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Ethnoscience of Pringtulis Jepara Carving Art for Middle School Science Learning

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Abstract. *Woodcarving in Jepara is a traditional community practice that contains local knowledge and has potential as a context for science learning. This study aimed to explore the ethnoscience embedded in woodcarving practices in Pringtulis Village, Jepara Regency, and identify their connections with the concepts of force, pressure, simple machines, and plant utilization. This study employed a qualitative descriptive-exploratory method. Data were collected through observations, semi-structured interviews with five informants from two woodcarving businesses, and documentation. The data were analyzed through data reduction, data presentation, and conclusion drawing, with method and source triangulation. The findings indicate that the woodcarving process involves eight stages, beginning with wood selection and preparation and ending with product inspection and repair. Artisans use motifs such as punggel Bali and pepatran, as well as tools including penilap, pengukir, kol, and coret. The use of a mallet to strike carving tools illustrates the concept of force, while the contact area between the tool tip and wood provides a conceptual explanation of pressure. The sharp edge of the carving tool is related to the wedge principle as a simple machine. The use of teak wood also illustrates the utilization of plant resources. These findings suggest that woodcarving in Pringtulis Village can serve as a contextual resource for junior high school science learning, although further validation and classroom testing are needed.*
Keywords: *Ethnoscience; Force and pressure; Jepara woodcarving; Science learning; Simple machines;*

Abstrak. Seni ukir kayu Jepara merupakan salah satu praktik masyarakat yang mengandung pengetahuan lokal dan berpotensi dimanfaatkan sebagai konteks pembelajaran IPA. Penelitian ini bertujuan untuk mengeksplorasi unsur etnosains dalam praktik seni ukir kayu di Desa Pringtulis, Kabupaten Jepara, serta mengidentifikasi keterkaitannya dengan konsep gaya, tekanan, pesawat sederhana, dan pemanfaatan tumbuhan. Penelitian ini menggunakan metode deskriptif kualitatif dengan pendekatan eksploratif. Data dikumpulkan melalui observasi, wawancara semi-terstruktur terhadap lima informan dari dua usaha ukir kayu, dan dokumentasi. Data dianalisis melalui tahap reduksi data, penyajian data, dan penarikan kesimpulan, dengan menggunakan triangulasi metode dan sumber. Hasil penelitian menunjukkan bahwa proses pembuatan ukiran kayu terdiri atas delapan tahapan, mulai dari pemilihan dan persiapan kayu hingga pemeriksaan serta perbaikan produk. Pengrajin menggunakan motif seperti punggel Bali dan pepatran, serta beberapa alat, antara lain penilap, pengukir, kol, dan coret. Penggunaan palu untuk memukul alat ukir menunjukkan konsep gaya, sedangkan luas bidang sentuh antara ujung alat ukir dan kayu dapat dijelaskan melalui konsep tekanan. Bagian tajam pada alat ukir berkaitan dengan prinsip baji sebagai salah satu jenis pesawat sederhana. Selain itu, penggunaan kayu jati menunjukkan pemanfaatan sumber daya tumbuhan. Temuan ini menunjukkan bahwa seni ukir kayu di Desa Pringtulis berpotensi menjadi sumber belajar kontekstual IPA SMP, meskipun masih memerlukan validasi dan pengujian dalam pembelajaran di kelas.
Kata kunci: Etnosains; Gaya dan tekanan; Pembelajaran IPA; Pesawat sederhana; Seni ukir Jepara

1. INTRODUCTION

Science education plays an important role in helping students understand natural phenomena and develop scientific thinking skills. Students' understanding of science concepts can be enhanced through learning activities that connect theoretical knowledge with real-life phenomena. Contextual learning provides opportunities for students to

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observe their surroundings, identify problems, and relate their experiences to scientific concepts. Ethnoscience has the potential to support this process by connecting local knowledge with science learning and developing students' scientific literacy (Hikmah et al., 2025). Similarly, ethnoscience-based science modules have been examined as relevant learning resources for junior high school students (Lestari & Zulirfan, 2024).

Ethnoscience is an approach that examines community knowledge and practices and connects them with scientific concepts. Such knowledge develops through experience, customs, and interactions between communities and their environments, and can be integrated into science learning as a contextual resource (Kisworo et al., 2026). Ethnoscience-based learning has also been discussed as a way to support students' scientific literacy (Jurianti et al., 2026), and various forms of local wisdom have been identified as potential science learning resources (Adawiah et al., 2026). The effectiveness of local wisdom-based learning in improving scientific literacy has also been examined (Allan et al., 2026).

Jepara Regency, Central Java, is widely recognized as an area with a strong tradition of woodcarving. Woodcarving is a skill that involves transforming wood into specific patterns or shapes using specialized tools and techniques. This activity has artistic and cultural value and potentially contains scientific concepts that can be explored through an ethnoscience approach. Previous research examined Jepara woodcarving as an alternative context for culture-based mathematics learning and identified mathematical concepts within its patterns and practices (Utami et al., 2024). These findings demonstrate that Jepara woodcarving can serve as a learning context that connects local culture with academic knowledge. Research from a science education perspective, particularly concerning force, pressure, simple machines, and plant utilization, still needs to be conducted by considering the characteristics of carving practices and the knowledge possessed by artisans.

Preliminary interviews were conducted at two woodcarving businesses in Pringtulis Village, Nalumsari District, Jepara Regency. Both businesses employ similar carving techniques but market their products in different regions. The interviews provided information about the artisans' activities, the tools used, carving techniques, and the process of transforming wood into carved products. The preliminary interviews also provided information about the materials used in woodcarving, particularly the types of wood selected by artisans. The artisans explained that the selection of materials could depend on the needs and requests of customers. These preliminary findings provide an overview of the local knowledge and practices that can be examined further through an ethnoscience perspective.

Woodcarving activities involve the use of various tools with different shapes and functions depending on the carving process. The characteristics of these tools provide an opportunity to examine the application of scientific principles in traditional practices. Previous studies have explored local wisdom as a context for explaining the concept of pressure in science learning (Putra et al., 2021). Local wisdom has also been integrated into science learning materials related to work and simple machines (Yohana et al., 2025). These studies provide a basis for examining the relationship between traditional woodcarving tools and science concepts.

The use of wood as a raw material in woodcarving can be connected to the science concept of plant utilization. In this study, teak was the main wood used by the observed artisans, while other wood types may be chosen according to customer requests but were not identified directly. The biological discussion is therefore limited to the use of woody

plants as natural resources for handicraft production rather than a comparison of plant diversity. This context can introduce students to the benefits of plants in everyday life and the importance of responsible natural resource utilization.

Previous studies have also developed local wisdom-based learning resources, such as science modules integrated with local wisdom (Nakjah & Khatami, 2026) and ethnoscience integrated into environmental education (Sihombing et al., 2025). Ethnoscience studies of traditional production processes, such as the making of gethuk (Putri et al., 2025), Jenang Kudus (Ahdan et al., 2025), dumbeg (Wahyuni & Fawaida, 2024), and cooling powder (Kothrun Nada et al., 2025), have likewise identified science concepts that can serve as learning sources. However, research specifically examining woodcarving practices in Pringtulis Village through an ethnoscience approach, particularly their connections with force, pressure, simple machines, and plant utilization, remains limited. Therefore, further exploration is needed to identify the artisans' knowledge, the tools and techniques they use, and the raw materials involved in the carving process.

Based on this background, this study aims to explore the ethnoscience embedded in woodcarving practices in Pringtulis Village, Jepara Regency, and identify their connections with the science concepts of force, pressure, simple machines, and plant utilization. Data were collected through observations and interviews at two woodcarving businesses to examine the artisans' activities, tools, techniques, and materials. The findings are expected to provide a foundation for developing a junior high school science learning resource book that connects local cultural knowledge with scientific explanations. Through this resource, students are expected to understand science concepts through examples from their surrounding environment while also developing appreciation for Jepara's traditional craftsmanship.

2. RESEARCH METHOD

This study employed a qualitative approach with a descriptive-exploratory method to explore local knowledge embedded in woodcarving practices in Pringtulis Village, Jepara Regency. The study focused on identifying the stages of woodcarving production, the tools and materials used by artisans, and their connections with the science concepts of force, pressure, simple machines, and plant utilization. Data were collected through direct observations of woodcarving activities, semi-structured interviews with five informants from two woodcarving businesses, and documentation in the form of photographs and field notes. Informants were selected using purposive sampling based on their experience and knowledge of woodcarving practices. Data were analyzed through data reduction, data presentation, and conclusion drawing. Data credibility was examined through method and source triangulation. The collected information was then interpreted by comparing the artisans' local knowledge and practices with relevant scientific concepts to identify their potential as contextual learning resources for junior high school science.

3. RESULT AND DISSCUSION

Woodcarving is a traditional skill that combines artistic creativity, practical knowledge, and the use of natural materials. In Jepara Regency, woodcarving is one of the local crafts that has developed through community experience and skills passed down across generations. In Pringtulis Village, this practice can be observed through the selection of wood materials, the use of carving tools, the formation of motifs, and the finishing of carved products. These activities provide a basis for exploring the

relationship between local knowledge and science concepts in junior high school learning. (Usfatun Khasanah, 2024).

Jepara Regency is a region in Central Java known for its wood-carving craftsmanship. The carving skill referred to by the local community as natah is a form of traditional knowledge passed down through generations (Sari et al., 2023). A hallmark of Jepara woodcarving is the frequent use of plant and floral motifs specifically flowers with detailed petals and gracefully curving stems. These motifs serve as a cultural identifier for the people of Jepara, having evolved throughout history under the influence of various cultures, including Chinese, European, Hindu, Buddhist, and Islamic traditions. Jepara carvings also feature distinct structural elements, such as primary forms, the wuni fruit motif, intricate decorative embellishments, and a foundational base.

As times have changed, the application of Jepara woodcarving has evolved. While in the past such carvings were primarily used for traditional or religious ornamentation, this craft is now applied to a wide range of furniture products, including cabinets, chairs, tables, beds, and gebyok (traditional carved wooden partitions) (Fathonah et al., 2025). Teak wood is a primary material frequently used due to its renowned quality and durability. Jepara wood carvings are marketed across various regions in Indonesia and even internationally. This demonstrates that the art of wood carving serves not only as a cultural heritage but also as a source of livelihood for the community. Consequently, carving skills must be preserved by passing on knowledge to the younger generation and developing products that maintain the distinctive characteristics of Jepara-style carvings (Prasiska & Wati, 2024).

Based on observations and interviews conducted at two wood-carving workshops in Pringtulis Village, Jepara Regency, it is evident that wood carving remains a skill practiced by the local community. One of the interviewees, Mr. Aji, explained that the products created include items such as villa doors and gates, which are customized to meet consumer requests. The production process requires expertise in selecting the appropriate type of wood, determining material dimensions, utilizing carving tools, crafting intricate motifs, and carrying out the final finishing stages.

Based on observations and interviews, teak wood was identified as the main material used in the observed woodcarving businesses, and the artisans mentioned that other types of wood could be selected according to customer requests, although these were not identified in detail. The thickness of the wood varied according to the product, approximately 2 cm for certain products and 3–4 cm for doors. These measurements represent the conditions observed in the research locations and should not be interpreted as general standards.

In the carving process, artisans use designs as a guide to ensure the final form aligns with the client's specifications. Specific motifs mentioned during interviews include punggel Bali and pepatran. During the finishing stage, some products undergo up to three layers of painting. Items intended for the Jepara market generally retain the wood's natural brown color, whereas orders destined for Bali often feature a more diverse color palette. A portion of the output is also marketed to Bali. Should a product sustain damage during transit such as the wood cracking it is sometimes returned to the artisan for repair. These findings demonstrate that the artisans' local knowledge extends beyond carving techniques to encompass material selection, product customization, and the finishing of the crafted pieces. (Prasiska & Wati, 2024).

The knowledge and skills involved in this woodcarving art must be preserved so that they do not disappear as time progresses. Passing on these skills from artisans to the

next generation is one way to ensure the continued existence of Jepara woodcarving. This aligns with discussions regarding the importance of skill transmission in maintaining the sustainability of the Jepara woodcarving tradition (Rokhis Saidah, 2017). Furthermore, the art of woodcarving possesses both aesthetic value and a level of craftsmanship that serve as essential components of Jepara relief artworks (Rahmawati et al., 2017). Thus, the art of woodcarving in Pringtulis Village can be understood as local knowledge that has developed through the community's experiences, customs, and skills.

Based on observations and interviews with the artisans, the woodcarving production process in Pringtulis Village consists of eight stages, starting from wood selection and preparation to the inspection and repair of the finished product. Each stage involves specific activities that reflect the artisans' knowledge and skills. The stages of the production process are presented in Table 1.

Table 1. Stages in the Process of Creating Wood Carvings

Production stage	Picture	Description
Selecting and preparing the wood		The artisan selects wood according to the product and customer request. The study recorded the use of teak and other types of wood. Related science concept: Diversity of materials; observable differences in colour, grain, texture, and hardness.
Determining dimensions		The wood is measured or prepared according to the intended product. Field notes recorded approximately 2 cm thickness for certain items and 3–4 cm for doors. These are observations, not universal standards. Related science concept: Measurement and physical quantities.
Preparing the pattern		The motif or design is used as a guide before the wood is carved. Motifs documented in this study include punggel Bali and pepatran. Related science concept: Shape, pattern, and geometry; local cultural knowledge.
Drawing pattern designs		Craftspeople create or transfer patterns onto the surface of the wood according to the desired design. These patterns serve as a guide during the carving process, ensuring that the final form of the carving aligns with the original plan. Related science concept: Mathematics and measurement: relate to shapes, lines, patterns, dimensions, and proportions. Physics (light): craftspeople rely on their vision to observe patterns and the surfaces of the wood.

Carving the wood		The artisan guides the carving tool by pushing it and, when needed, striking it with a hammer. Wood material is removed to form the design. Related science concept: Force; pressure at the tool–wood contact area.
Smoothing the surface		The carved surface is smoothed before finishing, where this stage is part of the observed production process Related science concept: Surface texture and changes in material appearance.
Painting/finishing		Some products receive up to three coats of paint. The colour and finishing may vary according to the customer or destination market. Related science concept: Surface coating; changes in colour and appearance; protective function of coating.
Checking and repairing		The product is checked; the field notes indicate that some items damaged during transport, such as cracked wood, may be returned for repair. Related science concept: Material properties, defects, and product quality.

These stages show that creating wood carvings requires not only the skill to shape motifs, but also knowledge of material selection, tool use, and product finishing. Each stage serves a distinct purpose and is connected to the others to produce a carved piece that meets the consumer's requirements.

A motif is an essential element in the art of carving, as it serves as the form or pattern that gives character to the crafted piece (Artha & Nuriarta, 2019). Based on interviews with artisans in Pringtulis Village, two motifs were identified: punggel Bali and pepatran. These motifs are part of the artisans' repertoire, guiding them in the creation of carved products according to specific designs and consumer requests.

The Patra Punggel motif is a traditional Balinese decorative pattern. The word punggel means a piece or a segment, and the motif is derived from a stylized representation of the curved stems of young fern fronds (Suardina et al., 2021). It is characterized by a repeating pattern of broad, elongated leaf-like shapes combined with elements such as ampas nangka, batun poh, and kuping guling, and is frequently used on temple entrances, traditional structures, and the bade (ceremonial cremation tower) used during Ngaben funeral rites in Bali (Suardina et al., 2021)

Pepatran (or pepatraan) refers to a category of traditional Balinese ornamental motifs based on stylized botanical forms such as leaves, flowers, and other plant parts, arranged in repetitive or evolving sequences. Philosophically, pepatran ornaments embody protection, tranquility, and comfort, with the aim of fostering harmony in life.

There are several types of pepatran motifs: Patra Punggel, which takes its form from the curvature of a fern stalk; Patra Samblung, inspired by a broad-leaved creeping vine; Patra Cina, which reflects Chinese cultural influence and features a stylized hibiscus flower; and Patra Wangga and Patra Sari, which resemble blooming flowers or buds with leafy tendrils. These forms show that Balinese decorative art draws inspiration from

plants, which are developed into ornamental designs with both aesthetic value and cultural philosophy (Wayan et al., 2021).

The diversity of motifs shows that woodcarving is not merely technical skill in using tools, but is also connected to the creativity and cultural knowledge of a community. Jepara woodcarving, with its plant and floral motifs shaped by various cultures, can therefore serve as a subject for ethnoscience education, as it reveals the interplay between community skills, cultural values, and local craft practices.

Community knowledge of woodcarving in Pringtulis Village is not limited to the ability to produce crafts, but also represents local knowledge developed through experience and community practices, which carries cultural values. In the ethnoscience approach, this knowledge is connected with scientific explanations so that both perspectives can be understood side by side. Sari et al. (2023) stated that ethnoscience studies can be used to identify local knowledge and integrate it into science learning, in line with Syazali & Umar (2022), who explained that culture can serve as a meaningful context for science education.

The relationship between community knowledge and scientific knowledge needs to be established through a research process rather than by simply presenting local culture as an example in science education. Community practices should first be understood within their cultural context and then interpreted using appropriate scientific concepts. For example, Ilhami et al. (2021) showed that the local practice of manongkah in Indragiri Hilir Regency can be used as an ethnoscience-based learning resource, and Rikizaputra et al. (2022) demonstrated how local knowledge can be examined to identify its relevance to biology learning. Thus, ethnoscience provides a way to examine community knowledge scientifically while respecting its cultural context.

Using local knowledge in science learning can give students experiences that are closer to their everyday lives. (Verawati & Wahyudi, 2024) indicated that integrating local wisdom into science instruction can support students' scientific literacy, (Lestari & Zulirfan, 2024) identified ethnoscience-based modules as one approach to developing contextual learning resources, and (Hikmah et al., 2025) confirmed the potential of ethnoscience to support science education and scientific literacy. Local food-making culture in Rembang has likewise been identified as a source of both physics and biology learning (Wahyuni & Fawaida, 2024), and integrating local wisdom can connect scientific concepts with students' social and cultural environments (Rosyidah et al., 2025). On this basis, woodcarving in Pringtulis Village can be regarded as local knowledge with potential to be explored through an ethnoscience approach.

The wood carving process in Pringtulis Village, Jepara Regency, demonstrates the relationship between artisans' skills and concepts in science learning. Observations at two businesses showed that artisans use tools including *penilap*, *pengukir*, *kol*, and *coret*, and a mallet to strike the carving tools so that parts of the wood are chipped away according to the desired pattern. These activities relate to the concepts of force, pressure, simple machines, and the use of plants as raw materials for handicrafts.

The concept of force can be observed when artisans strike carving tools with a mallet during the motif-forming process. Force is a push or pull that can affect the motion or shape of an object (Lubis et al., 2025). The mallet's impact applies force to the carving tool, causing it to move and helping remove the targeted parts of the wood, and the accuracy of the striking direction is important for producing the intended motifs. How the tool contacts the wood surface can then be explained through the concept of pressure.

Pressure is the amount of force acting per unit area of a surface (Solihat & Mahendrawan, 2019). When artisans strike carving tools with a mallet, the impact force is transmitted through the tool to the wood surface, chipping the wood into specific motifs. Conceptually, the resulting pressure depends on the magnitude of the force and the contact area between the tool and the wood: for the same force, a smaller contact area produces greater pressure. The shape and sharpness of the tool's tip and the artisans' skill in directing their strikes also play a role (Curti et al., 2021). Pressure and frictional force have likewise been identified in the traditional process of making cooling powder (Kothrun Nada et al., 2025). This explanation is a conceptual connection rather than the result of direct pressure measurements at the research site.

The tools are also related to the concept of simple machines, particularly the wedge, which helps cut or split materials. This principle can be found in the sharp edges of carving tools, whose shape helps remove and shape the wood surface when force is applied (Williams & Patel, 2016). The mallet's impact force is transmitted through the tool to the wood and is influenced by the shape and sharpness of the tip, the direction of the force, and the characteristics of the material.

The use of a mallet cannot automatically be classified as an application of the lever principle, which requires a fulcrum, a load, and an effort; here, the mallet is used to strike the carving tool. Therefore, the discussion of simple machines focuses on the wedge principle found in the sharp edges of the carving tools. The shapes and mechanisms of individual tools, such as *penilap*, *pengukir*, *kol*, and *coret*, have not been documented in detail, so the identification is limited to the wedge principle (Dehipawala et al., 2023).

The use of wood as a raw material is related to the concept of plant utilization. Interviews showed that teak is the main raw material in the observed businesses, while other wood species may be selected according to customer requests but were not identified in detail. The biological aspect therefore focuses on the use of woody plants as natural resources for handicraft production, which provides a context for discussing the benefits of plants and the responsible use of natural resources (Susana et al., 2023). Ethnoscience and ethnobotanical studies of local plants, such as parijoto, likewise show how community knowledge of plants can be constructed as indigenous knowledge (Fawaida et al., 2025). The discussion of wood characteristics remains consistent with the available data, which focus on the carving process and teak rather than on comparing wood species or examining environmental impacts.

Wood carving in Pringtulis Village shows that several science concepts can be identified within a single community activity: force in the mallet's striking action, pressure in the force acting over the contact area of the tool's tip, simple machines in the wedge of the sharp edge, and plant utilization in the use of teak. These connections show that artisans' knowledge and skills can be examined through interrelated scientific concepts that are relevant to everyday life.

The findings show that carving activities in Pringtulis Village can be used as a learning context. However, simply adding a cultural activity to a science lesson does not mean that ethnoscience has been integrated; community knowledge must be explained with scientific concepts and then matched with the material taught in school. Fadilah et al. (2019) did this for the Jambi Malay customary procession by mapping its concepts to junior high school science competencies. In the same way, the carving stages in Table 1 can be used as a learning flow in which each stage points to one concept that students can investigate, as has been reported for the production stages of pendap (Walid et al., 2022) and gethuk (Putri et al., 2025).

The carving activities relate to several topics commonly taught in junior high school. The mallet strike is a real example for introducing force, and students can be asked why a sharp tool tip removes wood more easily than a blunt one, which opens the discussion of pressure. The sharp edge of the tool can introduce the wedge as a simple machine. Traditional tools are already recognized as potential science learning sources, for example the tangkul fishing gear at Lake Sipin, Jambi (Putra et al., 2021). The wood thicknesses recorded in the field, about 2 cm for certain products and 3–4 cm for doors, can serve as real data for practicing measurement, similar to the quantities, units, and measurement found in a customary procession (Fadilah et al., 2019). These links are conceptual and proposed for learning: pressure was not measured directly at the research site, and the only simple machine identified was the wedge.

How concepts are delivered is as important as the concepts themselves. A systematic review of ethnoscience research in Indonesia found that project-based and discovery learning are the models most often combined with ethnoscience and that most applications are in senior high school biology (Jannah et al., 2022), so physics-related contexts at the junior high school level are still rarely explored. Carving activities that highlight force, pressure, and simple machines may help fill this gap, for example by comparing the results of a sharp tip and a blunt tip on the same material, or by asking students to guess which part of a carving tool works as a wedge. These activities are only proposals and still need to be tested in classrooms.

Adding local contexts is also expected to support scientific literacy, which systematic reviews link to ethnoscience in science learning. For this benefit to reach students, suitable learning resources are needed. A needs analysis at a junior high school in South Sumatra found that students relied on the standard textbook and worksheets and that 95.7% of them needed e-modules based on local wisdom and ethnoscience-based e-modules have already been developed for topics such as work and simple machines (Yohana & Nasir, 2025). The carving data from Pringtulis can therefore be developed into a learning resource book that starts with the carving activity students already know, continues with guiding questions about force, pressure, and the wedge, and ends with a reflection on the use of wood as a resource. Plant-inspired motifs such as Patra Punggel can also introduce plant forms, but they are decorative patterns and should not be treated as evidence of plant diversity in the research area.

Besides helping conceptual understanding, this integration has a cultural function. Jepara carving skills are passed down across generations and face a challenge of regeneration, and learning that treats the artisans' knowledge as material for scientific investigation can help students see the value of this craft in their own community. A review showed that local wisdom is widely included in science learning in Indonesia, especially in elementary and junior high school, with impacts and challenges that need attention. Even so, the proposed integration is limited by the available data: how each tool works, the wood species used, and measurements of force or pressure have not been documented, and the resulting learning resource must be validated by science teachers and experts and tested with students before its effect can be stated. Within these limits, woodcarving in Pringtulis Village is a promising context for connecting students' local culture with force, pressure, simple machines, and plant utilization in junior high school science learning.

4. CONCLUSSION

This study shows that woodcarving in Pringtulis Village, Jepara Regency, is a form of local knowledge that can be connected to science learning. The carving process consists of eight stages that can be examined through the concepts of force, pressure, and simple machines: striking the carving tool with a mallet illustrates force, the contact area between the tool tip and the wood relates to pressure, and the sharp edge of the tool can be explained through the wedge principle. The use of teak as the main raw material also connects woodcarving with plant utilization. These findings show that local craftsmanship can provide meaningful examples for science learning that are close to students' everyday lives. However, force and pressure were not measured directly, the working mechanisms of the tools were not examined in detail, and other wood species were not identified. Further research is therefore needed to examine the tools more thoroughly, measure the physical aspects of the carving process, identify the wood types, and validate the proposed learning resource with science teachers and experts before it is tested with students.

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