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ETHNO-STEAM INTEGRATION USING KASONGAN POTTERY IN SCIENCE LEARNING (A Study in Bachelor of Islamic Elementary School Teacher Education)

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Abstrak. Penelitian ini bertujuan untuk menganalisis potensi penerapan pendekatan Etno-STEAM berbasis kearifan lokal Gerabah Kasongan dalam pembelajaran Ilmu Pengetahuan Alam (IPA) pada Program Studi Pendidikan Guru Madrasah Ibtidaiyah (PGMI) UIN Sunan Kalijaga Yogyakarta. Penelitian ini menggunakan metode kualitatif dengan teknik pengumpulan data berupa analisis dokumen pembelajaran, khususnya Rencana Pembelajaran Semester (RPS) mata kuliah IPA. Hasil penelitian menunjukkan bahwa Gerabah Kasongan memiliki karakteristik yang relevan dan potensial untuk diintegrasikan dalam pembelajaran IPA berbasis Etno-STEAM. Karakteristik tersebut meliputi penggunaan tanah liat sebagai bahan alam yang merepresentasikan sifat fisik dan kimia material, proses pembentukan gerabah yang melibatkan prinsip gaya, tekanan, dan keseimbangan, serta proses pembakaran yang menunjukkan perubahan fisika dan kimia akibat pengaruh suhu tinggi. Karakteristik ini memungkinkan integrasi unsur sains, teknologi, engineering, seni, dan matematika secara kontekstual dalam mata kuliah IPA.
Kata kunci: *Ethno-STEAM, Local Wisdom, Kasongan Pottery, Science Learning*.

Abstract. This study aims to analyze the potential application of an Ethno-STEAM approach based on the local wisdom of Kasongan pottery in science learning within the Madrasah Ibtidaiyah Teacher Education (PGMI) Program at UIN Sunan Kalijaga Yogyakarta. The study employed a qualitative method, with data collected through the analysis of instructional documents, particularly the Semester Lesson Plan (Rencana Pembelajaran Semester/RPS) for the science course. The findings indicate that Kasongan pottery possesses relevant characteristics and strong potential for

integration into Ethno-STEAM–based science learning. These characteristics include the use of clay as a natural material representing the physical and chemical properties of matter, pottery-forming processes that involve principles of force, pressure, and balance, and firing processes that demonstrate physical and chemical changes resulting from high temperatures. In addition, activities involving dimensional measurement, size comparison, and volume estimation in pottery making reflect the application of mathematical concepts in real-world contexts. In conclusion, an Ethno-STEAM approach based on the local wisdom of Kasongan pottery has strong potential to be developed as a contextual and meaningful science learning model in pre-service Madrasah Ibtidaiyah teacher education, as it effectively connects theoretical concepts with authentic local cultural practices.

Keywords: *Ethno-STEAM, Local Wisdom, Kasongan Pottery, Science Learning.*

INTRODUCTION

Education in Indonesia faces a significant challenge in preparing the younger generation to not only master science and technology (Afkarina Izzata Dini & Febri Setiya Rini, 2024) but also to have awareness and appreciation of local culture (Sari et al., 2022). Therefore, schools must provide a learning environment where students can develop the knowledge, skills, and characteristics to support their future success . One approach that is considered effective in overcoming this challenge is Ethno-STEAM (Science, Technology, Engineering, Arts, Mathematics) based learning, which integrates modern science with local wisdom (Babalola & Keku, 2024; Sahrir* et al., 2024). The Ethno-STEAM approach aims to introduce scientific concepts and preserve existing cultures, thereby creating more relevant and applicable learning for students (Wulandari et al., 2024).

This Ethno-STEAM approach can help students see the direct relationship between the theories they learn in class and the realities of everyday life. In addition, by

linking Natural Science learning with local culture, students are expected to more easily understand and appreciate the cultural diversity of Indonesia, as well as become more motivated to learn. Various studies show that learning that links science with local culture has the potential to increase students' motivation and understanding of Natural Science material (Setianingrum & Jumadi, 2023; Sudarmin et al., 2023; Wulandari et al., 2024).

One example of local culture with great educational potential in Yogyakarta is *Kasongan Pottery*. Kasongan, located in Bantul, Yogyakarta, is famous for its pottery crafts, which are widely known nationally and internationally. Kasongan Pottery is a handicraft that uses clay as its basic material. It is processed using traditional techniques that have been practiced for centuries. Making pottery involves many concepts of science technology, and art that can be integrated into Ethno-STEAM-based Natural Science learning.

Ethno-STEAM-based Natural Science learning integrates five important elements, namely Science, Technology, Engineering, Arts, and Mathematics, with the local wisdom found in each region (Aini et al., 2024; Fuad et al., 2024; Naela Khusna Faela Shufa & Tito Pangesti Adji, 2024; Sahrir* et al., 2024; Setianingrum & Jumadi, 2023; Suprapto et al., 2024; Tresnawati et al., 2020; Wulandari et al., 2024). In this case, using Kasongan Pottery as a learning medium provides an opportunity to explore science through practical application. For example, in making pottery, students can learn the principles of chemistry related to the process of firing clay, physics regarding temperature and pressure in crafting, technology related to the tools used, and mathematics in calculating the volume and shape of pottery.

Kasongan pottery offers considerable potential as a medium for Ethno-STEAM-based Natural Science learning. The pottery-making process, from clay preparation and shaping to drying and firing, provides authentic cultural contexts for exploring scientific concepts, including the properties of materials, heat transfer, thermodynamics, and physical and chemical changes. Integrating local pottery-making practices into science learning can help students connect scientific theories with real-life experiences and appreciate the relationship between science, technology, engineering,

arts, mathematics, and local cultural knowledge (Ardianti et al., 2023; Rahmat Hidayatullah et al., 2023; Rupilele et al., 2021). Drawing on students' cultural backgrounds and familiar artifacts can also promote meaningful learning, conceptual understanding, and student engagement (Cohen, 2020; Govender & Mudzamiri, 2022).

Therefore, this study aims to explore the potential of Kasongan pottery as a contextual medium for Ethno-STEAM-based Natural Science learning and to identify the scientific concepts and interdisciplinary connections embedded in the pottery-making process. Specifically, it examines how local knowledge and traditional pottery practices can be integrated into science learning activities relevant to the PGMI study program. The contribution of this study lies in providing a culturally grounded learning framework that can support prospective primary school teachers in designing contextual, interdisciplinary, and culturally responsive science instruction. By connecting local wisdom with scientific concepts, the study is expected to enrich science learning in the PGMI program and help prepare future teachers to develop meaningful learning experiences that integrate scientific literacy, STEAM competencies, and appreciation of local cultural heritage.

On the other hand, integrating art into Natural Science learning, part of Ethno-STEAM, allows students to express their creativity through pottery making. Art can be a valuable tool in science education, providing a flexible method for learning Natural Science (Mierzwa & Goodsell, 2021). Art also helps students understand abstract concepts through tangible artistic representations, encouraging greater understanding (Mierzwa & Goodsell, 2021; Ricci et al., 2023). This integration encourages creativity and critical thinking, allowing students to engage with complex scientific ideas more relevantly (Namukasa, 2024). Students can visualize and interpret scientific principles by creating concrete works of art, improve their problem-solving skills, and encourage a deeper understanding of both disciplines (Namukasa, 2024).

Although the concept of Ethno-STEAM learning offers great potential, several challenges must be addressed in its implementation. One is the limited educational resources and teacher competence in integrating local culture into Natural Science learning. The application of Ethno-STEAM in Indonesia is often hampered by a lack of

training for teachers in developing curricula that combine science with local culture (Nurfajariyah & Kusumawati, 2023). In addition, the development of teaching materials that can directly connect science and local culture is still limited, so efforts are needed to develop more innovative modules or teaching aids.

Furthermore, the current education curriculum does not fully support the integration of local culture in Natural Science learning. The existing curriculum focuses more on scientific theories without linking them to real-world applications, often making it difficult for students to connect what they learn with their daily lives. The PGMI study program at UIN Sunan Kalijaga Yogyakarta produces classroom teachers at the MI/SD level. PGMI study program graduates must master all subjects in MI/SD except Religious Education and Physical Education. This provides an opportunity for Natural Science courses to conduct learning using the Ethno-STEAM approach. To overcome the obstacles to implementing Ethno-STEAM in Indonesia. However, the learning carried out so far has not used the ethnoscience and Ethno-STEAM approaches. Therefore, this study aims to examine the potential of the Kasongan Pottery Ethno-STEAM approach in Natural Science course learning and provide recommendations for developing a more relevant curriculum.

METHODS

This study employed a qualitative approach with a document analysis design to examine the potential implementation of an Ethno-STEAM approach based on the local wisdom of Kasongan pottery in science learning within the Madrasah Ibtidaiyah Teacher Education (PGMI) Program. The research focused on official instructional documents used in science courses, particularly the Semester Lesson Plan (Rencana Pembelajaran Semester/RPS). This approach was chosen to gain an in-depth understanding of the instructional structure, content coverage, and opportunities for integrating local wisdom into science learning in teacher education programs.

The primary data sources consisted of Science course Semester Learning Plans (Rencana Pembelajaran Semester, RPS) used in the Primary School Teacher Education (PGMI) Program at UIN Sunan Kalijaga Yogyakarta. The documents were analyzed to

examine the alignment between course learning outcomes, instructional materials, learning activities, and assessment methods and the principles of the Ethno-STEAM approach. Ethno-STEAM integrates local cultural knowledge and practices (ethno) with five interdisciplinary components: Science, Technology, Engineering, Arts, and Mathematics. Science focuses on understanding natural phenomena and material properties; Technology concerns the tools and techniques used in production; Engineering involves designing, shaping, and improving products; Arts encompasses cultural aesthetics, creativity, and traditional designs; and Mathematics includes measurement, geometric forms, proportions, and quantitative relationships. This approach positions local cultural practices as meaningful contexts for connecting scientific concepts with students' everyday experiences.

Previous studies have highlighted the potential of integrating ethnoscience and STEAM in science education to contextualize scientific concepts, connect formal scientific knowledge with local wisdom, and promote interdisciplinary learning (Ardianti et al., 2023; Rahmat Hidayatullah et al., 2023; Rupilele et al., 2021). Research on culturally responsive and context-based learning has also emphasized the importance of familiar cultural artifacts in supporting students' engagement and understanding of scientific ideas (Cohen, 2020; Govender & Mudzamiri, 2022). Building on these perspectives, this study mapped the potential connections between the five STEAM components and the characteristics of Kasongan pottery, including the properties of clay, the tools and techniques used in pottery production, the processes of shaping and firing, the artistic and cultural significance of pottery designs, and the measurement and geometric principles involved in shaping pottery. These connections were then considered in relation to the learning outcomes, instructional content, learning activities, and assessment methods specified in the PGMI Science course RPS documents. This analytical process was intended to identify opportunities for integrating Kasongan pottery into contextual, interdisciplinary, and culturally grounded science learning in the PGMI study program.

Data analysis was conducted through the stages of data reduction, data display, and conclusion drawing. During the data reduction stage, learning components relevant

to the elements of science, technology, engineering, art, and mathematics were identified. The data were then presented in the form of analytical descriptions demonstrating the interrelationships between Kasongan pottery, the Ethno-STEAM approach, and science learning. Conclusions were drawn by interpreting the findings to determine the level of suitability and the potential for developing an Ethno-STEAM approach based on local wisdom in science learning for pre-service Madrasah Ibtidaiyah teachers.

RESULTS AND DISCUSSION

Constructivist Learning Theory in Ethno-STEAM-based Natural Science Learning

Ethno-STEAM-based Natural Science learning combines elements of science, technology, engineering, art, and mathematics with a rich local cultural context (Babalola & Keku, 2024; Sahrir et al., 2024). This approach aims to provide students with a more relevant and meaningful learning experience by integrating local wisdom into every aspect of learning (Hanum et al., 2023; Haryanto et al., 2024). One theory that strongly supports the success of Ethno-STEAM-based Natural Science learning is constructivism. Constructivism, first proposed by Jean Piaget and further developed by Lev Vygotsky, provides the foundation for learning that focuses on the active role of students in constructing their own knowledge through direct experience and social interaction (Peng et al., 2023). In the constructivist learning, teachers act as facilitators, guiding students in their learning journey. Students are encouraged to explore, experiment, and engage in problem-solving activities, which foster a deeper understanding of the subject matter (Mijanović, 2023). Meanwhile, Vygotsky emphasizes the importance of social interaction in learning. In Ethno-STEAM-based Natural Science learning, students can work in groups to solve problems or design experiments based on local culture. This collaboration allows students to share ideas, solve problems, and build social knowledge. This process reinforces learning, as students learn from their personal experiences and peers (VYGOTSKY, 1980).

One of the main principles of constructivism is that knowledge should be built through direct experience, not just given in theory. In Ethno-STEAM-based Natural

Science learning, direct experience allows students to see and feel how the scientific theories they learn in class are applied in practice (Wood et al., 1976). Furthermore, Ethno-STEAM-based learning allows students to conduct culture-based experiments, allowing them to learn from conversations, interactions, and discussions with their classmates (Qomaria & Wulandari, 2022). These direct experiences encourage students to ask questions, design experiments, and draw conclusions, which are at the core of constructivist learning.

Vygotsky's constructivist theory also emphasizes the importance of scaffolding or social support that teachers or peers provide in the learning process. In the context of Ethno-STEAM, scaffolding can take the form of teacher guidance, who help students organize their understanding of scientific concepts by providing hints or directions during experiments (Çakar Özkan, 2022). This shows that in a context such as Ethno-STEAM's, teachers can effectively support students' understanding of scientific concepts through targeted guidance (Çakar Özkan, 2022). In addition, students can also learn from each other through group collaboration, where they share different knowledge and ideas. Etno-STEAM-based Natural Science learning can occur when students make pottery together, discussing the most effective techniques or explaining their observations regarding changes in clay material (Wood et al., 1976). Group work involving collaboration and discussion is crucial to help students develop social and intellectual skills. They not only learn to work together, but also learn to solve problems collectively. Thus, learning does not only focus on mastering academic content, but also on developing social and emotional skills that are very important in everyday life.

Contextual Teaching and Learning (CTL) Theory in the Ethno-STEAM Approach

The Ethno-STEAM learning approach provides opportunities for students to learn natural sciences in contexts that are relevant to their lives. One theory that supports Ethno-STEAM-based learning is the theory of contextual learning (*Contextual Teaching and* Learning/CTL). This theory emphasizes the importance of connecting learning to the real-life contexts of students, so that learning becomes more meaningful and relevant. Contextual learning theory is an approach that allows students to see the direct relationship between the knowledge they learn and its practical application in the

real world. In the context of Ethno-STEAM, this theory is critical because it allows students to learn science, technology, arts, and mathematics concepts through an approach based on the local culture that they are familiar with and experience in their daily lives (Talita Revina & Astuti, 2023). Thus, Ethno-STEAM-based Natural Science learning enhances students' conceptual understanding and develops the life skills they need in society.

Jerome Bruner and David Ausubel are two figures who have made significant contributions to contextual learning theory. Bruner developed the concept of active learning, in which students are not merely recipients of information but are also active in the learning process. This aligns with the concept of scaffolding (social support), in which students are guided to connect new information with the knowledge they already possess. Meanwhile, Ausubel argued that learning becomes more effective when the information taught can be understood and is relevant to the students' previous experiences and knowledge.

Contextual learning emphasizes the importance of the connection between the knowledge being learned and the students' daily lives (Uliyah et al., 2024). The CTL approach emphasizes the importance of linking learning to social and cultural contexts relevant to students, hoping that learning will become more meaningful and easier to accept (Jolliffe, 2007). Contextual Learning Theory focuses on several key principles that can improve students' understanding and engagement in learning, including:

a. Connection to Real Life

   Learning must connect the material taught with the real-life context of students (Uliyah et al., 2024). For example, in Ethno-STEAM-based Natural Science learning, concepts such as temperature, changes in form, and chemical reactions can be taught by making Kasongan pottery, which is part of local wisdom.

b. Active Student Involvement

   Effective learning involves students actively participating in the learning process (Mbangar, 2023; Ngadiyo, 2023). In the Ethno-STEAM approach, students do not just passively receive information. However, they are involved in experiments,

collaboration, and exploration of scientific concepts through activities based on local culture, such as making pottery.

c. Problem Solving

Contextual learning encourages students to solve real problems, not just theoretical questions (Ronald, 2023). Students in Ethno-STEAM learning can learn to solve problems related to pottery making, such as regulating the firing temperature to produce strong and durable pottery.

d. Collaboration and Social Interaction

Learning that prioritizes social context allows students to learn from their peers through discussion, cooperation, and idea sharing. In the Ethno-STEAM approach, students work in groups to conduct experiments or create projects based on local wisdom, which allows them to develop social skills.

e. Metacognitive Skills

Contextual learning also involves the development of students' metacognitive skills, which is the ability to think about their own thinking processes. With this approach, students are taught to reflect on what they have learned and how they acquired it.

In the context of Ethno-STEAM-based Natural Science learning, the Contextual Learning theory is very relevant because it provides opportunities for students to connect scientific concepts with their local cultural realities. For example, when making Kasongan pottery, students can understand physics and chemistry concepts through direct experience. Here are some ways to apply CTL principles in the Ethno-STEAM approach:

a. Using Local Wisdom as a Learning Context

Ethno-STEAM-based Natural Science learning connects Natural Science material with local cultural processes, such as pottery making. Using this context, students learn about the properties of materials (such as clay) and physical processes (such as temperature changes and burning) directly related to their lives. For example, students can observe how clay turns into ceramics after being

fired at high temperatures, while learning the theory of changes in the form of materials.

b. Project-Based Learning

In Ethno-STEAM-based learning, students can engage in pottery-making projects that involve various scientific, technical, artistic, and mathematical concepts. They can work in groups to design and make pottery, which allows them to learn actively, collaborate, and solve problems creatively. This learning focuses on applying knowledge in relevant contexts.

c. Collaboration and Group Discussion

In the application of Ethno-STEAM-based learning, students work in groups to conduct experiments, such as testing the right temperature for firing pottery, while discussing and sharing ideas on how these experiments can be carried out. This collaboration increases students' social engagement and strengthens their understanding of Natural Science concepts.

d. Developing Metacognitive Skills

Through culture-based projects such as pottery making, students can reflect on their processes and think of new ways to improve their experimental results. CTL-based learning allows students to develop metacognitive skills for problem-solving and independent learning.

Contextual Learning Theory (CTL) provides a strong foundation for Ethno-STEAM-based Natural Science learning. Connecting learning to real-life contexts and students' local cultures makes learning more relevant, engaging, and meaningful. Through CTL principles, students learn science in theory and apply that knowledge in projects involving creativity, collaboration, and problem-solving. Therefore, Contextual Learning Theory contributes significantly to creating a more effective and beneficial learning experience for students in developing their academic and social skills.

Local Wisdom of Kasongan Pottery

Kasongan pottery is a handicraft produced by the community in the Kasongan area of Yogyakarta. This local wisdom encompasses the skill of making pottery and reflects the knowledge and understanding of natural resources, technology, and

aesthetics passed down from generation to generation. Making Kasongan pottery utilizes natural materials such as clay and fire and traditional techniques that contain scientific values in each production stage, such as material selection, mixing, modeling, firing, and finishing.

Kasongan pottery reflects local wisdom's richness, combining traditional expertise, cultural adaptation, and educational integration. This wisdom is preserved through the pottery and its role in education and community empowerment. The Kasongan pottery tradition has evolved, adapting to cultural and environmental changes while maintaining its core identity. This evolution is evident in the transformation of pottery designs and techniques, which have shifted from purely functional forms to more artistic and decorative ones. Integrating local skills into the educational context further highlights Kasongan pottery's importance in developing students' critical thinking skills.

In education, Kasongan pottery improves students' lateral thinking skills by integrating scientific concepts from physics, chemistry, and biology into pottery-making (Setyaningsih et al., 2024). Pottery-making can be linked to natural science concepts, such as materials and their properties, energy (heat and fire), and manufacturing technology. This educational approach connects traditional practices with modern science education, offering new methods for cultural preservation and skill development (Setyaningsih et al., 2024).

This shows that local wisdom, such as Kasongan Pottery, can be a source of learning that combines science and culture, enriching students' understanding of abstract scientific theories with direct and authentic experiences. Although Kasongan pottery is deeply rooted in local wisdom, it also faces challenges such as the need for modernization and market expansion. Balancing traditional practices with contemporary demands is essential for the continued vitality of this cultural heritage. Integrating local wisdom into a broader educational and economic framework can ensure the sustainability and relevance of Kasongan pottery in the modern world.

The Potential of Ethno-STEAM-Based Natural Science Learning with the Local Wisdom of Kasongan Pottery

Ethno-STEAM-based Natural Science learning, highlighting the local wisdom of Kasongan pottery, has excellent potential to improve students' understanding and skills in various aspects. Here are some of the potential outcomes:

a. Strengthening Science Concept Understanding: integrating scientific concepts from physics, chemistry, and biology into the pottery-making process (Setyaningsih et al., 2024). Using the context of pottery making, students can learn physics concepts (such as temperature and changes in shape), chemistry (combustion reactions), and the principles of technology and engineering in pottery production.
b. Creativity and Innovation: The STEAM approach emphasizes creativity by integrating art into STEM, which can increase student engagement and recognize diverse learning styles. This approach is recommended to enhance STEM learning by combining skills common to the arts and STEM disciplines (Allina, 2018; Kim et al., 2019).
c. Character Education: Local wisdom-based learning also introduces cultural and ethical values to students, which helps develop their character, such as a love for local culture, discipline, and perseverance in work.
d. Contextual Relevance: Using local wisdom makes learning more relevant to students, as they can see the direct connection between the knowledge learned in class and their daily lives.
e. Improved Problem-Solving Skills: Arts education encourages creative problem-solving strategies, such as tolerance for ambiguity and visualization, which are essential for innovation in science and engineering (Cotantino et al., 2010; Ulger, 2019).
f. Curriculum Integration: Integrating art into the curriculum can align with contemporary educational theory, promoting learning and creativity through conceptual connections between art and science (Lisi & Rajendran Nagappan, 2024; Marshall, 2005).

Despite its benefits, integrating art with STEM faces challenges, such as differences in language and thinking styles across disciplines. Effective implementation

requires conscious curriculum design and interdisciplinary learning opportunities (Lisi & Rajendran Nagappan, 2024). Teacher creativity in interdisciplinary education can significantly enhance students' comprehensive competencies, including innovative thinking and problem-solving skills (Yang et al., 2024).

CONCLUSIONS

Based on the analysis of instructional documents, it can be concluded that an Ethno-STEAM approach based on the local wisdom of Kasongan pottery has strong potential to be integrated into science learning in the Madrasah Ibtidaiyah Teacher Education (PGMI) Program. The characteristics of Kasongan pottery, which include the use of natural materials, forming processes, and firing techniques, are aligned with science concepts and enable the contextual integration of science, technology, engineering, art, and mathematics. This integration not only strengthens the connection between theory and practice but also provides more meaningful learning opportunities that are relevant to local cultural contexts. Therefore, an Ethno-STEAM approach based on Kasongan pottery can be developed as a contextual science learning model in pre-service Madrasah Ibtidaiyah teacher education.

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