

Ethnomathematical Analysis of the Menggelek Tobu Activity: Mathematical Modeling of Cylindrical Rotation in Malay Kuok Cultural Practices

Hanifatul Rahmi^{1*}, Hasnah Faizah², Mahdum³, Hermandra⁴, Elmustian⁵

¹Institut Teknologi dan Bisnis Riau Pesisir

^{2,3,4,5}Universitas Riau

Corresponding Author: Hanifatul Rahmi hanifatul.rahmi6332@grad.unri.ac.id

ARTICLE INFO

Keywords: Ethnomathematics, Menggelek Tobu, Rolling Resistance, Rotational Motion, Mathematical Modelling

Received : 15 March

Revised : 25 April

Accepted: 30 May

©2026 Rahmi, Faizah, Mahdum, Hermandra, Elmustian: This is an open-access article distributed under the terms of the [Creative Commons Attribution 4.0 International](https://creativecommons.org/licenses/by/4.0/).



ABSTRACT

This study aims to analyze the mathematical and mechanical concepts embedded in a Malay Kuok cultural activity known as Menggelek Tebu. The research employed an analytical-conceptual study approach based on field observations through observation, documentation, interviews, and simple measurements of the sugarcane rolling activity. The findings indicate that the Menggelek Tobu activity involves concepts of cylindrical geometry, translational-rotational relationships, mechanical energy, and rolling resistance. Sugarcane stems were modeled as cylinders undergoing rolling motion without slipping, characterized by the mathematical relationships: $s=r\theta$ Motion resistance was analyzed using the rolling resistance model: $F_r=C_{rr}\times mg$ which is more appropriate than the kinetic friction model. The analysis results demonstrate that the rolling method is significantly more efficient than dragging because rolling resistance is substantially smaller than kinetic friction. This study extends previous ethnomathematics research, which was primarily limited to the exploration of geometric forms and traditional cultural aspects. The findings support the development of contextual mathematics and physics learning based on local cultural practices

INTRODUCTION

Ethnomathematics is an approach that views mathematics as a cultural product inseparable from the social practices of society. D'Ambrosio explains that mathematical ideas such as counting, measuring, modeling, and explaining develop through human experiences in responding to their environment (Rosa & Orey, 2020). This perspective enables local cultural practices to be studied as contextual sources of mathematics learning that can bridge students' understanding between formal school concepts and real-life societal practices (Silalahi et al., 2025). Through ethnomathematical studies, local wisdom values can be integrated into the curriculum to enhance educational relevance while simultaneously preserving cultural identity (Fatmawati et al., 2026).

One of the cultural practices of the Kampar Malay community, particularly the Ocu people in the Kuok region, is the tradition of Menggelek Tobu or Manggelek (Febrian & Astuti, 2023). This tradition involves crushing sugarcane using a traditional wooden rolling device to extract sugarcane juice, which is then processed into nisan (traditional palm sugar). Socially, this activity is carried out collectively through cooperation and serves as an important medium of social interaction within the local community (Astuti et al., 2023). Over time, this tradition has also transformed into one of the cultural tourism icons of Pulau Belimbing. Previous studies have attempted to explore ethnomathematical elements embedded in traditional technologies in Kampar Regency. Astuti et al. identified concepts of two-dimensional and three-dimensional geometry, angles, and geometric transformations within the structure of the traditional sugarcane crusher (Zulfah et al., 2022). However, these studies have generally remained descriptive and limited to the identification of static geometric forms. In fact, the Menggelek Tobu activity contains more complex dynamic mathematical dimensions, ranging from traditional measurement systems used to determine the maturity of nisan to estimating the volume of sugarcane juice based on the quantity of raw materials (Fatmawati et al., 2026).

The current research gap lies in the absence of studies employing rotational mechanics and energy optimization approaches to analyze the rolling process of the wooden device. Previous explanations have tended to equate motion resistance with ordinary kinetic friction, whereas in the dynamics of rolling without slipping, the primary resistance acting on the system is rolling resistance (Hierrezuelo & Ruiz, 1995; Mungan, 2021). The efficiency of the rolling method compared to dragging can be mathematically modeled through the rolling resistance equation: $F_r = C_{rr} m g$. Represents the rolling resistance coefficient, whose value is significantly lower than the coefficient of kinetic friction (Mungan, 2021). This model not only provides a physical explanation for the efficiency of traditional technology but also offers innovative and applicable learning materials for mathematics and physics education (Padang, 2023).

Based on this background, this study aims to conduct a more holistic exploration focusing on:

1. Identifying mathematical concepts (geometry and measurement systems) embedded in the Menggelek Tobu activity.

2. Developing a mathematical model of sugarcane rolling motion based on rotational mechanics.
3. Analyzing energy efficiency through the concept of rolling resistance to demonstrate the superiority of this traditional technology.
4. Exploring the implications of the findings as a source of mathematics and physics learning based on local wisdom.

LITERATURE REVIEW

Ethnomathematics is a field of study that examines the relationship between mathematics and culture by viewing mathematics as a product of human activity that develops within specific social contexts (Rosa & Orey, 2020). D'Ambrosio defines ethnomathematics as the practices of cultural groups in carrying out mathematical activities such as counting, measuring, and modeling everyday reality (D'Ambrosio, 1985). The application of this approach in formal education promotes culturally responsive learning, enabling students to connect abstract mathematical concepts with local wisdom, such as the Menggelek Tobu tradition in Pulau Belimbing, Kampar Regency (J. Ningsih et al., 2024; Sandi, 2025). This tradition, which has existed since the eighteenth century, is not merely a process of sugar production but also a medium of social interaction and intergenerational cooperation that requires collective physical coordination (Kadir et al., 2023; J. Ningsih et al., 2024). The "Gelek Tobu" tool used in this tradition consists of several main components, including a large wooden cylinder functioning as a grinding roller, a supporting base, and a structural frame. Previous studies conducted by Astuti and colleagues identified various static geometric elements in the construction of this tool, such as circles in the roller cross-section, squares in the supporting pillars, triangles in the water channels, and cylinders as the primary three-dimensional form of the grinder. Furthermore, concepts of angles and translational motion were also observed when the tool was pushed linearly by the community members. However, these investigations remained largely descriptive and recommended deeper exploration to reveal more complex mathematical and physical principles suitable for higher levels of education (Astuti et al., 2023).

From a mechanics perspective, the Menggelek Tobu activity demonstrates the principle of rolling without slipping, which combines rotational and translational motion (Hierrezuelo & Ruiz, 1995; Martens et al., 2007). The efficiency of this traditional technology can be explained through the concept of rolling resistance, in which the resistance experienced by wooden cylinders is significantly smaller than the coefficient of kinetic friction found in dragging methods (Arwanto, 2017; Mungan, 2021). The knowledge of the Melayu Kuok community in optimizing human energy through rolling techniques reflects a sophisticated form of ethnoscience grounded in practical energy calculations. Therefore, integrating this tradition into the school curriculum is highly relevant for teaching topics such as geometry, torque, and the law of conservation of energy, while simultaneously enhancing students' scientific literacy and strengthening their cultural identity (Abbas & Zamrotin, 2024; Sianipar & Silalahi, 2025).

METHODOLOGY

This study employed a qualitative approach with an ethnographic design to explore in depth the mathematical and physical practices embedded within local cultural traditions (Sari et al., 2022; Sholahuddin & Admoko, 2021). The ethnographic method was selected because it enables researchers to investigate cultural phenomena from the participants' perspectives while identifying the intuitive mathematical reasoning underlying the traditional Menggelek Tobu technology (Arifudin et al., 2021; Fitri & Fathurohman, 2025). The research was conducted on February 14, 2026, within the Melayu Kuok community in Kampar Regency, Riau, particularly in areas that continue to preserve the Menggelek Tobu tradition, such as Pulau Belimbing. The main research participant was Mr. Syarkawi, a cultural figure and manager of the Kandil Kemilau Emas Museum. As a native member of the Kuok community in Kampar Regency, he possesses extensive knowledge and a deep understanding of the Manggelek Tobu (Sugarcane Rolling) tradition. The participant was selected purposively due to his cultural expertise, long-term involvement in preserving the tradition, and comprehensive understanding of the historical, social, and technical aspects of the practice.

Data collection was carried out through three primary techniques to ensure the depth and validity of the findings. First, participatory observation was conducted by directly engaging in the sugarcane rolling process to observe the dimensions of the equipment, the mechanics of movement, and the social interactions occurring during the activity (Fatmawati et al., 2026; Puspitarani, 2025). Particular attention was given to measuring the physical characteristics of the tool, including its diameter, length, and wooden mass, as well as the technical aspects of the rolling mechanism. Second, in-depth interviews were conducted with the participant to explore his understanding of traditional measurement systems, estimations of production outcomes, and the rationale for selecting rolling methods over other transportation techniques (Langtang & Mataubenu, 2020). Third, documentation in the form of video recordings and photographs was used as primary data for rotational motion analysis and mathematical modeling (Sa'diyah et al., 2024). These visual records enabled frame-by-frame analysis to calculate angular velocity and displacement during the rolling process.

The principal research instrument was the researcher as a human instrument, supported by interview guidelines, observation sheets, mechanical measuring tools such as measuring tapes and weighing scales, and motion analysis software used to verify the developed mathematical models. Data analysis was conducted systematically through several stages. Initially, data reduction was performed by selecting information relevant to geometry, traditional measurement systems, and motion mechanics (Fatmawati et al., 2026). Subsequently, mathematical modeling was carried out by converting observational data into dynamic mathematical representations. This process included calculating the moment of inertia of the wooden cylinder, analyzing forces under rolling without slipping conditions, and determining energy efficiency through the rolling resistance coefficient (Halliday et al., 2013; Jewett

& Serway, 2008). The analyzed data were then presented in descriptive narratives, comparative energy tables, and graphical models illustrating the rotational movement of the rolling device (Fatmawati et al., 2026). Finally, conclusions were drawn by synthesizing the ethnomathematical and ethnophysical findings to formulate their implications for teaching topics such as geometry, torque, and work-energy concepts (Kyeremeh et al., 2023; Pramana & Zamaya, 2021).

To ensure the trustworthiness of the findings, the study applied source and technique triangulation by comparing interview data across different observations and matching field findings with theoretical physics models (Fatmawati et al., 2026). In addition, member checking was conducted by presenting the analytical results back to Mr. Syarkawi to confirm that the researchers' interpretations accurately reflected the cultural meanings and practices of the local community (Fatmawati et al., 2026).

RESULT AND DISCUSSION

The findings of this study reveal that the Menggelek Tobu tradition practiced by the Melayu Kuok community in Kampar Regency represents not only a cultural activity but also an integrated manifestation of mathematical reasoning, physical principles, and social values embedded within local wisdom. Based on field observations conducted on February 14, 2026, the activity of moving and grinding sugarcane involves the use of a large wooden rolling instrument (golekan) operated collectively by community members. This process reflects a strong tradition of mutual cooperation (gotong royong), in which work efficiency is achieved through both social coordination and mechanical effectiveness simultaneously (Astuti et al., 2023). In line with the ethnomathematical perspective proposed by Pereira et al. (2020), this practice demonstrates that mathematical ideas within traditional societies emerge from practical needs to manage physical reality efficiently.

Field measurements indicated that the rolling instrument can be modeled geometrically as a cylindrical object. The wooden roller used in the tradition had a length of 2.5 meters, a diameter of 0.12 meters, a radius of 0.06 meters, and an estimated mass of 5 kilograms. These dimensions confirm the existence of fundamental geometric concepts embedded within the traditional technology, supporting previous findings by Astuti et al. (2023) regarding the presence of geometric forms in Kampar cultural artifacts. The volumetric capacity of the cylinder can be represented using the standard cylinder volume equation: $V = \pi r^2 L$.

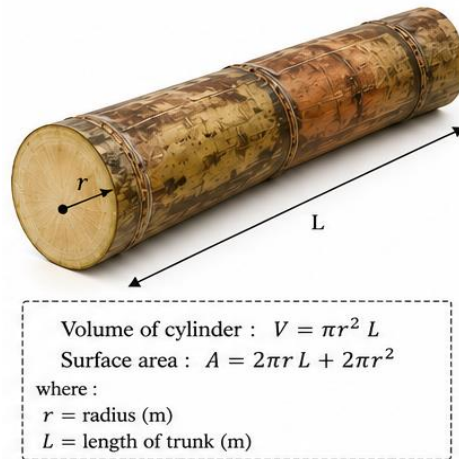


Figure 1. Cylindrical Model of Sugarcane Trunk

Figure 4.1 illustrates a mathematical model of a sugarcane trunk represented as a three-dimensional cylinder. In the figure, the trunk is characterized by its radius (r), which is measured from the center to the outer surface of the circular base, and its length (L), which represents the height of the cylinder. This modeling approach simplifies the natural shape of the sugarcane into a well-defined geometric form, making it easier to analyze using mathematical concepts. Through this representation, the physical properties of the sugarcane can be studied more systematically. Additionally, the figure presents the formulas for the volume and surface area of a cylinder, namely $V = \pi r^2 L$ and $A = 2\pi r L + 2\pi r^2$. The volume is used to determine the capacity or internal space of the sugarcane trunk, while the surface area relates to the outer part that interacts with the environment, such as in processes involving contact or friction. This demonstrates that mathematical concepts are not merely abstract, but can be directly applied to understand real-world objects like a sugarcane trunk. where r represents the radius of the circular base and L represents the length of the sugarcane trunk. This formula allows us to estimate the physical capacity or size of the trunk, which can be useful in agricultural contexts such as measuring yield or storage.

The use of cylindrical structures in the golek community demonstrates the community's intuitive understanding of spatial geometry and mechanical practicality. Beyond identifying static geometric forms, the findings further reveal that the community possesses practical knowledge related to the relationship between shape, motion, and efficiency. Observations of the rolling process on dry ground showed a precise relationship between translational and rotational motion. With a radius of 0.06 meters, one complete rotation of the wooden cylinder produced a linear displacement of approximately 0.377 meters. The motion follows the kinematic relationship: $s = r \theta$



Figure 2. Rolling Sugarcane Activity (Geometric Overlay)

These results indicate that the effectiveness of linear movement directly depends on the physical dimensions of the rolling instrument selected by the community. This finding aligns with classical mechanics principles concerning rolling motion without slipping (Ellis-Robinson & Coles, 2021; Hierrezuelo & Ruiz, 1995). More importantly, it suggests that the Melayu Kuok community has long applied practical mechanical reasoning in designing tools that optimize movement efficiency. The study also identified the significant role of rolling resistance in explaining the effectiveness of the Menggelek Tobu technique. Using an estimated rolling resistance coefficient of 0.02 (Mungan, 2012; Wulan et al., 2021), the resisting force acting on the rolling cylinder was calculated using the equation: $F_r = C_{rr} m g$. The illustration works against rolling resistance in the below:

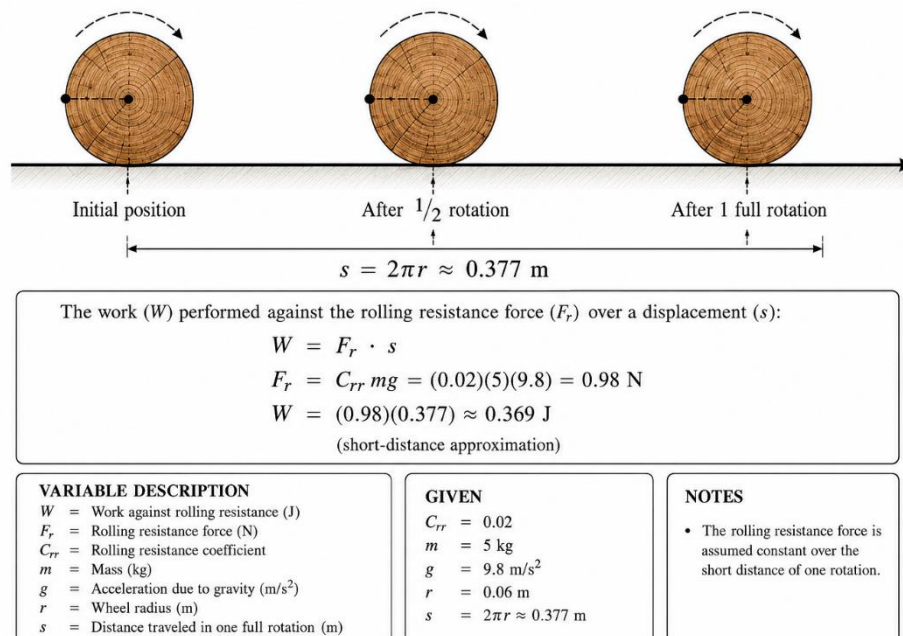


Figure 3. Illustration of works against rolling resistance

Substituting the measured parameters into the equation produced a rolling resistance force of approximately 0.98 N. In contrast, if the same 5-kilogram object were dragged across the surface using kinetic friction with an

estimated coefficient of friction of 0.3, the resisting force would reach approximately 14.7 N. This comparison demonstrates mathematically that the rolling method is nearly fifteen times more efficient than dragging. Such findings provide strong evidence that the community's preference for rolling techniques is not accidental but reflects an empirically developed understanding of energy conservation and mechanical efficiency (Jusmaniar et al., 2024; Minkin, 2026; Nursyahfira et al., 2023). Energy optimization in the activity of rolling sugarcane can be understood through several interconnected principles. First, using rolling motion instead of dragging reduces contact friction with the ground, resulting in lower resistance and less energy consumption. A smoother and flatter surface also minimizes the rolling resistance coefficient (C_{rr}), making the movement more energy-efficient. In group activities, coordinated and synchronized pushing helps maintain stable rotation and reduces unnecessary energy loss caused by unbalanced motion. The cylindrical shape of the sugarcane or log further supports efficient movement because it distributes weight evenly and allows easier rotational motion, representing a natural form of mechanical optimization found in local cultural practices. Additionally, controlling the rotational speed is important because excessively fast movement can increase instability and additional friction, whereas steady motion conserves energy more effectively. From an ethnomathematical perspective, traditional communities have intuitively applied the principle of energy optimization through cultural experience by choosing to roll heavy objects rather than drag or lift them. This demonstrates that local cultural practices inherently contain mathematical and physical concepts related to work efficiency, force minimization, and energy optimization.

Theoretically, this study extends ethnomathematics research beyond the identification of static geometric elements toward the exploration of dynamic mechanical principles embedded within cultural practices. Previous studies primarily focused on visual geometric forms found in traditional tools (Asma & Kadir, 2022; Astuti et al., 2023). In contrast, the present study demonstrates that the Menggelek Tobu tradition also incorporates concepts of rotational dynamics, translational motion, force analysis, and energy optimization. This contribution is consistent with D'Ambrosio's perspective that ethnomathematics encompasses broader processes of measuring, modeling, explaining, and solving problems within cultural contexts. The Melayu Kuok community not only recognizes cylindrical forms but also understands the causal relationship between cylinder radius, applied force, and energy efficiency. Consequently, mathematical knowledge within this cultural setting appears holistic and integrated rather than fragmented into separate academic disciplines. Overall, the framework demonstrates how ethnomathematics serves as a bridge between culture and mathematics, enabling students to construct mathematical knowledge through meaningful, real-life cultural experiences.

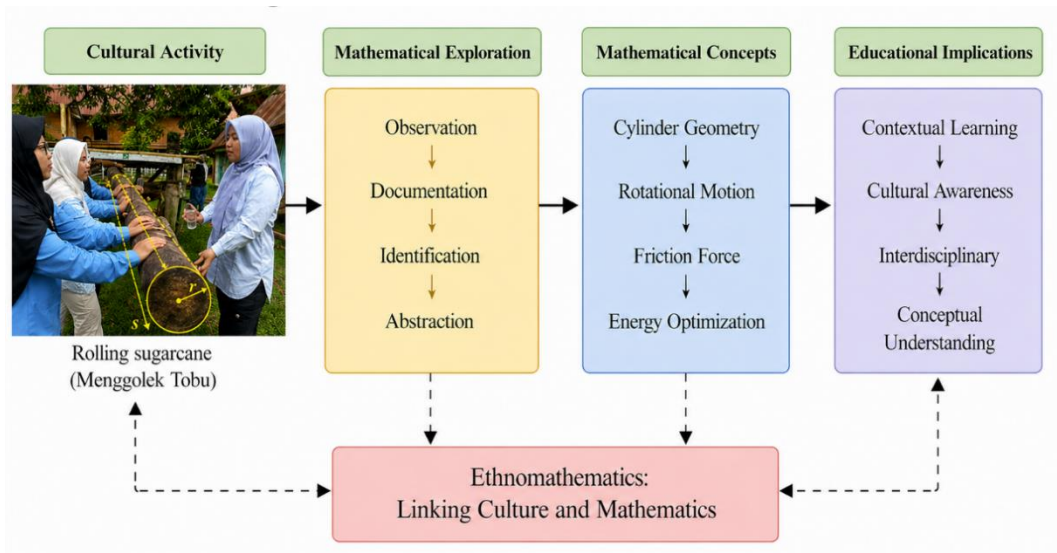


Figure 4. Rolling Sugarcane Research Framework

Another important finding concerns the ethno-physical dimension of the tradition. The community's intuitive understanding of rolling resistance reflects practical knowledge comparable to concepts formally discussed in modern tribology and mechanics. Similar conclusions have been reported in studies of traditional Indonesian agricultural technologies, where communities unconsciously apply physical principles in labor and energy optimization (Chaniago, 2023; Nurianti et al., 2023; Pertiwi et al., 2022). The consistency of these findings across different cultural contexts suggests that traditional societies develop systematic scientific knowledge through prolonged empirical experience with natural environments.

In addition to its mechanical and mathematical dimensions, the Menggelek Tobu tradition also embodies strong social and cultural values. The collective participation involved in rolling and grinding sugarcane reflects social solidarity, intergenerational cooperation, and the preservation of communal identity (Manarfa & Lasaiba, 2024; A. G. Ningsih et al., 2024). From an ethnomathematical perspective, this demonstrates that mathematical practices are not purely individual cognitive activities but also collective social processes shaped by communication, coordination, and shared cultural norms. This interpretation aligns with Rosa and Orey's conception of ethno as encompassing language, symbols, behaviors, traditions, and social practices within cultural groups (Astuti et al., 2023; Deta et al., 2024).

Furthermore, the transformation of Menggelek Tobu into a cultural tourism attraction in Pulau Belimbing illustrates the process of glocalization within ethnomathematics. The tradition now functions not only as a productive technology but also as a cultural representation presented to broader audiences while maintaining its original social and technical meanings. Such developments indicate that local mathematical and physical knowledge systems remain adaptive and relevant within contemporary contexts. From an educational perspective, this study provides substantial implications for culturally responsive mathematics and physics learning (Wulansari & Admoko, 2021). The

integration of geometry, rotational motion, translational motion, mechanical energy, and mathematical modeling within a single cultural context offers a more holistic learning framework than conventional fragmented instruction. Students learning through the context of Menggelek Tobu are not merely memorizing formulas but are also understanding how scientific concepts emerge from authentic cultural practices. This supports previous studies demonstrating that contextual learning based on local culture enhances student engagement, conceptual understanding, and cultural identity (Fatmawati et al., 2026; Fitrah et al., 2025; Olofsson et al., 2013).

The findings also suggest several implications for curriculum development and instructional practice. First, schools may develop integrated mathematics and physics modules based on local cultural traditions, extending beyond static geometry toward dynamic mechanical systems and energy optimization. Second, teachers require training to identify ethnomathematical and ethnophysical elements embedded within local traditions so that these can be transformed into meaningful learning resources. Third, assessment systems should evaluate not only procedural understanding but also students' ability to connect scientific concepts with cultural contexts and real-life applications.

Despite its contributions, this study has several limitations. The mechanical analysis employed an idealized model that did not fully account for material deformation, uneven surfaces, or variations in applied force during rolling activities. Future research may therefore incorporate more precise experimental approaches using advanced motion analysis and engineering simulations. In addition, this study primarily focused on technical and mechanical aspects, leaving philosophical and epistemological dimensions of knowledge transmission across generations relatively unexplored. Future investigations may further examine how traditional scientific knowledge is preserved, transformed, and adapted within changing social and technological environments. Overall, the Menggelek Tobu tradition represents an elegant synthesis of mathematics, physics, and socio-cultural values embedded within local wisdom. The tradition demonstrates that scientific reasoning and cultural practices are deeply interconnected, thereby enriching both ethnomathematics and ethnophysics scholarship while offering valuable foundations for more inclusive, contextual, and culturally grounded science education.

CONCLUSIONS AND RECOMMENDATIONS

This study concludes that the Menggelek Tobu tradition of the Melayu Kuok community represents an integrated form of ethnomathematical and ethnophysical knowledge embedded within local cultural practices. The findings demonstrate that the community intuitively applies concepts of geometry, rotational and translational motion, rolling resistance, and energy efficiency through the use of cylindrical wooden rollers in sugarcane processing activities. The rolling method was proven to be significantly more efficient than dragging, indicating that the tradition embodies practical mechanical optimization developed through long-term empirical experience. Beyond its technical dimensions, the tradition also reflects important socio-cultural values such as mutual cooperation, collective participation, and intergenerational knowledge

transmission, confirming that mathematical and physical reasoning in traditional societies is inseparable from social and cultural contexts.

Theoretically, this study contributes to the development of ethnomathematics and ethnophysics by extending previous research beyond the identification of static geometric forms toward the analysis of dynamic mechanical systems within indigenous cultural practices. The results reinforce the perspective that traditional communities possess sophisticated scientific understanding grounded in practical experience and environmental adaptation. From an educational standpoint, the Menggelek Tobu tradition provides authentic contextual resources for mathematics and physics learning, particularly in topics related to geometry, rotational dynamics, work-energy concepts, and mathematical modeling. Integrating such local cultural knowledge into formal education may strengthen students' conceptual understanding while simultaneously fostering cultural identity and appreciation of indigenous wisdom.

Based on these findings, future research is recommended to employ more advanced experimental and engineering approaches to obtain more precise measurements of motion dynamics and energy efficiency in traditional rolling systems. Educators and curriculum developers are also encouraged to design culturally responsive learning materials that integrate ethnomathematical and ethnophysical elements from local traditions into classroom instruction. In addition, collaboration among schools, cultural institutions, local governments, and community leaders is essential to preserve and document the Menggelek Tobu tradition as both cultural heritage and a valuable source of indigenous scientific knowledge for future generations.

REFERENCES

- Abbas, M. L. H., & Zamrotin, S. M. (2024). Kajian Etnofisika Tari Lenggang Kencana Dalam Pembelajaran Fisika Pada Materi Gerak Dan Gaya. <https://doi.org/10.19184/jpf.v13i3.52685>
- Arifudin, A., Septya, F., Yendi, Y., & Dermawan, O. M. (2021). Melestarikan Tradisi Manggelek Sebagai Tradisi Budaya Desa Kuok Kecamatan Kuok Kabupaten Kampar Provinsi Riau. *Journal Of Community Services Public Affairs*, 1(4), 116-120.
- Arwanto, A. (2017). Eksplorasi Ethnomatematika Batik Trusmi Cirebon Untuk Mengungkap Nilai Filosofi Dan Konsep Matematis. *Phenomenon Jurnal Pendidikan MIPA*, 7(1), 40-49. <https://doi.org/10.21580/phen.2017.7.1.1493>
- Asma, A., & Kadir, K. (2022). Eksplorasi Etnomatematika Proses Pembuatan Kue Tradisional Cangkung Sebagai Sumber Belajar Matematika. *AKSIOMA Jurnal Program Studi Pendidikan Matematika*, 11(4), 3168. <https://doi.org/10.24127/ajpm.v11i4.6024>

- Astuti, A., Zulfah, Z., Nursyahfira, N., Wulan Sari, R., Ningrum, S., & Saputra, M. (2023). Eksplorasi Etnomatematika Pada Tradisi Manggelek Tobu di Kuok. *Journal of Education Research*, 4(1), 125–133.
- Chaniago, S. (2023). Ethnoscience of Physics-Math: Calculation of Energy and Wages of Hoeing Farmers in Indonesia. *Jurnal Penelitian Pendidikan IPA*, 9(11), 9667–9671. <https://doi.org/10.29303/jppipa.v9i11.5244>
- D'Ambrosio, U. (1985). Ethnomathematics and Its Place in the History and Pedagogy of Mathematics. *For the Learning of Mathematics*, 5(February 1985), 44-48 (in 'Classics').
- Deta, U. A., Arisanti, A., Hudha, M. N., Lestari, N. A., Admoko, S., Uulaa, R. F. R., Prahani, B. K., & Suprpto, N. (2024). Physics Concepts Analysis in the Traditional Games of Kekehan. *International Journal of Research and Community Empowerment*, 2(1), 24–34. <https://doi.org/10.58706/ijorce.v2n1.p24-34>
- Ellis-Robinson, T., & Coles, J. W. (2021). School, university and community collaboration to promote equity through inclusive cultural competence. *Education Policy Analysis Archives*, 29, 44. <https://doi.org/10.14507/epaa.29.4670>
- Fatmawati, R. A., Supriyono, S., & Arifin, S. N. (2026). Eksplorasi Etnomatematika yang Terkandung Pada Budaya Bertani Masyarakat Jombang. *SCIENCE Jurnal Inovasi Pendidikan Matematika Dan IPA*, 6(1), 79–95. <https://doi.org/10.51878/science.v6i1.8931>
- Febrian, F., & Astuti, P. (2023). Ethnomathematical Study on Indigenous Fish Trap: Example from Kijang, Bintan Regency. *Mathematics Education Journal*, 17(1), 21–36. <https://doi.org/10.22342/jpm.17.1.18787.21-36>
- Fitrah, M., Sofroniou, A., Setiawan, C., Widiastuti, W., Yarmanetti, N., Puspita, M., Jaya, S., Panuntun, J. G., Arfaton, A., Beteno, S., & Susianti, I. (2025). The Impact of Integrated Project-Based Learning and Flipped Classroom on Students' Computational Thinking Skills: Embedded Mixed Methods. *Interactive Learning Environments*, 27(8), 1028–1046. <https://doi.org/https://doi.org/10.1080/10494820.2018.1481103>
- Fitri, A. A. Z., & Fathurohman, A. (2025). Eksplorasi Konsep Fisika Pada Penggunaan Alat Panen Tradisional Kelapa Sawit. *OPTIKA Jurnal Pendidikan Fisika*, 9(1), 16–25. <https://doi.org/10.37478/optika.v9i1.5073>
- Halliday, D., Resnick, R., & Walker, J. (2013). *Fundamentals of physics*. John Wiley & Sons.

- Hierrezuelo, J., & Ruiz, C. C. (1995). Sliding and rolling: the physics of a rolling ball. *Physics Education*, 30(3), 177-182. <https://doi.org/10.1088/0031-9120/30/3/009>
- Jewett, J. W., & Serway, R. (2008). Physics for scientists and engineers with modern physics. *Vectors*, 1(2), 633.
- Jusmaniar, J., Riani, I., Anderson, E., Lee, M. C., & Oktavia, S. W. (2024). Gasing Game: Ethnoscience Exploration of Circular Motion in Physics Learning on the Coast of East Sumatra to Build the Character of Perseverance. *Schrödinger Journal of Physics Education*, 5(1), 1-9. <https://doi.org/10.37251/sjpe.v5i1.902>
- Kadir, I. S. A., Faizah, H., Elmustian, & Syafril. (2023). Tradisi Menggelek Tobu di Pulau Belimbing Kuok Kabupaten Kampar Provinsi Riau.
- Kyeremeh, P., Awuah, F. K., & Dorwu, E. (2023). Integration of Ethnomathematics in Teaching Geometry: A Systematic Review and Bibliometric Report. *Journal of Urban Mathematics Education*, 16(2), 68-89.
- Langtang, D., & Mataubenu, K. D. (2020). Identifying physics concepts in yarn production by none fortress society, tetaf village. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, 5(1), 31-37.
- Manarfa, A., & Lasaiba, D. (2024). Jejak Karakter di atas Budaya: Menelusuri Identitas dalam Pendidikan. *Lani.*, 4(1), 67-75. <https://doi.org/10.30598/lanivol4iss1page67-75>
- Martens, R., Bastiaens, T., & Kirschner, P. A. (2007). New Learning Design in Distance Education: The impact on student perception and motivation. *Distance Education*, 28(1), 81-93. <https://doi.org/10.1080/01587910701305327>
- Minkin, L. (2026). Revisiting the Coefficient of Rolling Resistance: A Phenomenological Approach. *European Journal of Physics*.
- Mungan, C. E. (2012). Rolling friction on a wheeled laboratory cart. *Physics Education*, 47(3), 288-292. <https://doi.org/10.1088/0031-9120/47/3/288>
- Mungan, C. E. (2021). A Race Between Rolling and Sliding Up and Down an Incline. *The Physics Teacher*, 59(4), 247-249. <https://doi.org/10.1119/10.0004147>

- Ningsih, A. G., Firmansyah, F., Hastuti, W. S., Kawuryan, S. P., Kuswidyanarko, A., & Rizki, I. A. (2024). Enhancing Students' Mathematical Creative Thinking through Ethnomathematics-Based Differentiated Learning. *Jurnal Pendidikan MIPA*, 25(3), 1618-1634.
- Ningsih, J., Arianti, I. S., Cahyani, I., Ramadhani, N., Melyani, N., & Elmustian. (2024). Menjelajahi Desa Wisata Pulau Belimbing Dari Tradisi Menggelek Tobu Sebagai Kearifan Lokal Melalui Study Culture Eksperiment.
- Nurianti, T., Lubis, N. A., & Nurmasiyah, N. (2023). Ethnophysics study of the concept of work and energy in the aceh traditional game "taloe yeye" as physics teaching material. *Berkala Ilmiah Pendidikan Fisika*, 11(2), 175-184.
- Nursyahfira, Zulfah, Z., & Astuti, A. (2023). Validasi Instrumen Eksplorasi Etnomatematika pada Pembuatan Lomang (Lemang) di Kabupaten Kampar Riau. *Jurnal Pengabdian Masyarakat Dan Riset Pendidikan*, 2(1), 189-193. <https://doi.org/10.31004/jerkin.v2i1.140>
- Olofsson, U., Zhu, Y., Abbasi, S., Lewis, R., & Lewis, S. E. (2013). Tribology of the wheel-rail contact - aspects of wear, particle emission and adhesion. *Vehicle System Dynamics*, 51(7), 1091-1120. <https://doi.org/10.1080/00423114.2013.800215>
- Padang, D. S. (2023). Ethnomathematical Exploration of Traditional Agricultural Tools In Hutamanik Village, Sumbul. *Indonesian Journal of Science and Mathematics Education*, 06(2), 137-151. <https://doi.org/10.24042/ijsme.v5i1.17003>
- Pereira, D., Cortes, D. O., & Orey, D. C. (2020). Connecting Ethnomathematics and Modelling: a mixed methods study to understand the dialogic approach of Ethnomodelling Conectando las Etnomatemáticas y la Modelación: un estudio de método mixto para comprender el enfoque dialógico de la Etnomodelación C. *Revemop - Journal of Mathematics Education and Cultural Practices (Special Issue / Book Chapter Series)*, 1-25. <https://doi.org/https://doi.org/10.33532/revemop.e202011>
- Pertiwi, P. D., Pujiastuti, H., & Fathurohman, M. (2022). Implementasi Pendekatan Metakognitif dalam Pembelajaran Matematika: Systematic Literature Review. *Edukatif: Jurnal Ilmu Pendidikan*, 4(6), 7904-7918.
- Pramana, A., & Zamaya, Y. (2021). The Potential Identification of Pulau Belimbing Village for the Development of Halal Tourism in Kampar Regency. *Jurnal Dakwah Risalah*, 32(1), 96. <https://doi.org/10.24014/jdr.v32i1.12704>

- Puspitarani, P. (2025). Integrasi Etnomatematika Berbasis Budaya Keraton Yogyakarta dalam Pembelajaran Luas Belah Ketupat untuk Siswa Sekolah Dasar. *Jurnal Pengajaran Sekolah Dasar*, 4(2). <https://doi.org/10.56855/jpsd.v4i2.1484>
- Rosa, M., & Orey, D. C. (2020). Discussing culturally relevant education and its connection to cultural aspects of mathematics through ethnomathematics. In *Revista Eletrônica de Educação Matemática*.
- Sa'diyah, H., Mustafaroh, V. A., Rizaldi, D. F., Ashfy, A. C., & Suliyannah, S. (2024). Identifikasi Konsep Fisika pada Kearifan Lokal Pembuatan Tuak dan Budaya Nitik Tuak di Kabupaten Tuban. *Jurnal Ilmu Pendidikan Dan Pembelajaran*, 2(2), 90–98. <https://doi.org/10.58706/jipp.v2n2.p90-98>
- Sandi, E. K. (2025). Exploring Ethnomathematics in Local Culture: A Bridge Between Tradition and Classroom Mathematics. *Aksioma Education Journal*, 2(1), 38–45. <https://doi.org/10.62872/rbrtaa18>
- Sari, A. K., Budiarto, M. T., & Ekawati, R. (2022). Ethnomathematics study: cultural values and geometric concepts in the traditional “tanean-lanjang” house in Madura-Indonesia. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, 46–54.
- Sholahuddin, M., & Admoko, S. (2021). Exploration of Physics Concepts Based on Local Wisdom Kolecer Traditional Games. *PENDIPA Journal of Science Education*, 5(1), 70–78. <https://doi.org/10.33369/pendipa.5.1.70-78>
- Sianipar, H. F., & Silalahi, T. (2025). Utilization Of Technology In Ethnomathematics-Based Geogebra Learning Media. 4(1), 103–110.
- Silalahi, D. R., Sihite, N. S., Siregar, M. U., & Simbolin, K. L. (2025). Eksplorasi Konsep Etnomatematika Pada Makanan Tradisional Klepon dan Permainan Tradisional Congklak. <https://doi.org/10.31004/cendekia.v9i3.4288>
- Wulan, E. R., Inayah, A. M., Khusnah, L., & Rohmatin, U. (2021). Etnomatematika: Geometri Transformasi Dalam Konteks Monumen Simpang Lima Gumul Kediri. *JMPM: Jurnal Matematika Dan Pendidikan Matematika*, 6(2), 187–203.
- Wulansari, N. I., & Admoko, S. (2021). Eksplorasi Konsep Fisika pada Tari Dhadak Merak Reog Ponorogo. *PENDIPA Journal of Science Education*, 5(2), 163–172. <https://doi.org/10.33369/pendipa.5.2.163-172>

Zulfah, Z., Astuti, A., Rizki, L. M., Herlinda, N., Juliana, I., & Febriani, S. R. (2022).
Diseminasi Eksplorasi Etnomatematika pada Teknologi Tradisional di
Kabupaten Kampar. *Jurnal Pengabdian Masyarakat Dan Riset Pendidikan*,
1(1), 33-37. <https://doi.org/10.31004/jerkin.v1i1.5>