inquiry Learning Model on Student Learning Outcomes

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Abstract

This research is based on the low participation and learning outcomes of students due to IPAS learning which is still dominated by lecture methods. This study aims to determine the effectiveness of the Eco Rocket-media-assisted guided inquiry learning model on student learning outcomes on Newton's Law III material in grade V of SDN Pengampelan. The research uses a quantitative approach with a quasi-experimental method (Quasi Experimental DeSign) in the form of a Nonequivalent Control Group DeSign. The study sample amounted to 52 students divided into VA class (experimental group, n=26) and VB class (control group, n=26), determined by saturated sampling technique. Data were collected through a multiple-choice test of 20 questions that had been tested for validity, reliability, difficulty, and differentiating power, and then analyzed using the Shapiro-Wilk normality test, the Levene's Test homogeneity test, the N-Gain test, and the Independent Sample t-Test hypothesis test. The results showed that the average score of the experimental class increased from 57.88 (pretest) to 79.23 (posttest), with an N-Gain of 51.38% (medium category), while the control class only increased from 54.62 to 55.96, with an N-Gain of 5.41% (low category). The Independent Sample t-Test yields a Sig value. (2-tailed) of 0.000 (<0.05), so H0 is rejected and Ha is accepted. It was concluded that the Eco Rocket-media-assisted guided inquiry learning model has proven to be effective and significantly improve student learning outcomes on Newton's III Law material compared to conventional learning.

Keywords Eco Rocket Media; Guided Inquiry Learning Model; Learning Outcomes; Newton's Law III

INTRODUCTION

Education is essentially a planned effort to develop the potential of students as a whole, as mandated Law of the Republic of Indonesia Number 20 of 2003 about the National Education System. The complexity of education as a process that involves many dimensions of human development makes the application of a learning model that suits the characteristics of students

a must, no longer an option (Wutsqa, 2022). One approach that focuses on the process of discovery through investigation is the inquiry-oriented learning model, which encourages students to think critically and actively find solutions to a problem (Sutarningsih, 2022).

Natural and Social Sciences (IPAS), especially in the implementation of the independent curriculum, plays an important role in honing students' knowledge and skills. However, in the field, there are still various obstacles in the form of learning difficulties that hinder the achievement of learning objectives (Nathasya, 2024). This condition can be seen at SDN Pengampelan, especially in fifth grade students, where IPAS learning is still dominated by lecture methods so that students are less actively involved. The impact can be seen from students' low understanding of Newton's Law III material, especially the concept of action and reaction forces. Based on data on summative results for the second semester of the 2025/2026 school year, out of 26 students, half (13 students or 50%) obtained a score below the Learning Goal Achievement Criteria (KKTP) of 70, with an average class of only 70.5.

Previous research by (Yani et al., 2024) found that the discovery-based learning model succeeded in raising student learning outcomes in science subjects. However, most similar research still stops at the application of learning models without combining them with concrete materials from the students' environment, thus opening a gap for learning innovations that combine these models with more contextual and interesting media. Answering this gap, this research offers novelty in the form of a combination of guided inquiry learning models with media Eco Rocket recycled materials to teach Newton's Laws III in elementary schools.

Eco Rocket, or water rocket, is an experimental medium that uses water and air pressure to demonstrate action-reaction forces, made from simple, environmentally friendly materials such as used bottles (Silviana & Prayogi, 2023). This media transforms abstract concepts into more concrete and easy to understand than just verbal explanations, while fostering students' awareness of the importance of environmental sustainability. Based on this description, this study aims to find out the learning outcomes of students in the experimental class and the control class before and after learning, as well as to find out whether there are differences between the Significant in the learning outcomes of students who use the Eco Rocket-media-assisted guided inquiry learning model compared to conventional learning on Newton's Law III material in grade V of SDN Pengampelan.

METHODS

This study uses a quantitative approach with a pseudo-experiment method (Quasi Experimental DeSign) shaped Nonequivalent Control Group DeSign (Scott, 2026). The research population includes all grade V students of SDN Pengampelan for the 2025/2026 school year totaling 52 students, divided into VA and VB classes. The sample was determined by saturated sampling technique so that the entire population was sampled: the VA class (26 students) as an experimental class that received the treatment of the media-assisted guided inquiry learning model Eco Rocket, and the VB class (26 students) as a control class undergoing conventional learning.

The research instrument was in the form of a learning outcome test of 20 multiple-choice questions arranged based on the cognitive levels C1 (remembering), C2 (understanding), C3 (applying), and C4 (analyzing) referring to the revised Bloom taxonomy (. The instrument was validated by experts and empirically tested on 23 students using the Pearson Correlation technique, with the results of all 20 questions declared valid (r-count > r-table 0.413). Reliability test with Cronbach's Alpha yielded a value of 0.882 (very high category). The results of the difficulty test showed 3 questions in the easy category and 17 questions in the medium category, while the differentiating power test showed 5 questions in the very good category, 13 questions in the good category, and 2 questions in the sufficient category, so that all 20 questions were declared suitable for use. Data was collected through tests (pretest and posttest), documentation, and observation. Data analysis techniques include descriptive statistics, Shapiro-Wilk normality test, Levene's Test homogeneity test, N-Gain test with the Hake formula, and hypothesis test using Independent Sample t-Test through the SPSS program, with the H0 criterion rejected if the Sig. value < 0.05.

RESULTS AND DISCUSSION

Research Results

Descriptive statistical data on the learning outcomes of both classes showed that the average pretest of the experimental class of 57.88 increased to 79.23 in the posttest (up 21.35 points), while the control class only moved from the average of the pretest 54.62 to 55.96 in the posttest (up 1.34 points). The Shapiro-Wilk normality test showed that the entire data group was normally distributed (Sig. 0.077-0.238 > 0.05). The pretest homogeneity test yielded a Sig. of 0.913 (>0.05) which means that the initial ability of the two classes is equivalent, while the posttest homogeneity test yielded a Sig. 0.001 (<0.05) so that the hypothesis test refers to the line of Equal Variances Not Assumed. A summary of the results is presented in Table 1.

The average N-Gain of the experimental class of 51.38% (medium category) far exceeded the control class of 5.41% (low category). The results of the Independent Sample t-Test produced a t-value of 5.807, df 34.587, and Sig. (2-tailed) of 0.000 (<0.05), so H0 is rejected and Ha is accepted. This indicates a significant difference in learning outcomes between students in the experimental class (average 79.23) and students in the control class (average 55.96), with a difference of 23.27 points.

Table 1. Experimental Class and Control Class Learning Outcome Statistics

Yes	Data	Experimental Class (VA)	Control Class (VB)
1	Rata-rata pretest	57,88	54,62
2	Track-to-Track Posttest	79,23	55,96
3	N-Gain (%)	51,38	5,41
4	Category N-Gain	Medium	Low
5	Sig. (2-tailed) Uji-t	0,000	-
6	Remarks	Signifikan	-

Source: SPSS Output (2026)

Discussion

The research findings show a sharp gap between the improvement in learning outcomes of the experimental class and the control class. Improvement in the experimental classroom cannot be separated from the active involvement of students at every stage of the inquiry model, observing, formulating problems, making hypotheses, conducting experiments, collecting data, and drawing conclusions, which encourages students to build an understanding of concepts independently (Febrianti et al., 2025). Media Eco Rocket It also provides a concrete learning experience in understanding the concept of action-reaction style, so that material that was originally abstract becomes easier to understand. On the other hand, the low improvement in the control class was influenced by conventional learning centered on teacher and text explanations, plus the condition of some students whose reading skills were not fluent so that it was difficult to understand text-based evaluation instruments. These results are in line with (Herawati et al ., 2022) who found that the success of the inquiry model in boosting learning outcomes was driven by the active participation of students, and Silviana and Prayogi (2023) which reveals that experiment-based learning media helps elementary school students understand science concepts. These findings reinforce the constructivism theory that student understanding will be stronger if it is built independently through hands-on learning experiences, and consistent with research Lumbanraja et al. (2024) and Mulia and Suriani (2025) which concluded that the inquiry model has a great influence on improving the learning outcomes of elementary school students.

The findings demonstrate that the Eco Rocket media-assisted guided inquiry learning model produced a substantially stronger improvement in students' learning outcomes than conventional instruction. The experimental group increased from a mean pretest score of 57.88 to 79.23, representing a 21.35-point gain and an N-Gain of 51.38%, categorized as moderate. In contrast, the control group increased only from 54.62 to 55.96, with an N-Gain of 5.41%, categorized as low. The statistically significant difference between the two groups ($t = 5.807$, $p < .001$) indicates that the improvement cannot reasonably be attributed merely to normal learning progression or initial differences between the groups. The pretest homogeneity result ($p = .913$) further supports the interpretation that the two groups began from relatively comparable academic conditions. More importantly, the result should not be interpreted simply as evidence that "guided inquiry is effective." The stronger explanation is that the intervention changed the quality of students' learning activity: students were required to observe phenomena, formulate problems and hypotheses, conduct experiments, collect evidence, and draw conclusions. This sequence transformed Newton's Third Law from an abstract verbal proposition into a phenomenon that students could observe and interrogate directly. Such a mechanism is consistent with recent research showing that guided inquiry improves elementary students' cognitive achievement because it increases active engagement, critical thinking, and conceptual construction rather than merely increasing exposure to information (Rahmatullah, 2025). The meta-analysis by Safitri et al. (2025) likewise found that inquiry-based learning improves elementary students' learning outcomes and science literacy,

emphasizing that students construct knowledge through direct experience and analytical engagement. Thus, the present finding strengthens the argument that the effectiveness of inquiry learning depends less on the label of the model than on whether classroom activities actually require students to generate and test explanations from evidence.

The distinctive contribution of this study lies in the combination of guided inquiry with Eco Rocket media. The findings suggest that the media functioned not merely as an attractive teaching aid but as a cognitive bridge between an abstract physics principle and an observable event. Newton's Third Law is conceptually difficult for elementary students because action and reaction forces are invisible and occur simultaneously, making the relationship between the two forces difficult to represent mentally. The Eco Rocket provides a visible consequence of the underlying principle: students can observe the movement of the rocket and relate that movement to the interaction between expelled water and the rocket itself. Consequently, the media reduces the distance between concrete experience and conceptual abstraction. This interpretation is supported by Karlina et al. (2024), who found that guided inquiry improved elementary students' science process skills and concept mastery, with moderate gains following the intervention. It is also consistent with Mardhatillah et al. (2026), whose practicum-based guided inquiry study found a significant improvement in science learning outcomes and particularly strong mastery of learning objectives that were directly connected to practical activities. The similarity between these studies and the present research indicates that the critical mechanism is the integration of inquiry with experience, rather than inquiry as a purely verbal or worksheet-based procedure. Nevertheless, the present study extends previous findings by embedding the experiment in an environmentally relevant medium made from recycled materials. This creates a dual pedagogical function: the Eco Rocket represents a scientific phenomenon while simultaneously contextualizing science learning within environmental sustainability. The implication is theoretically important because it suggests that constructivist learning becomes more powerful when learners do not simply "discover" information but encounter a meaningful phenomenon that creates a need to explain, test, and revise their understanding.

The sharp difference between the experimental and control classes also provides an important critique of conventional teacher-centered learning in this particular context. The control group's extremely limited improvement from 54.62 to 55.96 suggests that explaining Newton's Third Law through verbal and textual representations alone was insufficient for students who had difficulty visualizing the relationship between action and reaction forces. The manuscript itself notes that conventional learning remained centered on teacher explanations and text-based activities, while some students experienced reading difficulties that further constrained their ability to process the assessment material. However, this result should not be interpreted as proof that conventional instruction is inherently ineffective. Rather, it indicates a mismatch between instructional representation and the epistemic demands of the content. A concept involving invisible forces requires opportunities for observation, manipulation, comparison, and explanation; therefore, a predominantly verbal

approach may provide insufficient representational support. This interpretation is strengthened by Kapici (2025), who found that inquiry-based environments can improve students' conceptual understanding and inquiry skills, although the effectiveness of the environment is influenced by the affordances of the learning setting and students' inquiry abilities. Similarly, Huang and Pei (2024) showed that inquiry learning can strengthen elementary students' engagement with scientific practices and conceptual development, particularly when learners participate in authentic activities rather than simply receive scientific information. The present study therefore contributes a more specific insight: for elementary science topics characterized by invisible mechanisms, the combination of guided cognitive scaffolding and concrete experimental representation may be more consequential than the inquiry model alone. This also explains why the gain was moderate rather than high. Although the intervention substantially improved achievement, students still had to translate an observable rocket movement into an abstract force relationship. The remaining conceptual gap indicates that hands-on activity does not automatically guarantee deep understanding; teacher questioning, hypothesis formulation, evidence interpretation, and explicit conceptual reflection remain necessary to connect experience with formal scientific principles.

From a theoretical perspective, these findings reinforce constructivism by demonstrating that meaningful science learning occurs when students actively construct explanations from experiences rather than passively receive completed explanations. The guided inquiry stages reported in the study observation, problem formulation, hypothesis development, experimentation, data collection, and conclusion drawing provide the cognitive structure through which students reorganize prior conceptions in light of empirical evidence. This is particularly relevant to Newton's Third Law because students may initially interpret the rocket's motion as being caused by a single force rather than by an interaction between two bodies. The Eco Rocket experiment creates a cognitive conflict between that intuitive conception and the observed phenomenon, while guided inquiry provides the scaffolding needed to resolve the conflict scientifically. Recent evidence supports this interpretation: Safitri et al. (2025) reported that inquiry-based learning improves outcomes because students engage critically and analytically while constructing knowledge through direct experience, whereas Rahmatullah (2025) emphasized active engagement and conceptual understanding as mechanisms underlying the effectiveness of guided inquiry.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the learning outcomes of students in the experimental class increased significantly from the average of the pretest of 57.88 to the posttest of 79.23 (N-Gain 51.38%, medium category), while the control class only increased from 54.62 to 55.96 (N-Gain 5.41%, low category). The Independent Sample t-Test produces Sig. (2-tailed) 0.000 (<0.05) so that H0 is rejected and Ha is accepted, indicating that the Eco Rocket-media-assisted guided inquiry learning model has proven to be effective and significantly improves student learning outcomes in Newton's Law III material

compared to conventional learning. Teachers are advised to use this model as an innovative alternative to science learning, especially for abstract materials, while further research is suggested to expand the scope of the material, level, and sample count.

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