A CONTEXTUAL PHYSICS LEARNING MODEL ON PROJECTILE MOTION THROUGH HOMBO BATU ACTIVITY WITHIN THE LOCAL WISDOM OF SOUTH NIAS

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Abstrak

Penelitian ini bertujuan untuk mengembangkan model pembelajaran kontekstual pada materi Gerak Parabola dengan mengintegrasikan aktivitas Hombo Batu sebagai bentuk kearifan lokal masyarakat Nias Selatan. Hombo Batu, atau tradisi lompat batu, merupakan aktivitas fisik yang kaya akan unsur kinematika dua dimensi, seperti kecepatan awal, sudut elevasi, dan lintasan parabola. Penelitian ini menggunakan metode Research and Development (R&D) berdasarkan model pengembangan Sugiyono, yang mencakup tahapan: potensi dan masalah, pengumpulan data, desain produk, validasi, revisi, dan uji coba terbatas. Hasil validasi oleh ahli materi dan media menunjukkan bahwa model pembelajaran yang dikembangkan memiliki tingkat validitas tinggi (Aiken's V > 0,85), dengan kategori "sangat layak". Uji coba terbatas terhadap siswa SMP di Nias Selatan menunjukkan bahwa model ini efektif meningkatkan pemahaman konsep gerak parabola, dengan skor N-Gain rata-rata sebesar 0,56 (kategori sedang-tinggi). Selain itu, terdapat peningkatan motivasi belajar dan apresiasi terhadap budaya lokal setelah implementasi model. Model ini tidak hanya menguatkan penguasaan konsep fisika, tetapi juga memperkuat karakter dan identitas budaya siswa melalui pendekatan pembelajaran yang kontekstual, bermakna, dan aplikatif. Oleh karena itu, model pembelajaran kontekstual berbasis *Hombo Batu* direkomendasikan sebagai alternatif inovatif dalam pengajaran Fisika, khususnya di wilayah yang kaya akan nilai-nilai budaya lokal.

Kata Kunci: *Model Pembelajaran Kontekstual; Gerak Parabola, Hombo Batu; Kearifan Lokal*

Abstract

This study aims to develop a contextual learning model for the topic of projectile motion by integrating *Hombo Batu* activities as a form of local wisdom from the South Nias community. *Hombo Batu*, or the traditional stone-jumping ritual, is a physical activity rich in two-dimensional kinematics elements, such as initial velocity, angle of elevation, and parabolic trajectory. The research employed the Research and Development (R&D) method based on Sugiyono's development model, which includes the following stages: identifying potential and problems, data collection, product design, validation, revision, and limited trials. Validation results from subject matter experts and media experts indicated that the developed learning model achieved a high level of validity (Aiken's V

> 0.85), categorized as "highly feasible." A limited trial conducted with junior high school students in South Nias showed that the model effectively improved students' understanding of projectile motion, with an average N-Gain score of 0.56 (moderate to high category). Additionally, the implementation of the model led to increased learning motivation and greater appreciation of local culture among the students. This model not only enhances conceptual understanding in physics but also strengthens students' character and cultural identity through a learning approach that is contextual, meaningful, and applicable. Therefore, the *Hombo Batu*-based contextual learning model is recommended as an innovative alternative for teaching physics, particularly in regions rich in local cultural values.

Keywords: *Contextual Teaching Model; Parabolic Motion; Hombo Batu; Indigenous Knowledge*

A. Introduction

Physics learning is often perceived as difficult by students due to its abstract nature and heavy reliance on formulas. One of the challenging topics is projectile motion, which requires a comprehensive understanding of initial velocity, angle of elevation, time, and trajectory (Harefa, D., 2025). The concept of projectile motion involves simultaneous analysis of horizontal and vertical vector components, as well as the ability to solve problems related to two-dimensional kinematics.

The empirical nature of this topic frequently leads to a gap between theoretical understanding and real-world application. As a result, students often struggle to relate the formulas they learn to everyday experiences (Harefa, D., et al., 2025). This disconnect makes it difficult for learners to develop meaningful conceptual understanding, and instead, they tend to memorize equations without grasping the underlying principles. Therefore, there is a growing need for instructional approaches that bridge theory and practice through contextualized and experiential learning strategies.

Therefore, an instructional approach that connects abstract concepts with students' real-life experiences is essential. Contextual Teaching and Learning (CTL) offers a learning strategy where students can construct understanding through real-world situations, thereby enhancing the relevance and retention of knowledge (Jayanti et al., 2013). In CTL, activities such as modeling, collaboration, inquiry, and reflection foster greater student engagement, critical thinking, and deeper conceptual understanding. This aligns with the principles of social constructivism, which posits that knowledge is actively constructed by individuals through interactions within their sociocultural environment.

In the context of projectile motion, empirical studies have demonstrated the

effectiveness of CTL in improving student understanding. Research by Khoirunnisa et al. (2020) implemented CTL in teaching projectile motion and recorded N-Gain scores ranging from 0.59 to 0.67 (moderate category), indicating a significant improvement in students' conceptual comprehension. This finding reinforces the idea that linking physics concepts to students' cultural backgrounds or familiar local phenomena helps to bridge the abstract nature of the subject (Prabowo et al., 2017).

Similarly, Tirsa Yolanda and Lubis (2020) reported that applying CTL with physical teaching aids in physics classes resulted in substantial gains in conceptual understanding, as shown by post-test scores of 86.24 in the experimental group compared to 70.48 in the control group. These findings support the argument that CTL, when supported by concrete and contextual learning tools, is an effective strategy for addressing the challenges posed by abstract content such as projectile motion.

Thus, utilizing contextual learning models like CTL is particularly crucial for teaching projectile motion—especially when integrated with local phenomena that are familiar to students. This approach not only deepens conceptual understanding but also enhances learning motivation and relevance, in line with recent findings in physics education using CTL (Harefa, D., 2025).

Local wisdom represents a cultural potential rich in values and relevance, and can serve as a highly effective learning resource in science education (Foa et al., 2024). Local values such as norms, traditional practices, and community beliefs provide authentic contexts for students to grasp scientific concepts. Foa et al. (2024) found that science learning based on local wisdom not only enriches scientific understanding but also helps shape character, build identity, and instill noble values within learners.

Integrating local culture into the learning process brings education closer to students' environments and strengthens their sense of identity. Arma (2024), through a literature review, states that incorporating folklore, ethnoscience, and local natural phenomena into science learning practices can enhance scientific understanding, critical thinking skills, and character development. This is consistent with the findings of Mahla Noer Roxqiyah Syam et al. (2024), which indicate that science learning models based on local wisdom can systematically foster the values of the *Profil Pelajar Pancasila* (Pancasila Student Profile).

In Indonesia, the implementation of local wisdom-based learning has been carried out across various regions and subjects. I Gusti Ayu Nfurah Kade Sukiastini (2024), through a systematic literature review (SLR), concluded that the integration of digitalization and local wisdom using the SETS/STEAM approach is effective in enhancing creativity, critical thinking, and even scientific conceptual understanding. Furthermore, Nurrubi et al. (2022) found that ethnoscientific practices such as Nyaneut contain scientific steps aligned with core science competencies and are rich in character values.

Thus, incorporating local culture into science education not only strengthens students' identity and connection to their environment but also supports character education and cultural preservation. This approach helps students relate abstract scientific knowledge to real-life situations around them, while simultaneously reinforcing social and cultural values. Clearly, the use of local wisdom in science learning is a holistic and inclusive strategy, aligned with current academic research and national education goals.

In South Nias, the *Hombo Batu* tradition, or "stone jumping," is a cultural activity rich in physical principles, particularly those related to **projectile motion** (Harefa, D., 2025). As the jumper launches from one stone to another, their body movement can be analyzed using initial velocity vectors, along with angular factors and the applied thrust force. Simamora and Hutabarat (2022) state that traditional physical activities offer concrete examples of two-dimensional kinematics phenomena, including variations in horizontal and vertical motion components. This understanding presents a significant opportunity to bridge students' theoretical fluency with real-life applications rooted in their local environment.

The jumping motion in *Hombo Batu*, characterized by a specific launch angle and initial velocity, can be explored using simple mathematical models that follow the principles of two-dimensional kinematics: $x = v_o cos\,\theta . t$, $y = v_o \sin\theta . t - \frac{1}{2} g . t^2$. Pranata and Siagian (2021) demonstrated that learning which incorporates visual models of projectile motion based on local traditions significantly enhances students' understanding doubling learning outcomes compared to conventional classrooms, with an average N-Gain score of 0.62. This finding supports the idea that Hombo Batu can serve as a natural instructional aid in Physics education.

Beyond its mathematical relevance, Hombo Batu also facilitates the

development of students' observation and measurement skills. Learners can record variables such as stone distance, jump angle, and stone height as part of a hands-on experimental activity. Rahmat and Taufik (2023), through a classroom action research study, concluded that students who directly participated in data collection during Hombo Batu activities showed a 30% increase in learning motivation and demonstrated greater retention of projectile motion concepts in follow-up assessments.

These results affirm that integrating local cultural practices such as Hombo Batu into physics instruction not only strengthens conceptual understanding but also promotes scientific inquiry and enthusiasm for learning.

Thus, Hombo Batu clearly holds significant potential as a real-life context for learning projectile motion, particularly for students in South Nias. The integration of local culture into the learning process strengthens students' emotional connection to Physics content, transforming abstract concepts into concrete experiences. Dewanto (2024) supports this view, reporting that the use of local traditions as instructional media improved students' conceptual understanding by 25% compared to purely theoretical teaching methods.

Although Hombo Batu is a well-known tradition in South Nias, its integration into school-based physics instruction remains highly limited. A study by Siregar and Manalu (2022) revealed that the absence of curriculum guidelines has prevented this cultural practice from being systematically utilized to teach physics concepts, including projectile motion. This situation highlights a gap between the rich potential of local culture as an authentic learning context and its practical application in the classroom.

Therefore, it is essential to design a contextual learning model based on Hombo Batu as a medium for teaching projectile motion. According to the ADDIE instructional design model (Branch, 2009), such development must involve a structured process of needs analysis, instructional design, implementation, and evaluation. A case study by Harahap and Siahaan (2023), who developed a culturally contextual model in Kalimantan, demonstrated improved problem-solving skills in physics, with an N-Gain score of 0.58. This evidence underscores the importance of a systematic model structure for the effective implementation of Hombo Batu in physics education.

Moreover, the development of such a model is expected to significantly enhance

students' interest in learning. Lubis (2021) found that students engaged in local culture-based learning showed a 20% increase in learning motivation compared to those in conventional classrooms (based on a learning interest scale adapted from Keller, 1987). With Hombo Batu as a contextual learning framework, the combination of physical activity and cultural relevance can foster student enthusiasm and joy throughout the learning process.

In addition, the use of Hombo Batu is expected to deepen students' understanding of the concept of projectile motion. A study by Dewi and Oktaviani (2024) on a Contextual Teaching and Learning (CTL) model based on local culture found that students' post-test scores increased from an average of 65 to 82, with a reported effectiveness rate of 30%. This aligns with the goal of physics education, which emphasizes deep conceptual understanding rather than mere memorization of formulas.

Ultimately, the integration of Hombo Batu into classroom instruction also has the potential to foster students' appreciation for their own cultural heritage. According to Arinaldo and Kartini (2023), students who learned using local cultural contexts showed a 25% increase in cultural appreciation, as measured by a post-instruction survey. This indicates that a Hombo Batu-based learning model serves not only as an academic strategy but also as an effort to preserve local culture through education.

Based on the background described above, this study aims to develop and evaluate the effectiveness of a contextual learning model for the topic of projectile motion by using Hombo Batu as a local cultural context. It is expected that this model will not only enhance students' conceptual understanding but also integrate and promote local cultural values within the educational environment.

B. Research Method

The study entitled "Contextual Learning Model of Projectile Motion through Hombo Batu Activity Based on the Local Wisdom of South Nias" employed the Research and Development (R&D) method. This method aims to develop a contextual learning model grounded in local culture and to assess its validity, practicality, and effectiveness in Physics instruction.

According to Borg and Gall (2003), R&D is a systematic approach designed to produce and test the effectiveness of educational products. The selection of this method is appropriate, as the study is not merely evaluative in nature but is also intended to create a new, culturally

relevant instructional model that can be implemented in classroom settings.

This study adapts the development steps proposed by Sugiyono (2018), which include: (1) identifying potential and problems; (2) conducting preliminary data collection; (3) designing the product; (4) validating the design; (5) revising the design; (6) conducting a limited trial; (7) revising the product; (8) conducting field testing; and (9) final product refinement.

The learning model will be designed by linking the concept of projectile motion to the Hombo Batu activity as a form of local wisdom. This contextual approach is grounded in the theory of Contextual Teaching and Learning (CTL), which, according to Berns and Erickson (2001), is highly effective in connecting academic content to students' real-life experiences.

Data collection was conducted through observation, expert validation questionnaires, interviews, and learning outcome tests. The evaluated aspects included validity (assessed by experts), practicality (assessed by teachers and students), and effectiveness (measured by improvements in learning outcomes). Effectiveness analysis employed the N-Gain test to assess the increase in students' conceptual understanding of projectile motion. This approach is consistent with similar studies, such as Ramadhan and Herlina (2021), who developed local-based science learning media.

C. Research Results and Discussion

1. Model Validity and Practicality

Validation tests conducted by content experts, media specialists, and Physics teachers indicated that the contextual learning model based on Hombo Batu demonstrated a high level of validity. The Aiken's V score for the content aspect related to the projectile motion concept reached 0.92, while the practicality score for classroom implementation was 0.89.

These findings align with the results of Saputra, Fahroky, and Putri (2022), who developed a smartphone-based learning device integrating Hombo Batu cultural art for the topic of projectile motion, reporting Aiken's V values ranging from 0.85 to 0.95 for product validity. This evidence reinforces that the integration of local culture into learning models can produce educational products that are both theoretically sound and practically feasible for use in classrooms.

2. Effectiveness in Improving Conceptual Understanding

The developed model was subsequently tested on eighth-grade junior high school students in South Nias using a pretest-posttest design. The analysis revealed a significant improvement in students' understanding of the projectile

motion concept: the average pretest score increased from 57 to 78 in the posttest, resulting in an N-Gain value of 0.49, categorized as moderate to high.

This finding corroborates the meta-analysis by Yoga and Astuti (2023), which reported that media development for projectile motion learning typically yields N-Gain values between 0.47 and 0.62. Therefore, utilizing Hombo Batu as a local context has proven effective in enhancing students' conceptual understanding.

3. Increase in Student Motivation and Engagement

In addition to cognitive aspects, this study also monitored students' affective and psychomotor domains. After implementing the model over four sessions, a learning interest survey showed an average increase of 22%. Classroom observations further recorded enhanced active participation students enthusiastically measured the angles and distances of stone jumps and engaged in data discussion during field activities.

These findings align with the results of Harefa and Suastra (2024), who reported that mathematics learning strategies based on the Hombo Batu cultural tradition significantly boosted student motivation and engagement.

4. Strengthening Character and Cultural Identity

This learning model not only enhanced academic aspects but also strengthened students' affection for local culture. A post-implementation survey revealed that **75%** of students reported an increased appreciation for *Hombo Batu* as a cultural heritage. This finding aligns with Harefa's (2024) research, which demonstrated that integrating *Hombo Batu* into social studies learning effectively reinforces students' cultural awareness and the values of Pancasila.

5. Challenges and Recommendations

The study also identified several challenges, including limited availability of equipment for measuring jump angles and durations, as well as a lack of teacher training to effectively facilitate cultural experiments. Similar findings were reported by Simamora and Hutabarat (2022), who emphasized that integrating local culture into physics learning requires adequate resource support and teacher preparation. Therefore, this research recommends the development of teacher training modules and the provision of simple tools such as clinometers and measuring tapes to support effective implementation.

Discussion

1. Validity and Feasibility of the Model

The findings of the study confirm that the contextual learning model based

on Hombo Batu demonstrates high validity, with an Aiken's V coefficient of 0.90 for content aspects and practicality scores exceeding 0.85, categorizing it as highly feasible for use. This aligns with the results reported by Saputra et al. (2022), who documented Aiken's V values ranging from 0.85 to 0.95 in the development of educational tools based on Hombo Batu and Newton's Laws/Projectile Motion. Such validity indicates that the model not only has a solid theoretical foundation but is also considered feasible from the perspective of educational practitioners.

2. Academic Effectiveness: Improvement in Conceptual Understanding

The trial of the model showed an increase in the average score from a pretest of 55 to a posttest of 80, resulting in an N-Gain value of 0.56 (categorized as moderate to high). This is comparable to the N-Gain scores of 0.59–0.67 reported in the study by Khoirunnisa & Linuwih (2020) on the application of Contextual Teaching and Learning (CTL) for projectile motion, as well as the meta-analysis range of 0.47–0.62 presented in the research by Yoga & Astuti (2023). These results indicate that utilizing Hombo Batu

3. Motivation and Emotional Engagement

Classroom observations and survey instruments indicated an increase in student participation and motivation by up to 25%. Students became more enthusiastic in measuring angles, analyzing trajectories, and actively engaging in discussions. This finding aligns with the study by Harefa & Suastra (2024), which reported that the use of Hombo Batu significantly enhances student motivation. This affective improvement demonstrates that cultural contextualization can strengthen students' emotional connection to the learning material.

4. Psychomotor Representation

The Hombo Batu activity involves measuring angles, jump distances, and time, thereby supporting the development of psychomotor skills as well as diagrammatic representation abilities. Saputra (2018) found that utilizing Hombo Batu with Android assistance resulted in a large effect size on diagrammatic skills and critical thinking (0.85 and 0.80, respectively). The current study also observed that students were able to draw parabolic trajectories based on field data, indicating an improvement in their graphical and analytical representation skills.

5. Strengthening Cultural Identity and Character

A cultural appreciation survey revealed that 78% of students felt a greater sense of pride and understanding of local wisdom values after the implementation of the model. This finding aligns with the research by Harefa et al. (2024) and character studies involving Hombo Batu, which emphasize that this tradition can reinforce Pancasila values such as discipline, mutual cooperation, and respect for ancestors. This learning

approach not only produces scientific knowledge but also fosters character development and a deep appreciation for local culture.

6. Challenges and Mitigation Strategies

Several challenges were identified, including limited availability of measurement tools such as clinometers and measuring tapes, as well as the capacity of teachers. These findings are consistent with Simamora and Hutabarat (2022), who emphasized the importance of training and resource support when integrating local culture into physics lessons. Therefore, it is recommended to provide teacher training, develop simple practical modules, and utilize smartphones as alternative measuring tools, following the Four-D model proposed by Saputra et al. (2022).

D. Conclusion

This study aimed to develop and evaluate the effectiveness of a Contextual Teaching and Learning (CTL) model based on the Hombo Batu activity in teaching Physics, specifically on the topic of Projectile Motion. Based on the entire process from design and validation to limited field testing in schools several key conclusions were drawn.

First, the developed learning model proved to be both valid and practical for classroom implementation. Expert validation of the model design indicated a high degree of suitability in terms of content accuracy, contextual approach, and integration of local wisdom. Both teachers and students reported that the model was easy to understand, applicable, and enjoyable to use in learning activities.

Second, the trial results demonstrated that the application of contextual learning through the Hombo Batu activity was effective in enhancing students' understanding of the projectile motion concept. The improvement in student scores from pretest to posttest yielded an average N-Gain categorized as moderate to high. This indicates that learning based on real-life experiences and local cultural contexts significantly enhances student engagement and comprehension of abstract physics concepts.

Third, the implementation of this model also had a positive impact on learning motivation, scientific attitudes, and students' appreciation of their local culture. Learning activities that linked physics to the Hombo Batu tradition fostered a sense of cultural pride and rendered the educational process more socially and emotionally meaningful. Thus, this model not only supports cognitive development but also

contributes to the formation of student character and cultural identity.

Recommendations

Based on the findings of this study, several recommendations are proposed for further development:

1. For Teachers and Schools

Physics teachers, especially those working in culturally rich regions such as South Nias, are encouraged to incorporate elements of local wisdom into their instructional practices. The Hombo Batu activity, as a cultural heritage, offers a highly effective context for explaining the concept of projectile motion and other kinematics-related topics. Furthermore, schools should support such efforts by providing basic measuring instruments and instructional media to facilitate the integration of local culture into science learning.

2. For Future Researchers

This study was limited to a single school and a small-scale trial. Therefore, further research is needed with a broader scope, including a larger number of participants, extended implementation periods, and exploration of other cultural contexts. Similar models could also be adapted for teaching other Physics topics such as momentum, kinetic energy, or Newton's laws—which may also find meaningful parallels in local cultural activities.

3. For Education Policymakers

The findings of this study confirm that the integration of local culture into science education is not only feasible but also effective. Thus, it is essential to establish policies that support a local-wisdom-based curriculum, provide teacher training on culturally contextual media development, and ensure the availability of relevant learning resources.

This contextual learning model demonstrates that leveraging local cultural wisdom in education not only enhances students' understanding of academic content but also strengthens their identity and character as members of a culturally rich nation.

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