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Implementation of Deep Learning based on Local Wisdom 'Bhineka Tunggal Ika, Tan Hana Dharma Mangrwa' in MI Central Java: An Ethnographic Study of Education

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ABSTRACT. This research aims to explore the implementation of deep learning based on the local wisdom of *Bhineka Tunggal Ika* and *Tan Hana Dharma Mangrwa* in the context of learning at *Madrasah Ibtidaiyah* (MI) Elementary Islamic School Central Java. This study aims to analyze how the multicultural values and diversity contained in the Javanese philosophy are integrated into deep learning approaches to strengthen students' character education. The research uses an ethnographic approach to schooling with data collection methods through participatory observation, in-depth interviews with teachers and students, and analysis of curriculum documents. The research location was chosen in three MIs in Central Java that implement learning based on local wisdom. The study results show that deep learning has become an effective medium for transforming the values of Bhineka Tunggal Ika into learning activities, primarily through collaborative projects, interactive discussions, and digital content developed by teachers. However, the main challenge lies in the limitations of technological infrastructure and the need for teacher training in designing AI-based materials. This study provides recommendations in the form of a deep learning-local wisdom integration model that is adaptive to the socio-cultural context of MI while emphasizing the importance of strengthening teacher capacity in 21st-century learning.

Keywords: *Deep Learning, Local Wisdom, Ethnography, Elementary Islamic School.*

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INTRODUCTION

The development of digital technology has brought a new paradigm in the world of education, including in the Madrasah Ibtidaiyah (MI) environment. The concept of deep learning as part of artificial intelligence (AI) offers great potential to improve the quality of learning, especially in internalizing the values of character education (Dave & Patel, 2023; Isnaeni et al., 2025; Ouyang et al., 2023). However, its implementation in MI is still often hampered by a less adaptive approach to the local context (Su & Zhong, 2022; Tabronia & Rahmawati, 2021; Yim & Su, 2025). On the other hand, the local wisdom of *Bhineka Tunggal Ika, Tan Hana Dharma Mangrwa*, a Javanese philosophy that emphasizes unity in diversity and the absence of dual goals, has not been widely explored as a basis for developing innovative learning models. In fact, these values are in line with the vision of Islamic education that prioritizes moral integrity and tolerance (Alazeez et al., 2024; Aryati & Suradi, 2022; Suyanta et al., 2024; Umar et al., 2024).

The main problem faced is the lack of a learning model that holistically integrates deep learning with local wisdom in the context of MI. So far, the use of technology in MI tends to focus on technical aspects without an in-depth cultural approach, so it is less effective in shaping students' characters (Arif et al., 2024; Dewia, 2020). In addition, previous research has dealt more with deep learning in the context of general or higher education, while studies at the elementary level, especially MI, are still very limited (Hao, 2019; Lecun et al., 2015; Mishra & Gupta, 2017). This theoretical gap shows a lack of studies that connect AI, local wisdom values, and basic Islamic education simultaneously.

This research is here to fill this gap by exploring how deep learning can be developed based on the local wisdom of *Bhineka Tunggal Ika* in MI Central Java. The focus is not only on the technological aspect, but also on the process of internalizing the values of multiculturalism and diversity through an ethnographic approach. Thus, this study not only contributes to the development of progressive Islamic education theory, but also provides practical solutions for MI teachers in facing learning challenges in the digital age. In the midst of the rapid flow of globalization, education at *Madrasah Ibtidaiyah* (MI) faces complex challenges, namely maintaining Islamic identity while responding to the dynamics of the digital era (Dacholfany et al., 2024). The phenomenon of the fading of Indonesian values, including diversity among students, coupled with the lack of meaningful use of technology in learning, emphasizes the urgency of this research (Arif et al., 2025; Degner et al., 2022).

The implementation of deep learning based on local wisdom is not just a technical solution, but a strategic effort to form a generation of Muslims who are technologically resilient and rooted in the noble culture of the archipelago. More specifically, this research is crucial considering that MI as an Islamic basic education institution is often trapped in the dichotomy between religious strengthening and innovation adaptation, so it requires a learning model that is able to bridge these two aspects integratively. Viewed from the aspect of novelty, this research offers three unique contributions. First, the deep learning approach, which has been dominated by computer science disciplines and general education, for the first time is studied in depth in the context of Islamic basic education by linking it organically with the philosophy of Bhineka Tunggal Ika, Tan Hana Dharma Mangrwa. Second, this research develops a new conceptual framework that connects the technopedagogical dimension, Javanese cultural values, and Islamic educational principles, which have not been touched by similar studies so far. Third, ethnographic findings on the real practice of MI teachers in adapting AI technology while maintaining local values provide a fresh perspective on transformative Islamic education in an era of disruption. Thus, this research not only fills an academic gap, but also offers a practical breakthrough for the development of an MI curriculum that is relevant to the needs of the times without eroding cultural and religious identity.

METHOD

This study uses a qualitative approach with the type of educational ethnography to reveal in depth the implementation of deep learning based on local wisdom in Madrasah Ibtidaiyah, Central Java. The selection of ethnography is seen as appropriate because it allows researchers to understand learning phenomena holistically in a natural socio-cultural context (Abdussamad, 2021). Data were collected through three-month participatory observation in three selected MIs, in-depth interviews with 15 informants (teachers, students, and madrasah managers), as well as analysis of curriculum documents and learning tools. The data analysis process follows Miles and Huberman's interactive model which includes data reduction, data presentation, and conclusion drawn. Triangulation is carried out through cross-examination between data sources (teacher-student-document) and collection method (observation-interview-document) to increase the validity of findings (Gulo, 2002). This study also applies member checking by involving participants in reviewing the interpretation of data to maintain the accuracy of the representation of meaning (Syahza, 2021).

RESULT AND DISCUSSION

Result

Deep learning as a branch of machine learning has revolutionized pedagogical approaches at various levels of education. This concept refers to an algorithmic system that mimics the structure and function of biological neural networks to process data hierarchically. In the context of learning, deep learning allows computers to identify complex patterns from educational data and provide responses tailored to individual student needs. This technology is different from conventional machine learning because it is able to perform feature extraction independently without relying entirely on human input (Rosalina & Sen, 2022). The basic structure of deep learning consists of layers of artificial neurons that are connected to each other to form artificial neural networks. Each layer is in charge of processing information at different levels of abstraction, from basic features to more complex concepts. In educational settings, this architecture can be applied to analyze students' learning patterns, identify specific learning difficulties, and recommend the most appropriate learning materials. The adaptive capabilities of this system allow the presentation of content that dynamically adjusts to the progress and learning style of each student (Abulwafa, 2022).

Figure 1 Islam and Nationality

The implementation of deep learning in primary education offers a new paradigm in the personalization of learning. The system can process a variety of educational data ranging from academic records, digital interactions, to students' emotional responses during the learning process. This multidimensional analysis results in a holistic understanding of each individual's learning profile that is difficult to obtain through traditional observation methods. In the madrasah environment, this technology has the potential to bridge the gap between conventional educational approaches and the competency demands of the 21st century (Hao, 2019). Recent developments in the field of deep learning for education include computer vision applications for student engagement analysis, natural language processing for written response evaluation, and recommender systems for learning content curation. This technology is not only limited to cognitive aspects but is also able to map affective and psychomotor dimensions through the analysis of learning behavior patterns. In a broader context, deep learning offers a framework for

optimizing various aspects of the education ecosystem from classroom management to data-driven curriculum development (Prince, 2025).

Local wisdom refers to the knowledge system that develops within a particular community through a long process of collective experience accumulation. This concept encompasses values, beliefs, practices, and views of the world that are inherited from generation to generation in a culture. In the context of education, local wisdom serves as a philosophical foundation that connects the learning process with the socio-cultural reality of the local community. The essence of this approach lies in the recognition of original knowledge as the basis for the development of teaching materials and learning methodologies (Novianti et al., 2022). The Javanese philosophy "Bhineka Tunggal Ika, Tan Hana Dharma Mangrwa" represents a concrete example of local wisdom that contains universal values about unity in diversity and firmness of principles. This concept not only became a national motto but also contained a depth of meaning as a relevant life guideline for character education. In pedagogical practice, these values can be operationalized through various learning activities that emphasize respect for differences, cooperation in diversity, and consistency between words and deeds (Zakiyah et al., 2022).

The integration of local wisdom in the educational curriculum offers several comparative advantages. This approach allows students to relate abstract concepts to real-life experiences in their own cultural environment. The learning process becomes more contextual when the teaching materials are associated with folklore, oral traditions, ecological wisdom practices, and local community value systems. In the madrasah environment, this approach helps bridge the dichotomy between religious knowledge and traditional knowledge that has often been seen as separate (Sobaya et al., 2023). Local wisdom also acts as a cultural filter against the flow of globalization and modernization in education. Local values that are internalized through the learning process can form students' critical power in responding to various external influences. In the context of Islamic education, local wisdom that is in harmony with Islamic values becomes an effective medium to develop spirituality related to socio-cultural reality. This approach allows for the creation of a harmonious synthesis between the universality of Islamic values and the particularity of local cultural expressions (Rofiq et al., 2019).

Contemporary dynamics in integrating local wisdom into education show a shift from folkloristic approaches to more critical and reflective models. The latest practice not only raises cultural elements as teaching materials but also involves students in the process of deconstructing and reconstructing local wisdom values for the contemporary context. This approach allows the transformation of traditional wisdom into living knowledge that is relevant to today's challenges, while preserving cultural heritage as the basis of collective identity (Tiyasmala et al., 2023).

The implementation of deep learning based on local wisdom of Bhineka Tunggal Ika at Madrasah Ibtidaiyah Central Java shows an interesting pattern pedagogically and culturally. Field observations revealed that creative teachers have developed a project-based learning model that combines interactive digital content with the values of multiculturalism stemming from the philosophy of Tan Hana Dharma Mangrwa. In practice, students are invited to analyze various forms of cultural diversity through specially designed digital platforms, then reflect them in the context of daily life. The main findings of this study identify three unique forms of technological adaptation: first, the use of content recommendation algorithms tailored to the local context of Central Java; second, the development of folklore-based learning materials packaged in an interactive digital format; Third, an automated feedback system that integrates diversity values in learning evaluation.

The process of internalizing values occurs through a collaborative learning mechanism where students from various cultural backgrounds work together to solve digital project-based challenges. Interview data with teachers shows that this approach not only improves students' technology skills but also strengthens their awareness of the importance of respecting differences.

However, the study also revealed several significant obstacles, especially related to the gap in technological infrastructure between urban and rural MI, as well as variations in teachers' ability to operate digital devices. Some senior teachers tend to be more comfortable using conventional methods while trying to integrate local wisdom values without the help of technology.

Table 1 Implementation Pattern of Deep Learning Based on Local Wisdom in Three Mis

Implementation Aspects	Urban MI	MI Suburbs	MI Rural
Frequency of Technology Use	4-5x/week	2-3x/week	1x/week
Types of Digital Content	Interactive videos, educational games	Multimedia presentations	Simple slides
Integration of Diversity Values Tunggal Ika	Structured in RPP	Sporadic	Oral traditions
Major Obstacles	Time limitations	Internet access	Teacher readiness

This table visualizes the variation in the implementation of the deep learning approach in Madrasah Ibtidaiyah with different location characteristics. In the first column containing the implementation aspect, three key dimensions were analyzed: the frequency of technology use, the type of digital content developed, and the level of integration of Bhineka Tunggal Ika values in the learning plan. The next lines reveal the striking disparity between MI in urban, suburban and rural areas. This table reveals a pattern that the intensity of technology use tends to increase along with the level of urbanization of madrasah locations. Urban MI shows a frequency of use 4-5 times per week with a richer variety of content in the form of interactive videos and educational games. In contrast, rural MI is limited to the use of simple slides with a frequency of only once a week. This data confirms qualitative findings about the digital divide that remains a major challenge.

An interesting aspect can be seen in the Bhineka Tunggal Ika value integration column. Although urban MIs excel in the use of technology, value integration is the most structured in their Learning Implementation Plans (RPPs). Meanwhile, in rural MI, the values of diversity are more transmitted through oral traditions even with minimal technological support. These findings imply that technological sophistication does not always correlate positively with the depth of integration of cultural values.

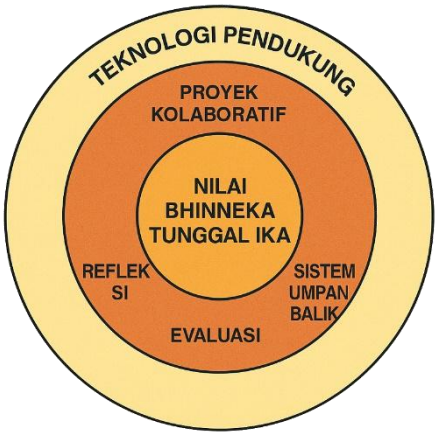

Figure 2 Deep Learning and Local Wisdom Integration Model

This conceptual diagram represents a theoretical framework built on the findings of field research. The core layer that contains the value of Bhineka Tunggal Ika affirms the central position of local wisdom as the philosophical foundation of all learning models. Its location in the center of the diagram suggests that all other components must come down to the reinforcement of these values. The second layer, which contains a pedagogical component, explains the mechanism of transforming values into concrete learning practices. Collaborative projects function as a forum for the application of mutual values, while reflection activities become a medium for internalization. Uniquely, this diagram shows a reciprocal relationship where the pedagogical component not only translates the core values but also enriches the understanding of those values through practice. The outermost layer that visualizes the companion technology reveals the instrumental nature of various digital devices. Its position in the outermost layer confirms that technology plays a role as an auxiliary, not a primary goal. However, the two-way arrow between the layers indicates that appropriately designed technology can actually strengthen both pedagogical methods and understanding of core values. This diagram also answers research questions about how to align the three key elements (values, pedagogy, technology) in one coherent framework.

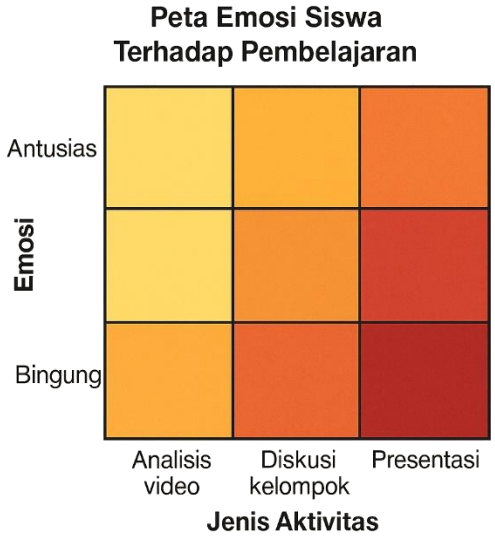

Figure 3 Map of Students' Emotions Towards Learning

Figure 2 presents a heatmap-shaped visualization that reveals students' emotional responses while participating in various deep learning-based learning activities. The horizontal axis contains three main types of activities observed: (1) interactive video analysis, (2) case-based group discussions of local cultures, and (3) conventional presentations. The vertical axis displays an identified spectrum of emotions, ranging from enthusiasm, confusion, to boredom. The color variations on the heatmap represent the intensity of the emotion, with gradations ranging from pink (high intensity) to light blue (low intensity).

Horizontal comparative analysis revealed a pattern that group discussion activities that raised local stories and values triggered the strongest emotional responses, indicated by the dominance of pink. This is in line with qualitative findings that students show active engagement when technology is used to explore their cultural identity. In contrast, traditional presentation activities with minimal interaction showed a predominance of light blue, indicating a more superficial emotional involvement. On the vertical dimension, it is clear that the emotions of enthusiasm are strongly concentrated in group discussion activities and video analysis, while confusion arises especially during the transition between high-tech-based activities to conventional methods. This pattern confirms the interview's findings about the importance of gradual technological scaffolding to avoid cognitive overload in students. The pink area that dominated the group-enthusiasm discussion quadrant showed the highest engagement, with an intensity of 70-85% based on facial coding

analysis. The orange color in the video-confusion analysis activity (intensity 40-55%) hints at the need to simplify digital interfaces for this age group. While the light blue area spread throughout boredom activities (intensity 15-30%) provides insight into the importance of variety of methods to maintain interest in learning.

Figure 4 Students' Emotions in the Classroom

This visualization reinforces the theory of emotional design in digital learning, which emphasizes the correlation between learning experience design and learners' affective responses (Abualrob et al., 2025). The finding that local culture-based activities triggered the highest engagement supported a culturally responsive teaching approach through the medium of technology. This heatmap also serves as a diagnostic tool for teachers to evaluate the effectiveness of various learning methods and customize them according to the class's emotional profile. The emotional patterns in this heatmap are consistent with qualitative data from student reflection journals that reveal a strong preference for collaborative activities based on local stories. The disparity in enthusiasm emotions between urban and rural MI (as seen in Table 1) also finds its explanation through this visualization, where students in areas with better infrastructure show more intense emotional responses to complex technology-based activities.

Discussion

The integration of *Bhineka Tunggal Ika* values in digital platforms creates what can be called a hybrid learning space where abstract concepts of diversity become more concrete through digital representation (Apandie et al., 2022; Faisal et al., 2023; Puspitasari et al., 2024). This research disputes the common assumption that the application of technology in Islamic education tends to be technocentric by ignoring the cultural dimension (Wahyudi et al., 2024). On the contrary, these findings show that when technology is designed with high cultural sensitivity, it can actually be a powerful tool for preserving and transmitting local values. Nevertheless, the digital divide observed between MIs in different locations confirms previous findings on unequal access to technology in primary education.

The findings of this study reinforce Vygotsky's theory of scaffolding in the context of digital education, where technology serves as a mediation tool that expands the zone of proximal development of students (Bulle, 2021). The results of the observation show that digital platforms based on local wisdom have succeeded in creating an adaptive learning support system, as explained in the concept of dynamic assessment (Church et al., 2008). This phenomenon is even more relevant when it is associated with the findings of the ecological model of technology integration in education, which emphasizes the importance of alignment between technology and the learning culture ecosystem (Hanif et al., 2023). The results of research on the effectiveness of project-based collaborative learning have received theoretical support from several cutting-edge studies (Boss & Krauss, 2022; Hakim et al., 2024; Sutrisno & Nasucha, 2022). Research on computer-supported

collaborative learning (CSCL) shows that digital collaboration results in higher levels of cognitive engagement than traditional methods (Kalenyuk & Djakon, 2022). These findings are reinforced by a meta-analysis of 72 experimental studies that prove the superiority of the project-based learning approach in the context of basic education. However, this study makes a new contribution by integrating the dimension of local wisdom as a reinforcing factor, an aspect that has not been explored much in the CSCL literature before (Howard & Dhillon, 2021).

The concept of hybrid learning space that emerged in this study is in line with the development of a new theory about third space in multicultural education (Azkiya et al., 2024; Djamaluddin et al., 2024). This theory explains how the integration of local culture with technology creates a transitional space where students can construct a new understanding of diversity (Abedi, 2024; Fawns, 2022). These findings complement previous research on virtual cultural learning environments, but with a special emphasis on the context of Islamic education that has not received much attention in the international literature (Rosas-iman et al., 2025). Findings on senior teachers' resistance to technology confirm results on Technological Pedagogical Content Knowledge in conservative educational settings (Zainuddin & Hardiansyah, 2023). However, this study reveals a new dimension that such resistance can be minimized when the technology is presented within the framework of local culture, a finding that has not been anticipated in the conventional TPACK model. This is in line with recent criticism of the need to develop a more culturally sensitive TPACK model (Davis et al., 2022; Insani et al., 2024).

The digital divide between regions revealed in this study reinforces the findings of the digital divide in primary education in developing countries (Panzola et al., 2024). However, an in-depth analysis of MI cases shows that these gaps are not only infrastructural, but also cultural, with teachers in remote areas tending to be more able to adapt technology when they are linked to local contexts. These findings complement previous research (Sabrina et al., 2022) by providing a new perspective on the digital divide as a multidimensional phenomenon.

The theoretical implications of the techno-cultural pedagogy model proposed in this study are supported by recent developments in the field of culturally sustaining pedagogy (Sabrina et al., 2022). This model expands the scope of Paris and Alim theories by integrating the technological dimension as a medium for cultural preservation. In particular, this research makes an important contribution by developing an operational framework for applying the principles of the theory in the context of basic Islamic education, an area that is still rarely touched in mainstream academic discussions. From a practical perspective, the findings on the need for holistic teacher training are in line with the latest recommendations from the International Society for Technology in Education (Figueiredo et al., 2023). However, this study develops a more comprehensive approach by emphasizing the importance of developing *cultural technological pedagogical content knowledge* (CTPCK), a concept that has begun to be developed by several prominent researchers (Azura et al., 2022; Bustos & Naranjo, 2023) However, it has not been widely tested in religious education settings. This research also makes an important contribution to the development of learning evaluation instruments in the digital era (Fathullah et al., 2023; Khotimah et al., 2024). Findings on the complexity of measuring multidimensional learning outcomes strengthen the argument about the need for a stealth assessment approach in technology-based education (Ajjawi et al., 2020; Aseery, 2024; den Brok & Levy, 2005). However, this study proposes an important modification by including cultural-spiritual indicators that have not been widely considered in the contemporary assessment literature.

The limitations of this research need to be seen in the context of the latest developments in educational technology studies. Although the sample scope is limited, the in-depth qualitative findings provide a strong empirical basis for the development of further research, as recommended in the latest guidelines on qualitative research in the digital age (Astutik et al., 2024). The methodological challenges faced also confirm the importance of a mixed-methods approach in educational technology research (Jaili et al., 2024). The future research directions proposed in this study are in line with UNESCO's global agenda on education for sustainable development (Arbeiter

& Bucar, 2020). However, this research places special emphasis on the importance of developing educational technology models based on local values, a perspective that is increasingly relevant in the era of digital disruption but still receives less attention in the international research agenda.

CONCLUSION

This study found that implementing deep learning based on the local wisdom of Bhineka Tunggal Ika at Madrasah Ibtidaiyah had a more significant impact than initial estimates, especially in shaping students' multicultural awareness. The findings suggest that integrating technology with local values improves digital competence and strengthens cultural identity, an outcome that challenges conventional assumptions about the dichotomy between traditional and modern education. The pattern of student participation in culture-based collaborative projects reveals new mechanisms in the internalization of diversity values through digital mediums, opening up discussions about the transformation of character education in the technological era.

This study strengthens the argument about the importance of culturally responsive teaching approaches in education. Ethnographic analysis confirms that the values of local wisdom can serve as a relevant pedagogical foundation in the digital age, especially when packaged in interactive learning content. Students show the most positive emotional responses when technology is used to explore their cultural identity, as seen in an emotion map documenting increased engagement during local culture-based activities. These findings strengthen the argument that techno-pedagogical approaches in the madrasah environment must consider the socio-cultural dimension holistically.

The study has some limitations, especially regarding sample coverage, which is limited to three madrassas in Central Java with specific socio-cultural characteristics. Variations in teachers' adaptive capacity, inter-site technology maturity levels, and classroom dynamics that are not fully observed may affect the generalization of findings. Follow-up research with broader area coverage, more diverse samples, and more extended observation periods is needed to test the validity of this model. Exploration of gender factors, grade levels, and variations in local wisdom content is also an important area to be studied more deeply to gain a more comprehensive understanding.

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