Harnessing Local Potential in Dusun Bengkung for STEAM Education: A Case Study Of Literacy Advancement at TBM Pelopor Literasi Dusunku

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ABSTRACT*:*
This study explores the potential of Dusun Bengkung's local resources to develop Science, Technology, Engineering, Arts, and Mathematics (STEAM)-based educational activities aimed at enhancing literacy and creativity among school-aged children. Employing a qualitative case study methodology, data were gathered through focus group discussions (FGDs) involving 15 community stakeholders and document analysis. The findings reveal three key local potentials: (1) strong social collaboration rooted in the village's cultural traditions, (2) abundant natural resources such as bamboo, rice, and fishponds, and (3) a substantial demographic of school-aged children eager for creative engagement. STEAM activities tailored to these local resources included bamboo-based string art, water filtration techniques, and natural dyeing using local plants. The Taman Bacaan Masyarakat (Community Reading Center) Pelopor Literasi Dusunku and its associated Rumah Belajar (Learning House) served as central hubs for facilitating these activities, supported by thematic community service programs and literacy initiatives aligned with the National Literacy Movement. The study highlights the impact of integrating local wisdom into STEAM education to foster literacy, creativity, and cultural sustainability. However, its focus on a single rural community limits generalizability. Future research should investigate the scalability of such models across diverse cultural and ecological contexts. Additionally, integrating digital tools into these localized frameworks offers opportunities for advancing digital literacy in rural education.

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ABSTRAK (BAHASA INDONESIA):

Penelitian ini mengeksplorasi potensi sumber daya lokal Dusun Bengkung untuk mengembangkan aktivitas pendidikan berbasis Science, Technology, Engineering, Arts, and Mathematics (STEAM) yang bertujuan meningkatkan literasi dan kreativitas pada anak usia sekolah. Dengan menggunakan metodologi studi kasus kualitatif, data dikumpulkan melalui diskusi kelompok terarah (FGD) yang melibatkan 15 pemangku kepentingan komunitas serta analisis dokumen. Temuan menunjukkan tiga potensi lokal utama: (1) kolaborasi sosial yang kuat berakar pada tradisi budaya desa, (2) sumber daya alam melimpah seperti bambu, padi, dan kolam ikan, serta (3) demografi anak usia sekolah yang signifikan dengan antusiasme tinggi terhadap kegiatan kreatif. Kegiatan berbasis STEAM yang disesuaikan dengan potensi lokal ini meliputi seni tali berbahan bambu, teknik penyaringan air, dan pewarnaan alami menggunakan tumbuhan lokal. Taman Bacaan Masyarakat (TBM) Pelopor Literasi Dusunku dan Rumah Belajar yang terkait menjadi pusat utama dalam memfasilitasi kegiatan ini, didukung oleh program pengabdian masyarakat tematik dan inisiatif literasi yang selaras dengan Gerakan Literasi Nasional. Studi ini menyoroti dampak integrasi kearifan lokal dalam pendidikan STEAM untuk mendorong literasi, kreativitas, dan keberlanjutan budaya. Namun, fokusnya pada satu komunitas pedesaan membatasi generalisasi. Penelitian lebih lanjut perlu mengkaji skalabilitas model seperti ini di berbagai konteks budaya dan ekologi yang berbeda. Selain itu, integrasi alat digital ke dalam kerangka lokal ini menawarkan peluang untuk meningkatkan literasi digital dalam pendidikan pedesaan.

Kata kunci: *Pendidikan STEAM; Integrasi Kearifan Lokal; Pengembangan Literasi.*

INTRODUCTION

The integration of Science, Technology, Engineering, Arts, and Mathematics (STEAM) education has emerged as a transformative approach to fostering holistic learning and addressing real-world challenges. Globally, STEAM frameworks are recognized for cultivating critical thinking, creativity, and interdisciplinary collaboration among learners (Katz-Buonincontro, 2023; Land, 2013; Mishra et al., 2021; Perignat & Katz-Buonincontro, 2019). These educational paradigms are particularly valuable in empowering underserved communities to harness local resources and address socio-economic barriers (Caplan, 2017; Kiyani et al., 2020). Despite its promise, STEAM education remains underexplored in rural and marginalized contexts, necessitating innovative and context-specific approaches (Karppinen et al., 2019; Wise et al.,

2022). This gap underscores the need for further research into localized applications of STEAM methodologies.

Previous studies highlight the transformative potential of localized STEAM interventions in diverse contexts. Kessler et al. (2024) demonstrated the effectiveness of STEAM certification programs in enhancing interdisciplinary teaching practices and fostering community partnerships. Similarly, Montes et al. (2024) emphasized the role of innovation spaces, such as STEAM Labs and Makerspaces, in bridging digital divides and promoting inclusivity. Research by Maidatsi et al. (2022) further showed how integrating IoT with STEM concepts enhances sustainability education by connecting pedagogy with competency-based learning. Initiatives such as Scientists for Tomorrow have also yielded significant improvements in students' attitudes toward STEAM disciplines, particularly in underserved regions (Caplan, 2017; Rockich-Winston & Wyatt, 2019; Rodrigues-Silva & Alsina, 2023). These examples highlight the diverse applications and benefits of STEAM education.

STEAM education is further enriched by incorporating cultural and environmental dimensions into its framework. Donatuto et al. (2020) illustrated the benefits of culturally embedded curricula, such as the 13 Moons program, for teaching environmental health and sustainability. Chen and Wu (2024) developed culturally responsive STEM curricula aimed at indigenous children, focusing on disaster prevention and sustainability. The integration of traditional arts into STEAM activities has also proven effective in enhancing motivation and inclusivity (Montero & Jormanainen, 2017; Weltsek et al., 2014). These findings emphasize the importance of contextualized and culturally relevant approaches in maximizing the impact of STEAM education.

Another essential dimension of STEAM education lies in its potential to address socio-economic challenges through active community engagement. Randolph et al., (2022) underscored the value of sustained academic-community partnerships in fostering mutual benefits and scientific discovery. Fields and Kafai (2023) highlighted the need for equitable, community-driven STEAM initiatives to bridge educational gaps. However, Ayanwale et al. (2024) reported that integrating advanced technologies like artificial intelligence into STEAM education faces obstacles, including insufficient infrastructure and inadequate teacher training. These challenges underscore the need to address systemic barriers to fully realize the potential of STEAM education initiatives.

STEAM methodologies have been widely applied to enhance skills across age groups and communities, demonstrating their versatility. Tillinghast et al. (2017) found that library-based STEM programs engage multiple generations and foster family participation in educational activities. Cross et al., (2017) showed that robotics activities not only build technical skills but also empower underrepresented groups, including young women, to pursue engineering careers. Similarly, Fogarty and Lardy (2019) observed that after-school STEM service-learning courses expanded undergraduate students' understanding of STEM teaching while improving primary school students' STEM competencies. These examples underscore the adaptability and inclusivity of STEAM initiatives when tailored to specific demographic needs.

This study focuses on Dusun Bengkung, a rural area with abundant local resources and a rich cultural heritage, to explore the potential for integrating STEAM education. Dusun Bengkung hosts the TBM Pelopor Literasi Dusunku, a community-based learning centre dedicated to promoting literacy and educational innovation. This unique setting offers an opportunity to examine how local materials, traditions, and environmental resources can inform the design of STEAM activities tailored to the community's needs (Damayani et al., 2021; Rianti et al., 2022). Leveraging these resources aligns with the broader goal of developing sustainable and contextually relevant educational frameworks.

Despite its potential, implementing STEAM education in rural contexts like Dusun Bengkung faces numerous challenges. Limited access to technology, insufficient teacher training, and socio-economic constraints hinder the effective adoption of STEAM initiatives (Ovcharuk & Soroko, 2024)(. Additionally, existing research often neglects the complex interplay between local knowledge systems and formal educational structures (Mendel & Szkudlarek, 2023; Röttger-Rössler, 2024). This study seeks to address these gaps by exploring strategies for effectively designing and implementing localized STEAM initiatives.

The primary aim of this research is to identify and develop STEAM activities that leverage the unique potential of Dusun Bengkung. By doing so, the study seeks to provide a replicable model for integrating STEAM education in rural and marginalized settings. The findings are expected to contribute

valuable insights into the development of culturally relevant and resource-efficient educational strategies, thereby advancing discussions on equitable and inclusive education.

METHODS

This study utilized a qualitative case study methodology to investigate the use of local potential in Dusun Bengkung for the development of STEAM (Science, Technology, Engineering, Arts, and Mathematics)-based literacy activities. A case study approach was chosen due to its ability to offer a comprehensive understanding of decisions, programs, processes, and organizational changes within a specific context (Cresswell, 2017). The primary focus of the research was on literacy activities and the development of a STEAM-based learning initiative at TBM Pelopor Literasi Dusunku. The study aimed to identify and harness local resources and potentials to design impactful STEAM activities that enhance literacy among school-aged children in Dusun Bengkung.

Data collection was conducted through focus group discussions (FGD), which facilitated the acquisition of detailed and accurate information from purposively selected informants. Data sources included both primary and secondary data. Primary data were collected through FGDs involving 15 participants representing various community roles: the village head (1), neighborhood leaders (6), representatives from the women's association and young mothers' community (2), volunteers from TBM Pelopor Literasi Dusunku (4), and professionals such as a teacher (1) and a lecturer (1). Secondary data were obtained through document analysis of materials related to the development of STEAM activities in the study area.

The data collection process employed tools such as an FGD guide to ensure structured discussions and a document review framework to systematically extract relevant information. Data analysis followed the interactive analysis model proposed by Miles, Huberman, and Saldana, which includes four iterative stages: data collection, data condensation, data display, and conclusion drawing/verification (Miles et al., 2014). Figure 1 illustrates the cyclical and interconnected nature of this analysis model.

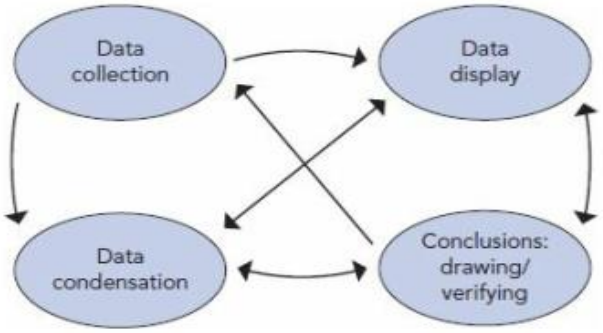

Figure 1. Interactive Analysis Model by Miles, Huberman, and Saldana (2014)

To ensure the reliability and validity of the findings, several strategies were implemented. Data triangulation, which combined FGDs and document analysis, was used to cross-verify information and enhance the credibility of the results. Purposive sampling ensured representation of diverse perspectives, while validated instruments such as the FGD guide and document review framework ensured consistency in data collection. Member checks were conducted, allowing participants to review and confirm the accuracy of interpretations and findings. Collectively, these measures enhanced the trustworthiness and robustness of the study outcomes.

FINDINGS

The Potential of Bengkung Hamlet for Local Wisdom-Based STEAM Development

Bengkung Hamlet holds great potential to become a center for developing STEAM (Science, Technology, Engineering, Arts, Mathematics) activities based on local wisdom by optimizing the Community Reading Park (TBM) Pelopor Literasi Dusunku and the Rumah Belajar initiative. Based on the results of focus group discussions (FGD), the Bengkung community warmly supports TBM's role as a literacy and creativity learning center for school-aged children. The deeply rooted tradition of mutual cooperation (gotong-royong) in the community serves as a social foundation that supports collaboration in various STEAM-based literacy programs. Additionally, Bengkung Hamlet's natural resources, such as rice plants, bamboo trees, and fish ponds, provide

contextual learning media to integrate multiple disciplines into creative activities. The presence of a significant population of school-aged children further strengthens opportunities to develop literacy and creativity that are relevant to both local and global needs.

This potential can be realized through various learning programs that utilize local resources to hone STEAM-based skills. For instance, bamboo can be used to create string art, which combines art and engineering elements. Fish ponds can serve as a medium for science learning, such as simple water filter experiments, while rice plants can be incorporated into real-life numeracy learning. These programs not only enhance literacy and creativity but also increase the relevance of education to the daily lives of children in Bengkung Hamlet.

Observations and analysis indicate that the local wisdom-based STEAM approach in Bengkung Hamlet has the potential to create an inclusive and sustainable learning ecosystem. According to the FGD results, the community strongly supports this initiative, appreciating TBM's role in facilitating literacy and creativity activities for school-aged children. Collaboration among the community, educational institutions, and the local environment can significantly improve children's skills while preserving the cultural and traditional values that define the community's identity. This approach not only promotes literacy improvement but also shapes a young generation capable of integrating modern technology with local wisdom, creating innovative solutions relevant to future challenges.

Local Wisdom-Based STEAM Activities

The development of STEAM activities in Bengkung Hamlet aims to enhance literacy and creativity among school-aged children through a local wisdom-based approach. The results of FGDs generated several innovative activities, such as balloon-powered cars to teach basic science principles using simple materials and string art utilizing local bamboo to foster creativity. Other activities include straw bridge construction to teach basic construction techniques with eco-friendly materials, fabric dyeing using tie-dye techniques with natural dyes from local plants, simple water filter experiments using sand and stones, CBS-powered rocket creation, and simple technologies such as paper

speakers and thermometers designed to introduce science and technology through a contextual approach.

These activities are designed to be flexible, conducted either indoors or outdoors, and emphasize relevance to the daily lives of children. This local wisdom-based approach enables children to practically understand scientific and technological concepts while appreciating the natural resources around them. Each activity fosters collaboration, creativity, and exploration, enriching the learning experience while strengthening the cultural identity of Bengkung Hamlet's children.

These activities demonstrate significant potential for building sustainable literacy and creativity within the local community. Using natural materials and local resources not only ensures efficiency but also integrates ecological and cultural values into children's learning experiences. This approach creates a space where science, technology, art, and culture interact harmoniously, establishing Bengkung Hamlet as a unique model for local wisdom-based STEAM education that can be replicated in other communities. This integration showcases how innovation can be rooted in local culture without limiting children's exploration and learning capabilities.

The Role of TBM and Rumah Belajar Pelopor Literasi Dusunku

TBM Pelopor Literasi Dusunku and the Rumah Belajar initiative play a central role in implementing STEAM-based literacy programs. One of TBM's primary contributions is facilitating learning by providing learning spaces equipped with reading materials, teaching aids, and STEAM learning media. Additionally, literacy training conducted by TBM volunteers helps children understand STEAM concepts through simple and enjoyable approaches. Collaboration with thematic literacy community service programs (KKN) from UIN Sunan Kalijaga further strengthens STEAM implementation through tie-dye activities and social media-based marketing training.

The presence of TBM and Rumah Belajar has significantly impacted improving critical thinking and creativity skills among children in Bengkung Hamlet. This local wisdom-based approach not only connects children with their cultural values but also provides opportunities to utilize local resources in

learning. This has proven effective in creating exploratory spaces that holistically support children's potential development.

The roles of TBM and Rumah Belajar extend beyond learning centers to become catalysts for community-level change. By leveraging collaboration with universities and maximizing local resources, TBM has successfully created an inclusive and innovative educational ecosystem. This approach demonstrates how the integration of local wisdom, STEAM-based education, and collaboration can provide sustainable impacts on literacy and creativity development in rural communities. This transformation reflects the immense potential of community-based education models to be adapted in other contexts with relevant adjustments.

Integration of STEAM Activities with GLN Literacy

As part of the National Literacy Movement (GLN), STEAM activities developed in Bengkung Hamlet encompass various types of literacy. The following table shows the correlation between STEAM activities and GLN literacy indicators:

Table 1. Correlation of STEAM Activities with GLN Literacy

No	Program	Reading-Writing	Numeracy	Science	Financial	Digital	Cultural & Civic
1	STEAM activity development	✓	✓	✓	-	✓	✓
2	Social media talk shows (Instagram)	-	-	-	-	✓	✓
3	Village map creation	✓	-	✓	-	✓	-
4	Tutoring for preschool and elementary students	✓	✓	✓	-	-	-
5	Creativity development using reading materials	-	-	✓	✓	-	-

6	Creative economy movement with technology	✓	-	-	✓	✓	-
7	Organic and non-organic waste management	-	-	✓	-	-	-

The table above shows that STEAM activity development strongly correlates with various types of literacy, particularly reading-writing, numeracy, science, and digital literacy. Social media talk shows (Instagram) effectively enhance digital and civic literacy, providing children with opportunities to engage in discussions relevant to their lives. Village map creation integrates reading-writing, science, and digital literacy, encouraging children to understand their local environment's structure. Tutoring activities encompass reading-writing, numeracy, and science literacy, forming the foundation of children's understanding in formal education.

Overall, integrating STEAM activities with GLN literacy creates holistic and contextual learning opportunities for Bengkung Hamlet's children. This approach not only enhances multidimensional literacy competencies but also fosters cultural and ecological awareness among children. This impact highlights the great potential of literacy-oriented STEAM education models to support sustainable education agendas in Indonesia.

Implications for Enhancing Children's Literacy and Creativity

The research results show that a local wisdom-based STEAM approach through TBM and Rumah Belajar has a positive impact on improving children's literacy and creativity. Engaging STEAM activities have successfully encouraged children's reading interest, making them more enthusiastic about learning. Furthermore, the exploratory spaces provided through local wisdom-based activities offer opportunities for children to develop their creativity by utilizing surrounding resources.

Moreover, the STEAM approach has proven effective in enhancing holistic literacy, including reading-writing, numeracy, science, and civic literacy, which are relevant to the community's daily life. The program's sustainability is supported by local community involvement and the utilization of local resources, creating a continuously evolving learning ecosystem. This establishes the local wisdom-based STEAM approach as a relevant and effective educational model that can be implemented in other communities.

This research reveals an innovative STEAM learning model rooted in local wisdom, significantly impacting literacy and creativity improvement among children in Bengkung Hamlet. This model integrates reading-writing, numeracy, science, and culture into activities relevant to daily life. Furthermore, this approach empowers local communities through sustainable resource utilization.

This model can be adapted to various communities with similar characteristics, particularly those with similar traits. The local wisdom-based STEAM approach not only supports sustainable education goals but also strengthens cultural and ecological identity. With appropriate adaptations, this model can inspire literacy and creativity programs for children in various regions, bridging the gap between modern education and preserving local values.

DISCUSSION

The exploration of local potential in Dusun Bengkung for STEAM activities, as identified in this study, aligns with the growing emphasis on integrating community resources into educational practices. Local resources, such as bamboo, paddy fields, and fish ponds, offer a unique opportunity to contextualize STEAM education within students' daily lives, fostering meaningful and relatable learning experiences. Previous studies have highlighted the importance of leveraging local knowledge and resources to enhance education, particularly in underserved areas (Donatuto et al., 2020; Kiyani et al., 2020). Furthermore, the strong social traditions in Dusun Bengkung, such as *gotong royong*, provide a collaborative foundation that resonates with cooperative learning models emphasized in sustainable education (Colomer et al., 2021; Maidatsi et al., 2022). These elements position

Dusun Bengkung as a promising model for implementing localized STEAM education.

The study's findings revealed significant enthusiasm among community members for the role of the community reading garden (*TBM*) and the *Rumah Belajar* initiative in advancing literacy and creativity through STEAM. Activities such as balloon-powered cars, bamboo-based string art, and natural dye techniques demonstrate the feasibility of integrating local wisdom into practical educational programs. These results align with research that emphasizes the role of hands-on, culturally relevant activities in increasing student engagement and fostering creativity (Caplan, 2017; Fields & Kafai, 2023; Potvin et al., 2023; Tillinghast et al., 2020). Unexpectedly, the study also found that activities integrating natural and digital literacy, such as mapping the village and social media workshops, resonated strongly with both students and volunteers, suggesting a growing interest in combining traditional and modern literacies (M.-K. Chen & Wu, 2024; Montes et al., 2024).

Comparisons with prior research highlight both consistencies and divergences. Similar to findings by Maidatsi et al. (2022), this study demonstrated that using local materials, such as bamboo, can effectively contextualize STEM education to promote sustainability. However, unlike Maidatsi et al., who focused on IoT integration, this research highlights simpler, hands-on approaches, underscoring the adaptability of STEAM frameworks to different resource contexts. Moreover, the collaborative aspects of STEAM activities in Dusun Bengkung echo findings by Colomer et al. (2021), emphasizing the importance of cooperative learning, but this study uniquely ties such cooperation to indigenous social traditions like *gotong royong*.

In contrast, some aspects of this research diverge from previous studies. For instance, while Montero and Jormanainen (2017) emphasized the use of robotics and high-tech tools in inclusive STEAM education, this study's reliance on low-tech, resourceful approaches demonstrates the viability of achieving similar educational outcomes in resource-limited settings. This contrast underscores the flexibility of STEAM methodologies in accommodating diverse educational and socioeconomic environments. Additionally, this study's integration of literacy-based activities into the STEAM framework aligns with

findings by Donatuto et al. (2020) but expands on them by including digital literacy and entrepreneurship elements, as supported by Chen et al. (2022).

The findings of this study can be attributed to the alignment of STEAM activities with the cultural and environmental context of Dusun Bengkung. Activities such as string art and natural dyeing harness local materials and traditional knowledge, making education relatable and sustainable. This aligns with theories of situated learning, which propose that education is most effective when grounded in authentic contexts (Röttger-Rössler, 2024; Wise et al., 2022; Zayyinah et al., 2022). Moreover, the success of *TBM* in facilitating these activities reflects the crucial role of community centers in bridging formal and informal education, as noted by Tillinghast et al. (2017) and Montes et al. (2024).

Despite these promising outcomes, it is essential to interpret the findings with caution. The reliance on community volunteers and local materials, while a strength, also poses challenges for scalability and consistency across different regions. Similar concerns have been raised in other community-based education studies (Maidatsi et al., 2022; Milara et al., 2020; Randolph et al., 2022). Furthermore, while the activities demonstrated potential in enhancing literacy and creativity, their long-term impact on academic achievement and socio-economic mobility remains to be evaluated.

The implications of this research are multifaceted. For educators, it provides a model for integrating STEAM education with local wisdom, thereby fostering cultural sustainability and environmental awareness. For policymakers, it underscores the need to support community-based educational initiatives with funding and infrastructure to ensure scalability and sustainability (Ovcharuk & Soroko, 2024; Patrick, 2020). Additionally, the findings advocate for the inclusion of digital literacy in rural education programs, aligning with global trends in educational innovation.

Overall, this study contributes to the growing body of literature on STEAM education by demonstrating the potential of local resources and traditions to enhance learning outcomes. Future research should explore the longitudinal impact of such programs on students' academic and socio-economic trajectories. Additionally, comparative studies across regions with different

cultural and environmental contexts could provide further insights into the adaptability and scalability of localized STEAM education frameworks.

CONCLUSION

This study highlights the significant potential of Dusun Bengkung's local resources for advancing STEAM-based education by integrating local wisdom, such as cultural traditions, natural resources, and the unique demographic characteristics of the community. Key findings reveal that activities like bamboo-based string art, natural dyeing using local plants, and water filtration techniques leveraging indigenous materials can effectively enhance literacy, creativity, and environmental awareness among learners. These activities illustrate how STEAM can be adapted to local contexts to foster not only educational outcomes but also cultural preservation and community sustainability. The study provides a practical framework for educators to integrate interdisciplinary approaches into rural education and encourages policymakers to support community-based educational models that bridge traditional knowledge with modern innovation.

However, this study acknowledges its limitations, particularly its focus on a single rural community, which may restrict broader applicability. The long-term impact of these activities on academic performance and socio-economic development remains unexplored. Future research should investigate the scalability and adaptability of this model in different cultural and ecological settings, as well as its effectiveness in improving learners' competencies over time. Additionally, the integration of digital tools within these localized STEAM frameworks offers a promising direction to address the growing demand for digital literacy in rural education systems, ensuring their relevance in modern educational landscapes.

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