Aktual

OPEN ACCESS

Jurnal Pengabdian Kepada Masyarakat
https://ejournal.gomit.id/index.php/aktual

Effort to Optimize Learning Physics at Integrated Islamic High School via a Physics based Ethnoscience Approach

Irwan Koto[1*], Iwan Setiawan[2], Bodi Gunawan[3], Netriani Veminsyah Ahda[4], Tiara Hardyanti Utama[5], Klarisa Yulia Sari[6], Arthur Muhamad Taufan Herlambang[7]

[1,2,3,4,5,6,7]Universitas Bengkulu, Indonesia
✉ irwan.koto@unib.ac.id *

Article Information:
Received September 10, 2024
Revised September 23, 2024
Accepted September 27, 2024

Keywords:
Cultural Diversity;
Ethnoscience-based Learning;
Local Traditions

Abstract

The aim of community service program is to enhance the educational experience at the integrated Islamic high school (SMA IT Khairu Ummah) Rejang Lebong district by employing an ethnoscience approach. The service program is implemented in SMA IT Khairu Ummah to address challenges posed by inadequate learning facilities and infrastructure, particularly in physics education, which may impede the teaching and learning process. The implementation of community service initiatives in 2024 comprises four phases. The first phase encompasses observational efforts within schools to acquire a comprehensive picture of the educational environment. The second phase involves the socialization of service activities and coordination with school principal and educators, particularly those teaching physics. The third phase entailed instructing educators on the development of ethnoscience-focused educational resources. The last phase entails regular assessment and guidance involving two Mahasiswa Kampus Merdeka Belajar program and five physics lecturers to guarantee that the community service program positively influences the learning process. The findings indicate that the training positively enhances teacher competencies by implementing ethnoscience education that leverages the local community's cultural and traditional diversity, even amidst constraints of limited facilities and infrastructure. Physics teacher and students of SMA IT Khairu Ummah SMA IT have implemented an ethnoscience-based physics approach that is effective in enhancing students' comprehension of scientific processes and their acquisition of related skills.

A. Introduction

Ethnoscience is derived from the Greek term "ethnos," meaning nation, and the Latin term "scientia," meaning knowledge (Harefa, 2017). Ethnoscience generally denotes the knowledge held by a community or nation, examining the knowledge system and cultural perspective of a certain society while emphasizing the distinctiveness of that nation's knowledge. Ethnoscience encompasses science, agriculture, ecology, medicine, and the study of flora and fauna (Asra et al., 2021). Ethnoscience originates from indigenous knowledge acquired via experimentation and has not been formalized into scientific education (Novitasari et al., 2017).

The science education must prioritize not only scientific knowledge but also maintain a balance between traditional and scientific perspectives on humanity while fostering critical thinking to elucidate the

How to Cite : Koto, I., Setiawan, I., Gunawan, B., Ahda, N. V., Utama, T. H., Sari, K. Y., & Herlambang, A. M. T. (2024). Effort to Optimize Learning Physics at Integrated Islamic High School via a Physics based Ethnoscience Approach. *Aktual: Jurnal Pengabdian Kepada Masyarakat*, *2*(3), 143–149. https://doi.org/10.58723/aktual.v2i3.265
ISSN : 2987-6052
Published by : CV Media Inti Teknologi

distinctions between the two (Lailiyah, 2019). Moreover, the integration of students' socio-cultural contexts with the science curriculum can enhance academic performance (Mavuru & Ramnarain, 2017). In the high school learning process, one method of implementing ethnoscience physics education involves leveraging local cultural phenomena as a source or medium for instruction (Wulansari & Admoko, 2021). Physics principles, including mechanics, waves, and energy, can be elucidated through indigenous cultural or technological practices, such as the utilization of traditional musical instruments, hunting techniques, irrigation systems, or local food processing processes (Edson & Nadaraj, 2021). Ethnoscience-based education enables students to recognize the relationship between traditional knowledge and physics principles and concepts (Wardani et al., 2023), hence enhancing the meaning of their learning experience (Sholahuddin et al., 2021).

Khairu Ummah Integrated Islamic Senior High School (SMA IT Khairu Ummah), located in Teladan village, South Curup District, Rejang Lebong Regency, Bengkulu province, is an educational establishment rooted in Islamic traditions. Notwithstanding its rather constrained educational facilities and infrastructure, it excels in executing the physics learning process. The diversity of local cultures and traditions surrounding this school is both a challenge and an opportunity for enhancing students' abilities and understanding, particularly in ethnoscience-based physics education.

In addition to improving physics understanding, the ethnoscience approach also aims to preserve local culture by exploring and utilizing local wisdom in the learning process. At the same time, this integration also helps to overcome the limited facilities and infrastructure in schools that may not have full access to physics experimental equipment. Ethnoscience provides an alternative approach by utilizing the resources around students, making learning more interesting, contextual, and easy to understand.

Given this context, the application of ethnoscience-based physics education at SMA IT Khairu Ummah may address the constraints of limited facilities and infrastructure while enhancing students' competencies and knowledge. Furthermore, this ethnoscience training is anticipated to enhance the involvement of school management, encompassing teachers and principals, to ensure that learning proceeds optimally and aligns with the specific conditions of the school. Consequently, ethnoscience-oriented physics learning at SMA IT Khairu Ummah imparts scientific knowledge while simultaneously valuing and preserving culture, thereby fostering connections between science and indigenous customs. This fosters the development of a new generation that is both scientifically literate and appreciative of their cultural heritage.

B. Methods

The approach employed for executing and documenting community service projects during the 2024/2025 fiscal year is descriptive-qualitative, focusing on socialization and training in the development of physics education within an ethnoscience framework. The educational framework at SMA IT Khairu Ummah is based on the concept of local cultural wisdom, following the stages of thematic learning established by the school. The phases executed in community service initiatives in 2024 are:

Stage I: The observation was conducted to SMA IT Khairu Ummah to get a detailed description of the current condition of the school. The school information that was observed was number and capacity of classrooms, the number of students, the availability of facilities and experimental equipment for physics lessons, and the available learning media. The school profiles are represented in Table 1.

Table 1. SMA IT Khairu Ummah Profiles

No	Identity	School's Profiles
1	School Name	Khairu Ummah Integrated Islamic Senior High School
2	School Address	Jalan Padat Karya Dusun I, Dusun Teladan, Curup Selatan Subdistrict, Rejang Lebong Regency, Bengkulu Province
3	School National Code	NPS 70042675
4	School Status	Private
5	Level of Education	Senior High School
6	Ownership	Islamic Foundation
7	School Establishment Letter	377/SK/YAC/VII/2022
8	Date of School Establishment Letter	16 July 2022
9	Operational License Decision Letter	503/16.1210/4/DPMPTSP-P.1/2023
10	Date of Operational License Decision Letter	07 Agust 2023

Currently, the educational service process for the 66 students of SMA IT Khairu Ummah is conducted by 9 teachers, of which five are engaged in administrative duties. The quantities of teachers, administrative personnel, and students enrolled at SMA IT Khairu Ummah are encapsulated in Table 2.

Table 2. Overview of Teachers, Educators, and Students at SMA IT Khairu Ummah

Identity	Teacher	Administration staff	Teacher and Administration	Student
Man	1	1	2	29
Women	3	0	3	37
Total	4	1	5	66

Stage II: Collaboration and communication with the principal, educators, and particularly physics teachers (see Figure 1). This is undertaken to furnish a comprehensive overview of the steps, and facilities required for the implementation.

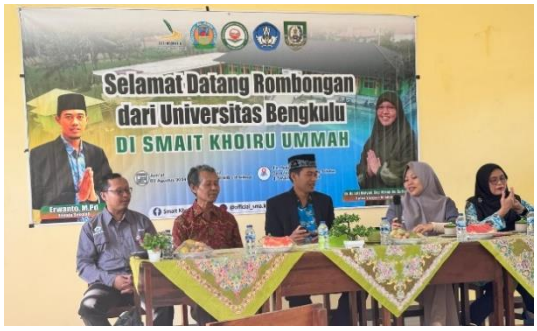

Figure 1. Meeting Team of Community Service with School Principal and Physics Teacher

Stage III. The implementation of the service involves training teachers in the development of physics educational instruments utilizing an ethnoscience approach, accompanied by the introduction of culture-based learning to high school students at IT Khairu Ummah. Lecturers in physics education, possessing expertise in imparting scientific process skills via modules and research findings, will enable the application of these skills. Physics instructors, possessing knowledge in theoretical physics and its practical applications, will promote ethnoscience education.

Figure 2. Following the Community Service Activity, Trainees Assemble for A Group Photograph

Stage IV: MBKM students and community service team periodically engage in evaluation and mentoring activities. This procedure is designed to ensure that community service activities result in substantial improvements in the learning experience. The efficacy of these activities will be evaluated based on observed alterations in student motivation and involvement in learning tasks (Figure 2)

C. Results and Discussion

The community service team utilized various approaches to gather research data and outline the community service process. The results demonstrate that the execution of physics education, employing ethnoscience-themed approaches, occurs through three principal processes: planning informed by ethnoscience observations, implementation of the plan, and subsequent assessment.

Observation in Ethnoscience-Based Planning

Observations at SMA IT Khairu Ummah revealed that the existing facilities and infrastructure were inadequate for facilitating successful physics education. Based on data for the 2023/2024 semester, none of the 16 facilities and infrastructure rooms are equipped with a laboratory. The absence of needed facilities constitutes a considerable impediment to facilitating physics practicums that depend on contemporary equipment. The ethnoscience method offers a feasible solution to enhance physics instruction for a student population of 66.

Table 3. Data on Facilities and Infrastructure of Khairu Ummah IT High School.

No	Types of Facilities and Infrastructure	2023/2024 Odd Semester.	2023/2024 Even Semester.
1	Classroom	4	5
2	Library	0	0
3	Laboratory	0	0
4	Practice class.	0	0
5	Leadership Room	1	1
6	Teachers Room.	1	1
7	Prayers Room	0	0
8	UKS Room	0	0
9	Toilet	4	6
10	Warehouse Space	0	0
11	Circulation Space	0	0
12	Sports Space	0	0
13	Administration Room	0	0
14	Counseling Room	0	0
15	OSIS Room	0	0
16	Building Space.	3	3
	Total	13	16

Implementation of Ethnoscience-Based Physics Learning

We facilitated skill development events for all educators at SMA IT Khairu Ummah utilizing presentations, discussions, and social interaction activities with kids. Subsequently, activities grounded in ethnoscience were implemented. These activities can be approached through traditional children's games, local wisdom or local art, and native musical instruments. Research conducted by Satria et al. (2022) on the

Banjarkemuning dance from Sidiarjo (East Java) integrates principles of equilibrium and center of mass. A performer of the Banjarkemuning dance must sustain equilibrium ($\sum F=0$ and $\sum \tau=0$) to avert falling.

An illustration of the socializing method utilized during community service at SMA IT Khairu Ummah is the incorporation of children's games, such as catapults (Figure 3). In ethnoscience-based learning process, teachers might utilize catapults as a medium to impart physics concepts in a more contextualized manner. Catapults, present in diverse civilizations, provide both traditional significance and serve as an exemplary demonstration of contemporary physics phenomena.

This method enables students to understand that the laws of physics extend beyond laboratory experiments and are also evident in commonplace tools and daily activities within their communities. In context of ethnoscience-based education, catapults serve as an excellent pedagogical instrument, connecting principles of physics to culturally relevant actions recognized by all leaners. Students are instructed to assemble a conventional catapult utilizing the subsequent guidelines

In context of ethnoscience-based education, catapults serve as an excellent pedagogical instrument, connecting principles of physics to culturally relevant actions recognized by all leaners. Students are instructed to assemble a conventional catapult utilizing the subsequent guidelines:

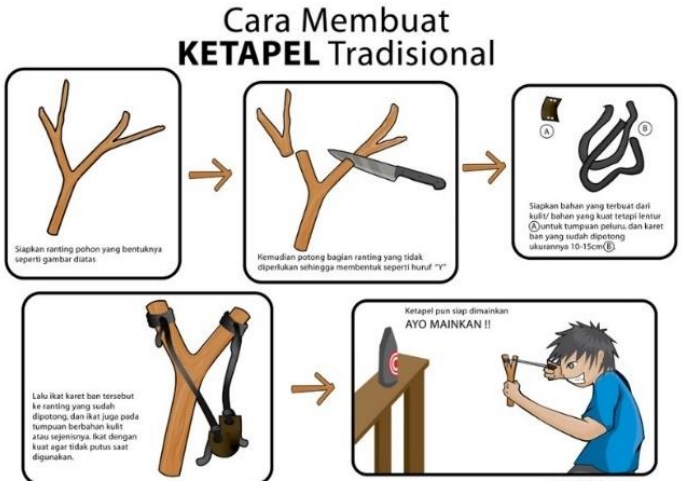

Figure 3. The Process of Making a Catapult

The catapult game is then connected to fundamental physics theories in the topics of Force and Newton's Laws, Potential and Kinetic Energy, Projectile Motion, Tension, and Elasticity (Fernández-Raga & Resines-Gordaliza, 2016). The theoretical explanation of the catapult game is as follows:

1. **Force and Newton's Laws**: A catapult utilizes force to propel an object (such as a stone). When the rubber band of the catapult is stretched, a force is exerted on the stone (Wan & Gorb, 2021). According to Newton's second law (F = ma), this force causes the stone to accelerate. Upon release of the rubber band, the stored potential force is transformed into kinetic force, launching the stone forward (Shi et al., 2018).
2. **Potential and Kinetic Energy**: Pulling back the rubber band of the catapult stores elastic potential energy (Patriot, 2019). The amount of potential energy is directly related to the distance the rubber band is stretched (Syahrial et al., 2022). When released, this stored potential energy is converted into kinetic energy, propelling the stone forward at high speed (Paasch & Paasch, 2024). This concept illustrates the principle of energy conservation, showing how potential energy is transformed into kinetic energy (Ritonga & Idris, 2017).
3. **Projectile Motion**: A catapult propels a stone in a parabolic trajectory. This motion illustrates projectile dynamics when the item traverses two dimensions influenced by gravitational force (Muliadi, 2018). In physics, students can investigate the variables affecting its motion, including launch angle and initial velocity, and their influence on the distance the stone traverses (Yuliati et al., 2020).
4. **Tension and Elasticity**: The catapult exemplifies the principles of tension and elasticity, especially concerning the rubber band (Rédei, 2020). Students can investigate the correlation between the exerted

force and the elongation of the rubber band, as delineated by Hooke's Law (Khera Ȧ et al., 2014), along with its elastic limit—the threshold at which the rubber band attains its maximum tension before rupture (Kang et al., 2017).

Upon acquiring a thorough comprehension of the ideas and engaging in practical exercises, students advance to addressing challenges associated with catapults. An illustration of this issue is: "*A catapult with a cross-sectional area of 0.1 m² possesses an initial length of 50 cm. Given an elastic modulus of the spring at 40 N/m², what is the force magnitude necessary to elongate the spring by 5 cm?"*

Evaluation of the Implementation of Ethnoscience-Based Physics Learning

The evaluation results indicated that all students exhibited enhanced grasp of scientific process skills, including conceptual knowledge procedural knowledge. Furthermore, there was a significant rise in students' excitement for learning physics after the adoption of the ethnoscience approach. In the context of physics education, we can further analyse, assess, and enhance the significant initiative of implementing ethnoscience at SMA IT Khairu Ummah. The efficacy of the learning process is not just indicated by academic performance but is also bolstered by the cultivation of students' attitudes and practical skills.

D. Conclusion

The application of the ethnoscience-based physics methodology at SMA IT Khairu Ummah has demonstrated efficacy in improving students' understanding of scientific processes and skills. By socializing and using ethnoscience-such as integrating traditional catapult games-educators have effectively connected contemporary physics concepts with local cultural activities familiar to the students. The catapult functions as an effective educational instrument for elucidating fundamental physics concepts, encompassing Newton's Laws, potential and kinetic energy, projectile motion, and the principles of tension and elasticity. Evaluation results demonstrate that students possess a heightened comprehension of physics concepts, and their excitement for the physics lesson has markedly enhanced after the implementation of the ethnoscience approach.

E. Acknowledgments

We express our profound appreciation to the Principal of SMA IT Khairu Ummah, for authorizing and facilitating the execution of this training. We offer our gratitude to all the teachers for their steadfast dedication and active involvement in the training, and to the students for their enthusiastic participation during implementation in class.

References

Asra, A., Festiyed, F., Mufit, F., & Asrizal, A. (2021). Pembelajaran Fisika Mengintegrasikan Etnosains Permainan Tradisional. *Konstan - Jurnal Fisika Dan Pendidikan Fisika*, *6*(2), 66–73. https://doi.org/10.20414/konstan.v6i2.67

Edson, M., & Nadaraj, G. (2021). Creating Indigenous Knowledge Spaces in Physics Learning Environments: Postcolonial Views and Insights from High School Physics Teachers. *Universal Journal of Educational Research*, *9*(9), 1628–1640. https://doi.org/10.13189/ujer.2021.090903

Fernández-Raga, M., & Resines-Gordaliza, J. A. (2016). Using video games, are a help to improve student's design skills? *Conference Proceeding. New Perspectives in Scienze Education*, 277–283. Google Scholar

Harefa, A. R. (2017). Pembelajaran Fisika Di Sekolah Melalui Pengembangan Etnosains. *Jurnal Warta Edisi*, *53*(1998), 1–18. https://doi.org/10.46576/wdw.v0i53.274

Kang, J., Li, K., Tan, H., Wang, C., & Cai, S. (2017). Mechanics modelling of fern cavitation catapult. *Journal of Applied Physics*, *122*(22). https://doi.org/10.1063/1.5009747

Khera Ȧ, K., Bhatia Ḃ, A., Kumar Ȧ, S., & Mahawal Ȧ, S. (2014). Design & Manufacturing of a Simple Catapult. *Research Article International Journal of Current Engineering and Technology*, *4*(6), 3810–3813. Google Scholar

Lailiyah, S. (2019). Pentingnya Membangun Pendidikan Sains. *Jurnal Kajian Pendidikan Sains*, *IV*(02), 178–187. Google Scholar

Mavuru, L., & Ramnarain, U. (2017). Teachers' knowledge and views on the use of learners' socio-cultural background in teaching natural sciences in grade 9 township classes. *African Journal of Research in Mathematics, Science and Technology Education*, *21*(2), 176–186.

https://doi.org/10.1080/18117295.2017.1327239
Muliadi, J. (2018). An empirical method for the catapult performance assessment of the BPPT-developed UAVs. *Journal of Physics: Conference Series*, *1130*(1). https://doi.org/10.1088/1742-6596/1130/1/012033
Novitasari, L., Agustina, P. A., Sukesti, R., Nazri, M. F., & Handhika, J. (2017). Fisika, Etnosains, dan Kearifan Lokal dalam Pembelajaran Sains. *Prosiding SNPF (Seminar Nasional Pendidikan Fisika)*, 81–88. https://doi.org/10.2573/snpf.v0i0.1617
Paasch, K. M., & Paasch, A. P. (2024). Estimation of catapult size and bolt dimensions by comparison of design formulae for early torsion-based catapults. *Acta IMEKO*, *13*(2), 1–8. https://doi.org/10.21014/actaimeko.v13i2.1823
Patriot, E. A. (2019). Analisis Level Pemahaman Siswa Pada Konsep Usaha Dan Energi Melalui Penerapan Pembelajaran Konseptual Interaktif Dengan Pendekatan Multirepresentasi. *Jurnal Ilmu Fisika Dan Pembelajarannya (JIFP)*, *3*(1), 34–41. https://doi.org/10.19109/jifp.v3i1.3227
Rédei, M. (2020). On the Tension Between Physics and Mathematics. *Journal for General Philosophy of Science*, *51*(3), 411–425. https://doi.org/10.1007/s10838-019-09496-0
Ritonga, D. A. A., & Idris, M. (2017). Karakteristik bahan steel 304 terhadap kekuatan impak benda jatuh bebas. *Wahana Inovasi*, *6*(2), 207–215. Google Scholar
Satria,P. A. M., Handayani, R. D., Prihandono, T., & Bachtiar, R. W. (2022). Analysis of Equilibrium Concepts at Traditional Dance of Tari Banjarkemuning, Sidoarjo as an Innovation of Physics Learning by Ethnoscience Approach. *Jurnal Penelitian Fisika Dan Aplikasinya (JPFA)*, *12*(1), 62–75. https://doi.org/10.26740/jpfa.v12n1.p62-75
Shi, Y., Shi, T., Ma, W., & Gao, C. (2018). Design and simulation of inner and outer cylinder–type steam catapult. *Advances in Mechanical Engineering*, *10*(4), 1–7. https://doi.org/10.1177/1687814018772363
Sholahuddin, A., Hayati, N., Iriani, R., Saadi, P., & Susilowati, E. (2021). Project-based learning on ethnoscience setting to improve students' scientific literacy. *AIP Conference Proceedings*, *2330*(March). https://doi.org/10.1063/5.0043571
Syahrial, A. H., Wulan Deliana, Vina Dwi Cahyani, & Ahmad Fakhri Husaini. (2022). Pembelajaran Fisika Materi Mekanika Benda Tegar: Review Media, Model, dan Metode. *Mitra Pilar: Jurnal Pendidikan, Inovasi, Dan Terapan Teknologi*, *1*(2), 119–140. https://doi.org/10.58797/pilar.0102.06
Wan, C., & Gorb, S. N. (2021). Body-catapult mechanism of the sandhopper jump and its biomimetic implications. *Acta Biomaterialia*, *124*, 282–290. https://doi.org/10.1016/j.actbio.2021.01.033
Wardani, K. S. K., Astria, F. P., & Nurwahidah, N. (2023). Development of Ethnoscience-Based Science Education Module Using a Case Based Learning Model. *Jurnal Penelitian Pendidikan IPA*, *9*(SpecialIssue), 473–478. https://doi.org/10.29303/jppipa.v9ispecialissue.6123
Wulansari, N. I., & Admoko, S. (2021). Identification of Physics Concepts in Reog Ponorogo's Dhadak Merak Dance as A Source of Learning Physics: An Analytical Study. *Berkala Ilmiah Pendidikan Fisika*, *9*(1), 105. https://doi.org/10.20527/bipf.v9i1.9862
Yuliati, L., Nisa, F., & Mufti, N. (2020). Acquisition of projectile motion concepts on phenomenon based physics' experiential learning. *Journal of Physics: Conference Series*, *1422*(1). https://doi.org/10.1088/1742-6596/1422/1/012007