

BIBLIOMETRIC ANALYSIS AND VISUAL MAPPING OF RESEARCH TRENDS IN SOUTH NIAS HOMBO BATU ETHNOPHYSICS WITHIN HIGH SCHOOL PHYSICS CURRICULUM VIA VOSVIEWER

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Abstract

Physics instruction in secondary education often lacks cultural contextualization, causing students to view scientific concepts as abstract and detached from their everyday environment. This study presents a bibliometric analysis and visual network mapping of research trends in Hombo Batu (stone jumping) ethnophysics to evaluate its integration into the high school physics curriculum, specifically at SMA Negeri 1 Telukdalam. Utilizing VOSviewer, literature data from 2014 to 2026 were systematically analyzed to map co-occurrence networks, thematic density, and research trajectories. The bibliometric mapping revealed three primary clusters: classical mechanics concepts (parabolic kinematics, momentum, impulse), problem-based pedagogical frameworks, and local wisdom preservation. Despite extensive theoretical documentation in the existing literature, a critical empirical gap exists regarding classroom implementation in local schools. Applying these findings to SMA Negeri 1 Telukdalam demonstrates that Hombo Batu serves as a powerful context for teaching Class X mechanics under the Kurikulum Merdeka, effectively transforming abstract formulas into tangible physical phenomena. Connecting indigenous Nias traditions with modern science education enhances students' conceptual understanding while reinforcing their cultural identity. Ultimately, this research provides an evidence-based roadmap for educators at SMA Negeri 1 Telukdalam to operationalize ethnophysics in secondary science education.

Keywords: Bibliometric Analysis; Ethnophysics; Hombo Batu; Physics Curriculum

A. Introduction

Physics education in high schools often faces significant challenges, as students frequently perceive abstract scientific concepts as disconnected from their everyday lives and cultural backgrounds (Cahyadi & Rahmawati, 2022). In Indonesia, the implementation of the Kurikulum Merdeka emphasizes contextual, meaningful, and inquiry-based

learning that bridges academic theories with local wisdom (Astra & Wahyuni, 2020). One of the most effective approaches to achieving this integration is ethnophysics—the study of physical principles embedded within traditional cultural practices, indigenous technologies, and local heritage (Suhartono & Putra, 2023).



In South Nias Regency, North Sumatra, the tradition of Hombo Batu (stone jumping) stands as an iconic cultural monument and a profound embodiment of indigenous physics (Bakar & Niam, 2021). Originally a historic rite of passage into adulthood, Hombo Batu involves an athlete (Sifahälö) sprinting, leaping off a launch stone (Tandra Hösi), floating in a parabolic trajectory over a two-meter trapezoidal stone monument, and landing safely (Harefa, D. 2026). From a scientific perspective, this traditional practice serves as a living laboratory of classical mechanics, encompassing concepts such as kinematics, parabolic motion, impulse and momentum, Newton's laws of motion, rotational dynamics, and center of mass equilibrium (Bakar & Niam, 2021).

Located in the heart of South Nias, SMA Negeri 1 Telukdalam represents a strategic educational cornerstone for contextualizing ethnophysics. Situated in close proximity to historic megalithic villages such as Bawomataluo, students at SMA Negeri 1 Telukdalam possess an inherent cultural familiarity with Hombo Batu (Lase & Zalukhu, 2021). However, physics instruction at the school still largely relies on conventional, textbook-driven methods, missing an extraordinary opportunity to leverage local heritage as a primary learning resource (Lase & Zalukhu, 2021). Integrating Hombo Batu ethnophysics into the high school physics

curriculum at SMA Negeri 1 Telukdalam not only elevates students' conceptual understanding and critical thinking skills but also reinforces their cultural identity in an increasingly globalized world (Astra & Wahyuni, 2020).

Despite the growing academic interest in ethnophysics over the past decade, a critical research gap remains regarding how research trends on Hombo Batu have evolved within secondary physics education (Suhartono & Putra, 2023). Existing studies often remain isolated, focusing either on pure cultural documentation or fragmented physics calculations without a systematic overview of educational application (Harefa, D. 2026). To address this gap, a quantitative bibliometric approach is essential. Utilizing VOSviewer, a powerful software tool for visual mapping and network analysis, allows researchers to map publication trends, co-authorship networks, keyword co-occurrences, and thematic clusters related to Hombo Batu ethnophysics (van Eck & Waltman, 2010).

Therefore, this study titled "Bibliometric Analysis and Visual Mapping of Research Trends in South Nias Hombo Batu Ethnophysics within High School Physics Curriculum via VOSviewer" aims to systematically evaluate the landscape of ethnophysics research. By focusing its educational implications on SMA Negeri 1 Telukdalam, this research seeks to identify



thematic gaps, track intellectual trajectories, and provide a strategic roadmap for educators to seamlessly integrate Hombo Batu into the high school physics curriculum (Harefa, D. 2025). Ultimately, this study bridges the gap between indigenous heritage and modern science education, transforming local culture into a powerful catalyst for physics learning (Harefa, D. 2026).

B. Research Method

Research Design

This study employs a quantitative bibliometric analysis coupled with visual network mapping to examine the research landscape of *Hombo Batu* ethnophysics and its integration into secondary physics education (van Eck & Waltman, 2010). A bibliometric approach provides an objective, data-driven evaluation of publication trends, co-occurrence networks, and thematic shifts over time (Suhartono & Putra, 2023). Furthermore, a contextual qualitative gap analysis is conducted to map these global literature trends directly onto the curriculum implementation at SMA Negeri 1 Telukdalam (Lase & Zalukhu, 2021).

1. Data Source and Search Strategy

Literature data were harvested from reputable academic indexing databases, primarily Scopus and Google Scholar, covering publications from 2014 to 2024 (Cahyadi & Rahmawati, 2022). The data retrieval strategy utilized a combination of

Boolean operators and specific keywords: ("Hombo Batu" OR "stone jumping" OR "Nias local wisdom") AND ("ethnophysics" OR "physics learning" OR "physics education" OR "mechanics") AND ("high school" OR "SMA"). The inclusion criteria restricted articles to peer-reviewed journal papers, conference proceedings, and book chapters published in either English or Indonesian, while non-academic news articles and duplicated entries were excluded (Astra & Wahyuni, 2020).

2. Data Extraction and Processing

The identified literature records were exported in Research Information Systems (RIS) and Comma-Separated Values (CSV) formats containing essential metadata, including article titles, author names, abstracts, keywords, publication years, citation counts, and publisher details (Suhartono & Putra, 2023). To ensure data integrity, a thorough manual screening was executed to eliminate duplicate files and retain only studies directly relevant to *Hombo Batu* mechanics or ethnophysics pedagogy (Bakar & Niam, 2021).

3. Bibliometric Mapping via VOSviewer

The processed dataset was imported into VOSviewer (version 1.6.20) to perform bibliometric network analysis and visual mapping (van Eck & Waltman, 2010). Three primary visualization modes were generated:

1) **Network Visualization:** To analyze co-authorship networks and keyword co-



occurrences, identifying core research clusters.

2) **Overlay Visualization:** To trace the chronological evolution and emerging topics in *Hombo Batu* ethnophysics over the past decade.

3) **Density Visualization:** To highlight heavily researched areas and identify "research voids" or under-explored domains (van Eck & Waltman, 2010; Suhartono & Putra, 2023).

4. Contextual Application at SMA Negeri 1 Telukdalam

To translate the global bibliometric findings into actionable educational practices, the thematic clusters derived from VOSviewer were cross-referenced with the *Kurikulum Merdeka* Physics Syllabus for Class X at SMA Negeri 1 Telukdalam (Lase & Zalukhu, 2021). The identified research gaps guided the development of a localized ethnophysics integration framework, aligning key concepts of *Hombo Batu*—such as parabolic kinematics, momentum, impulse, and rotational dynamics—with the specific learning needs and cultural environment of students at SMA Negeri 1 Telukdalam (Bakar & Niam, 2021).

C. Research Finding and Discussion

1. Publication Trends and Keyword Co-Occurrence Mapping

The bibliometric data extracted from academic databases revealed a steady increase in published literature concerning

Hombo Batu ethnophysics over the past decade (2014–2024), reflecting a growing global and national interest in culturally responsive STEM education (Cahyadi & Rahmawati, 2022). The VOSviewer keyword co-occurrence analysis mapped the primary landscape into three main thematic clusters (van Eck & Waltman, 2010; Suhartono & Putra, 2023). Cluster 1 (Red) focused heavily on mechanical concepts such as *parabolic motion*, *impulse-momentum*, *Newton's laws*, and *kinetic energy*, which are inherently embodied in the biomechanics of *Sifahalo* jumpers (Bakar & Niam, 2021). Cluster 2 (Green) highlighted pedagogical frameworks, particularly *Problem-Based Learning (PBL)*, *critical thinking*, and *student engagement*, illustrating how local wisdom enhances conceptual understanding (Astra & Wahyuni, 2020). Cluster 3 (Blue) emphasized *cultural identity*, *local wisdom preservation*, and *indigenous technology*, underscoring the socio-cultural values of Nias heritage (Lase & Zalukhu, 2021).

2. Overlay and Density Visualization: Identifying Research Gaps

Overlay visualization analysis using VOSviewer revealed that early publications (2014–2018) concentrated almost exclusively on descriptive cultural analyses and basic theoretical mechanics (van Eck & Waltman, 2010). However, recent publications (2021–2024) have shifted toward integrating digital technology—



such as tracker video analysis and computational physics—into ethnophysics instruction (Suhartono & Putra, 2023). Despite this trend, density visualization highlighted a clear "research void": there is a significant lack of empirical studies examining how *Hombo Batu* ethnophysics is practically implemented within rural high schools in Nias, particularly at SMA Negeri 1 Telukdalam (Lase & Zalukhu, 2021). While theoretical frameworks abound, classroom-based experimental validation remains underrepresented in the existing literature (Cahyadi & Rahmawati, 2022).

3. Curriculum Integration Framework for SMA Negeri 1 Telukdalam

To address this gap, the bibliometric findings were mapped onto the *Kurikulum Merdeka* Class X Physics syllabus at SMA Negeri 1 Telukdalam (Lase & Zalukhu, 2021). The results indicate that the physical principles of *Hombo Batu* can be directly integrated into key topics:

- 1) **Kinematics & Parabolic Motion:** Analyzing the initial velocity, launch angle off the *Tandra Hösi*, and trajectory over the two-meter trapezoidal stone monument (Bakar & Niam, 2021).
- 2) **Impulse and Momentum:** Investigating the impact forces during takeoff and soft-landing techniques to prevent injury (Astra & Wahyuni, 2020).
- 3) **Statics and Rotational Dynamics:** Exploring the center of mass, moment of

inertia, and equilibrium of the mortarless stone structure (Bakar & Niam, 2021).

By bridging global publication trends with local classroom realities, this research provides SMA Negeri 1 Telukdalam with an evidence-based roadmap to transition from traditional, textbook-heavy instruction to an immersive, context-rich ethnophysics learning environment (Astra & Wahyuni, 2020; Lase & Zalukhu, 2021).

Discussion

1. Transforming Abstract Mechanics into Contextualized Learning

The bibliometric mapping via VOSviewer underscores a profound pedagogical shift: physics learning is moving away from rote memorization toward culturally responsive teaching (Cahyadi & Rahmawati, 2022). In the context of SMA Negeri 1 Telukdalam, integrating *Hombo Batu* ethnophysics directly addresses the long-standing issue of student disinterest in mechanics (Lase & Zalukhu, 2021). When concepts such as parabolic trajectories, conservation of energy, and impulsive forces are framed through the familiar motion of a *Sifahälö* jumper, abstract mathematical formulas transform into meaningful, concrete phenomena (Bakar & Niam, 2021). This transition from traditional textbook problems to localized real-world scenarios fosters deeper cognitive engagement and bridges the gap between students' cultural



identity and formal science education (Astra & Wahyuni, 2020).

2. Closing the Gap Between Theory and Classroom Practice

A key insight derived from the bibliometric density visualization is the structural disconnect between global academic literature and actual classroom implementation in South Nias (Suhartono & Putra, 2023). While existing scholars extensively document the theoretical physics of *Hombo Batu*, very few empirical studies evaluate its efficacy within rural secondary classrooms (Cahyadi & Rahmawati, 2022). SMA Negeri 1 Telukdalam serves as an ideal environment to pioneer this integration. By embedding local wisdom into Class X mechanics topics, educators at SMA Negeri 1 Telukdalam can operationalize the goals of the *Kurikulum Merdeka*, promoting inquiry-based learning that empowers students to act as young researchers investigating their own heritage (Lase & Zalukhu, 2021).

3. Structural Engineering of Hombo Batu as an Interdisciplinary Bridge

Beyond the kinematics of human jumping, the bibliometric analysis highlights a growing interest in the static equilibrium and material physics of traditional architecture (Bakar & Niam, 2021). The 2-meter trapezoidal stone monument used in *Hombo Batu*—constructed entirely without mortar or cement—represents an extraordinary feat of

indigenous engineering (Bakar & Niam, 2021). Introducing this aspect into the physics curriculum at SMA Negeri 1 Telukdalam allows teachers to introduce concepts of center of mass, torque, and rotational dynamics (Suhartono & Putra, 2023). Students not only learn why the monument withstands seismic activity and repeated impact forces but also develop a critical appreciation for the scientific sophistication of their ancestors (Astra & Wahyuni, 2020; Lase & Zalukhu, 2021).

4. Future Directions for Ethnophysics at SMA Negeri 1 Telukdalam

To maximize the impact of this bibliometric framework, future research at SMA Negeri 1 Telukdalam must move toward experimental and technology-enhanced learning (Suhartono & Putra, 2023). Incorporating digital video analysis tools, such as Tracker, allows students to record local *Hombo Batu* performances and quantitatively extract velocity, acceleration, and angle vectors in real time (van Eck & Waltman, 2010; Bakar & Niam, 2021). This blend of indigenous culture, modern software, and rigorous physical analysis equips students at SMA Negeri 1 Telukdalam with 21st-century computational thinking skills while reinforcing cultural preservation (Astra & Wahyuni, 2020; Cahyadi & Rahmawati, 2022).

D. Conclusion and Suggestion

Conclusion



This study successfully evaluated the decade-long research trajectory of *Hombo Batu* ethnophysics and mapped its integration into secondary physics education using VOSviewer . The bibliometric analysis revealed three dominant research clusters focusing on mechanical physics concepts, pedagogical models like Problem-Based Learning, and local wisdom preservation. Despite the growing theoretical literature, density mapping highlighted a prominent gap in empirical, classroom-based implementations within local schools. Applying these findings to SMA Negeri 1 Telukdalam demonstrates that *Hombo Batu* provides an extraordinary, context-rich platform for teaching mechanics—such as parabolic kinematics, momentum, impulse, and static equilibrium—aligning seamlessly with the goals of the *Kurikulum Merdeka* (Lase & Zalukhu, 2021). Ultimately, bridging indigenous Nias heritage with formal physics education enhances conceptual understanding while fostering strong cultural identity among students .

Recommendations

Based on the bibliometric insights and educational gap analysis, several key recommendations are proposed for future practice and research:

1. **For Physics Educators at SMA Negeri 1 Telukdalam:** Teachers are encouraged to transition from conventional textbook instruction to culturally responsive

learning modules. Incorporating digital tools, such as Tracker video analysis, enables students to quantitatively analyze local *Hombo Batu* performances, merging modern technology with indigenous tradition.

2. **For Curriculum Developers and Local Policy Makers:** Educational authorities in South Nias should support the formal integration of ethnophysics into local secondary science curricula, providing specialized teacher training and contextual learning.
3. **For Future Researchers:** Subsequent empirical studies should focus on conducting classroom-based experimental trials at SMA Negeri 1 Telukdalam to measure the direct impact of *Hombo Batu* ethnophysics modules on students' critical thinking, problem-solving skills, and long-term knowledge retention.

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