Implementation of the Tulak-Tulak Script–Based Deep Learning Approach in Animal Life Cycle Learning as an Effort to Digitize Cultural Heritage

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Abstract: Local wisdom education can preserve traditional scripts (such as Tulak-Tulak) which are threatened with extinction by incorporating them into learning. This study aims to improve students' understanding of the Animal Life Cycle material through the application of a deep learning approach based on the Tulak-Tulak script as an effort to digitize and preserve Mandailing culture. The study was conducted at SD Negeri 150 Tano Bato, Mandailing Natal Regency, with 22 fourth-grade students as subjects. The method used was classroom action research (CAR) consisting of two cycles, each consisting of the planning, action, observation, and reflection stages. Data were collected through observation, interviews, and written tests. The results of the study showed a significant increase in student learning outcomes, with the percentage of completion increasing from 23.8% in Cycle I to 90.9% in Cycle II. The application of a deep learning approach based on meaningful, mindful, and joyful learning has been proven to improve students' conceptual understanding and foster higher learning interest. The integration of the Tulak-Tulak script in learning not only provides a contextual and interactive learning experience, but also introduces and preserves local cultural values through the science learning process. Thus, the implementation of the Tulak-Tulak script-based deep learning approach is an effective innovation in improving the quality of learning while strengthening efforts to digitize regional cultural heritage in elementary education environments.

Keywords: Animal life cycle; Cultural digitalization; Deep learning; Tulak-tulak script

Introduction

The objective of this study is to improve students' conceptual understanding of the Animal Life Cycle material through the implementation of a deep learning approach integrated with the Tulak-Tulak script. This integration aims not only to strengthen students' scientific comprehension but also to support the digital preservation of Mandailing cultural heritage within elementary education.

Based on Law Number 20 of 2003 concerning the National Education System, Article 1 paragraph 20, learning is defined as a process of interaction between students and educators and learning resources in a learning environment. Thus, there are five forms of interaction that can occur during the teaching and learning process, namely: (1) the interaction between educators and students; (2) the interaction between students or between peers; (3) interaction between students and resource persons; (4) interaction between students and educators with specially designed learning resources; and (5) the interaction between students and educators with the social and natural environment (Faizah & Kamal, 2024). In essence, the concept of learning is an activity carried out by educators to assist students in the learning process. This means that learning activities aim to place students in conditions that allow for behavioral changes in accordance with the

expected goals. In this process, there are several important components that are part of learning, namely: (1) physical environment, (2) social environment, (3) presentation methods or strategies by the teacher, (4) learning content or materials, (5) learning implementation process, and (6) learning outcomes or products.

Student understanding is a cognitive aspect that demonstrates a student's ability to grasp the meaning of learning material. Within the realm of cognitive taxonomy, understanding is at a higher level than simply remembering, as it requires students to be able to explain, interpret, classify, summarize, and provide examples of the concepts being studied (Hsu et al., 2021). Understanding is not only oriented towards the final result, namely the correct answer, but also the thought process behind that answer. Therefore, students are said to understand if they are able to rephrase the material in their own words and relate it to different situations (Magdalena et al., 2023).

Understanding is formed through a constructive process, in which students actively construct knowledge based on experiences and new information they receive. This process involves mental activities such as connecting old concepts with new ones, discovering patterns, and forming organized knowledge structures (Saguni, 2020). Learning that provides opportunities for students to discuss, ask questions, explore, and reflect on the material will be more effective in fostering understanding than one-way learning. Thus, the teacher's role is not merely as a transmitter of information, but as a facilitator who helps students construct meaning (Siregar et al., 2024).

Student understanding is also influenced by several factors, such as readiness to learn, interest, motivation, learning strategies, and the learning environment. Students who are highly motivated and feel comfortable in the learning process tend to grasp the material more easily. The use of a variety of learning methods and media can help students visualize abstract concepts more concretely. An interactive and conducive learning environment also supports the development of deeper understanding because students feel safe to express their opinions and ask questions (Sihombing et al., 2024).

A strong understanding will impact higher-order thinking skills. When students truly grasp a concept, they are able to analyze problems, evaluate information, and create new solutions based on their existing knowledge (Erlangga et al., 2023). This demonstrates that understanding is not an end in itself, but rather the foundation for the development of more complex cognitive abilities. Therefore, in the educational process, efforts to improve student understanding must be a top priority so that learning does not stop at memorization but rather produces meaningful and sustainable knowledge.

The deep learning approach offers an interactive and adaptive method that can enhance student understanding. By integrating deep learning into animal life cycles and incorporating the Tulak-Tulak script, students not only gain a better understanding of science but also gain an understanding and appreciation of local culture. The deep learning approach emphasizes learning through critical analysis, linking new information to existing knowledge, and applying it to real-world contexts. The implementation of deep learning at the elementary and secondary levels is expected to positively impact student learning outcomes (Kasi et al., 2025).

The deep learning approach proposed by Abdul Mu'ti emphasizes mindful, meaningful, and joyful learning experiences. Through this approach, students not only memorize but also understand and internalize the subject matter more deeply and reflectively (Fitriani & Santiani, 2025). Meaningful learning is the main foundation of the deep learning approach because it helps students understand the material more deeply, holistically, and integrated with their existing knowledge. Masayu Andayanie et al. (2025) states that this process involves combining new information with students' existing knowledge. This cognitive activity not only adds new knowledge but also builds a more complex and interconnected network of understanding. When students actively connect new concepts or phenomena with previous learning experiences, they gain a deeper and more lasting understanding, unlike rote learning, which is generally shallow and temporary (Sari & Amanda, 2025). Mindful Learning, as the second component, plays a crucial role in fostering full awareness and active student engagement throughout the learning process (Sitopu, 2020). Meaningful learning occurs when students are able to connect new information with prior knowledge, making the material more relevant and easier to understand (Andrews et al., 2023). This approach encourages students to actively participate in the learning process, think critically, and apply their knowledge to real-world situations. The implementation of project-based learning models, such as STEM-PjBL, has been proven effective in enhancing higher-order thinking skills in students (Maryani et al., 2021).

Joyful learning emphasizes the importance of creating a fun and motivating learning environment for students. Through this approach, students are expected to enjoy the learning process, ultimately improving their interest and learning outcomes (Yasid, 2025). The implementation of the joyful learning method, which utilizes songs and teacher creativity, has also proven

effective in strengthening students' memory and understanding of the material (Yasin, 2023).

In basic biology, every organism experiences a life cycle, a series of developmental processes that occur from the beginning of life to the reproductive stage to maintain the continuity of its species (Read & Ashford, 1968). This process is called a cycle because it repeats itself, starting from the beginning and returning to the starting point. The animal life cycle is the biological development process that animals undergo from birth to adulthood and reproduction. This process includes various changes in form, growth, and metamorphosis, depending on the animal species.

Indonesia is an archipelago consisting of 38 provinces, one of the largest being North Sumatra. North Sumatra is home to a diverse ethnic group and culture, one of which is the Batak people. The Batak people are Angkola, Karo, Mandailing, Pakpak/Dairi, Simalungun, and Toba. One of the cultural richness of the Batak people lies in their language, specifically their script, which is a crucial component of the language (Sinaga & Damanik, 2020). One of the functions of the Batak script is writing documents, ancient manuscripts, and other materials. The use of this script continued until the arrival of Islamic influence in the region and remained in use until the late 20th century (Revunenkova & Iankovskaia, 2024).

The Mandailing script is an ancient writing system used as a means of communication to convey information to others in the past. This script is the written language of the people of the South Tapanuli region and is a cultural heritage of our ancestors with high historical value in Indonesia's rich cultural heritage (Lubis et al., 2020). The Mandailing script is categorized as a stand-alone script because it has its own characteristics and distinctive features that distinguish it from other ethnic languages and scripts (Nasoichah, 2018). Its use is now very limited, as it is rarely used in writing stories, except for expressing feelings through writing on bamboo strips known as Ratapan (Amri & Rochmah, 2021). The Mandailing script, also known as Aksara Tulak-tulak, was generally used in the past for shamanism, astrology, letter writing, and lamentations. Early communities typically carved the script on sheets of alim tree bark called pustaha laklak. The Tulak-tulak script itself consists of 21 basic letters known as ina ni surat. The Batak Mandailing script, or tulak-tulak, has long been used by the Batak Mandailing people, from the time when they still adhered to the traditional belief of sipelebegu, which involves the worship of ancestral spirits through offerings, to the time when Islam began to influence the region. In fact, the use of this script continued until the late 20th century (Nasoichah et al., 2021). Therefore, the application of a deep learning approach to the animal life cycle through the Tulak-

Tulak script not only increases the effectiveness of science learning but also contributes to the preservation of Batak Mandailing culture, creating a synergy between science and cultural heritage in education.

The application of modern technology and the preservation of cultural heritage are integrated in this study. By utilizing a deep learning approach, it is hoped that the learning process of the animal life cycle can be more interactive and easier for students to understand. Furthermore, the use of the Tulak-Tulak script as a learning medium also serves to preserve Batak Mandailing culture, which may be increasingly forgotten. This not only improves students' understanding of the material but also contributes to preserving and introducing local culture to the younger generation, making it relevant and engaging.

The objective of this study is to improve students' conceptual understanding of the Animal Life Cycle material through the implementation of a deep learning approach integrated with the Tulak-Tulak script. This integration aims not only to strengthen students' scientific comprehension but also to support the digital preservation of Mandailing cultural heritage within elementary education.

The urgency of this work lies in the diminishing use of the Tulak-Tulak script, a traditional Mandailing writing system that carries significant historical and cultural value. In the current era of technological advancement, educational practices require innovative strategies that connect scientific learning with local cultural contexts. Incorporating this script into science learning activities provides an opportunity to revitalize cultural identity while enriching pedagogical practices.

Deep learning, characterized by meaningful, mindful, and joyful learning experiences, offers an approach that encourages students to construct knowledge through analysis, reflection, and contextual engagement (Fatihah et al., 2025). Embedding this approach into thematic science learning allows students to actively link new concepts with prior knowledge, strengthening both comprehension and learning motivation. Therefore, the application of a Tulak-Tulak script–based deep learning approach is positioned as a pedagogical innovation aimed at enhancing learning quality while simultaneously promoting the preservation and digitalization of cultural heritage in schools (Safardan, 2024).

This study is grounded in constructivist learning theory, which emphasizes that knowledge is actively constructed through learners' interaction with prior experiences and new information. Students achieve deeper understanding when they connect new concepts to their existing cognitive structures rather than relying on rote memorization. Therefore, instructional approaches that promote exploration, reflection, and

contextual engagement are essential to foster meaningful learning.

The research is also supported by meaningful learning theory, which highlights the importance of linking new knowledge with prior understanding to strengthen long-term retention and conceptual mastery. In addition, contextual teaching and learning theory asserts that integrating social and cultural contexts into instruction enhances relevance, motivation, and engagement. Cultural elements can function as cognitive tools that support comprehension rather than merely serving as supplementary content (List et al., 2024).

Furthermore, the concept of deep learning in education underlines the importance of analytical, reflective, and application-oriented learning processes. Deep learning encourages students to develop higher-order thinking skills and achieve conceptual understanding beyond surface-level knowledge. Learning experiences that are meaningful, mindful, and engaging contribute significantly to students' cognitive and emotional involvement (Haditsa et al., 2025).

This research was conducted due to several considerations. First, students' conceptual understanding of science material was observed to be relatively low, with learning often dominated by memorization rather than comprehension. Second, instructional practices frequently lack contextual and culturally relevant integration, reducing students' engagement and internalization of abstract concepts. Third, there is a growing need to incorporate culturally responsive pedagogy in order to preserve local heritage while improving educational quality. Therefore, this study aims to implement an innovative, culturally integrated deep learning approach to enhance students' conceptual understanding and overall learning effectiveness.

Method

Time and Location: This research was conducted over three months at SD Negeri 150 Tano Bato with 22 fourth-grade students. Using the classroom action research method, two cycles were conducted, each implemented through several research stages: planning, action, observation, and reflection. Learning activities integrated the Animal Life Cycle material with the Tulak-Tulak script using an immersive learning approach designed to encourage meaningful, attentive, and enjoyable learning.

The collected data were analyzed through classroom observations, written tests, and student interviews. Observations captured student engagement, written tests measured conceptual understanding, and interviews provided insight into students' learning experiences. Findings from Cycle I were used to revise

instructional strategies for Cycle II, focusing on improving lesson clarity and time management. The study was carried out over four months and aimed to enhance science learning while incorporating local cultural elements.
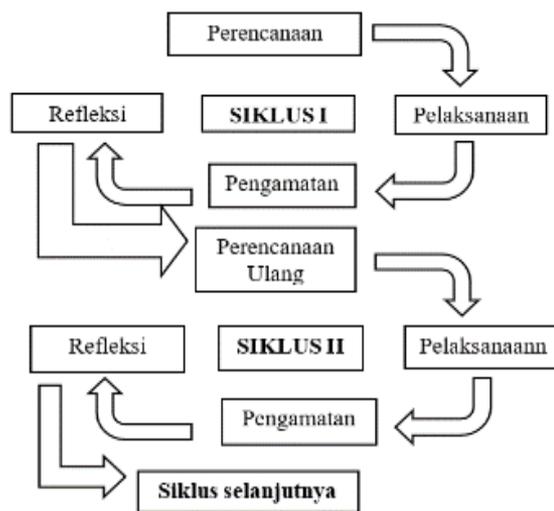

Figure 1. Research implementation stages

Results and Discussion

The results of Cycle I show that students' understanding of the Animal Life Cycle material was still relatively low. Only 23.8% of students achieved mastery, while most students scored below the minimum criteria. Several indicators, particularly indicators 6 and 10, showed weak conceptual comprehension. Although students demonstrated high enthusiasm and positive classroom interactions, difficulties emerged during the explanation and reinforcement stages. Poor time management and the lack of clear conceptual emphasis contributed to students' limited understanding.

Improvements were implemented in Cycle II by refining the pacing of instruction, simplifying explanations, and providing stronger conceptual reinforcement. These adjustments led to a significant increase in learning outcomes, with mastery rising to 90.9% and the class average improving to 78.86. Student performance became more evenly distributed, and no learners remained in the very low category. The clearer alignment between instructional activities and time allocation also enabled more effective reinforcement and feedback.

The integration of the Tulak-Tulak script contributed to increased engagement, as students responded positively to learning materials connected to their cultural environment (Schwartz et al., 2016). This cultural element supported contextual learning and strengthened students' motivation, allowing them to

connect new scientific concepts with familiar cultural symbols. The deep learning approach emphasizing meaningful, mindful, and joyful learning proved effective in fostering deeper understanding (Amri & Rochmah, 2021). Students not only participated actively but also demonstrated improved higher-order thinking skills through more focused questioning and reasoning.

Overall, the results indicate that the combination of improved instructional clarity, disciplined time management, and cultural integration through the Tulak-Tulak script created a more effective learning environment. The findings highlight that culturally contextual deep learning can significantly enhance conceptual mastery while simultaneously supporting the preservation of local cultural identity.

Table 1. Results of Data Analysis of 2 Cycles

Aspect	Cycle 1	Cycle 2	percentage of completion
No complete	16	2	23.8
complete	5	20	90.9

From the data, it can be seen that in Cycle I, time management and instructional design weaknesses occurred. Failure to align activities with the allocation of the lesson plan indicates weaknesses in realistic instructional design. Research by Rasam et al. (2025) confirms that the integration of local content into the curriculum often fails due to a lack of adequate time allocation and measurable planning of learning stages, resulting in cognitive overload on students (Fatkhiyani, 2018).
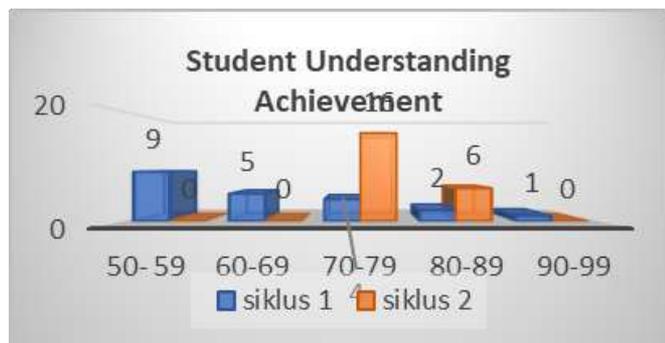

Figure 2. Comparison graph of student understanding in cycle 1 and cycle 2

Failure of Scaffolding and Concept Reinforcement: Symptoms of student confusion (frowns, blank stares) during concept reinforcement indicate that the given material was ineffective. According to Eveline et al. (2023), contextual learning must explicitly connect cultural elements with academic concepts. In Cycle I, this connection may not have been explained well, so that the Tulak-Tulak script was only seen as decoration, not as a thinking tool. Meanwhile, the transformation of Success in Cycle II: Synergy Between Context, Strategy,

and Management. The dramatic improvement in Cycle II, with classical completion reaching 90.9% and equitable understanding, indicates that the problems in Cycle I were instructional in nature, not related to the media or student potential. This success is empirical evidence of the effectiveness of data-driven reflection in classroom action research (MacNeil, 2017).

Key factors for the success of Cycle II are supported by recent research findings: Optimizing Scaffolding and Simplifying Language: Simplifying language and providing step-by-step explanations demonstrates the principle of differentiated scaffolding. This aligns with (Annisha, 2024) recommendation that in culture-based learning, teachers need to be "cultural translators" capable of bridging indigenous knowledge with formal academic knowledge through language appropriate to students' developmental levels.

Time Discipline and Direct Feedback in lesson plan revisions and adherence to time allocations that allow for discussion and reinforcement are key. Recent research by Wang (2023) confirms that the quality of learning time is more important than its quantity. Well-managed time allows for direct and specific formative feedback, which, according to a meta-analysis by (Wisniewski et al., 2020), has a significant impact on correcting misconceptions and consolidating understanding. From Activity to Deep Learning, the transformation into critical inquiry into understanding demonstrates a shift from active learning to deep learning. This confirms the findings of Gupta et al. (2021) that a culture-based approach will only be academically meaningful if it is able to trigger intrinsic motivation and encourage students to connect, reason, and reflect on the characteristics of 21st-century deep learning (Kivunja, 2014).

This proves that the students are now able to understand the material well and reinforce it. The success of the "aksara tulak-tulak" approach, which students have already enjoyed, has finally paid off, as key concepts have been conveyed clearly. The root problem in Cycle 1, namely poor time management, has been completely resolved. After a thorough evaluation of the lesson plans, learning activities in Cycle 2 are now in line with the planned time allocation. Time constraints are no longer a barrier; teachers have sufficient time to facilitate discussions, conduct thorough reinforcement, and provide direct feedback.

Discussing the theoretical and practical implications for local wisdom-based education, the findings of this study provide important contributions and implications, where the refinement of the local wisdom integration model offers a practical model. Culture as a cognitive tool, not just decoration. The Tulak-Tulak script successfully functions as a cognitive tool (Kuswono et al., 2021) after being supported by

appropriate instructional design. This addresses criticisms of culture-based learning that are often considered less substantive. Affirmation of the Importance of Teacher Pedagogical Competence: The success of Cycle II depends heavily on teachers' ability to reflect, adapt, and execute improvements. This reinforces the view of the Ministry of Education, Culture, Research, and Technology (2022) within the Merdeka Belajar framework that teachers as drivers must have learning diagnostic skills and be responsive to feedback. Confirmation of the reflective cycle approach of this study is a concrete example of how a rigorous plan-act-observe-reflect reflective cycle can effectively transform classroom practices, which remains the backbone of improving the quality of learning (Öcal, 2018).

Conclusion

This study shows how better culturally integrated teaching methods have significantly changed students' comprehension of the animal life cycle. Due to serious flaws in the instructional design, particularly in the areas of time management and conceptual emphasis, learning outcomes in Cycle I were unsatisfactory, with just 23.8% of students reaching minimum competence. Students became confused as a result of inadequate scaffolding, and the Tulak-Tulak script's integration was ineffectual—it just served as decoration with no clear links to academic ideas. Cycle II saw a sharp increase with 90.9% of students attaining mastery and a class average of 78.86, because of methodical improvements in language simplification, instructional pace optimization, and stronger conceptual reinforcement. Three crucial elements supported this success: first, the teacher's function as a "cultural translator" who used language that was developmentally appropriate to bridge local knowledge with academics; second, rigorous time management that provided precise and instant formative feedback to clear up misconceptions; and third, the shift from simple activity to deep learning that sparked intrinsic motivation and higher-order thinking abilities. With the help of suitable instructional design, the incorporation of the Tulak-Tulak script now effectively serves as an authentic cognitive tool, allowing students to make connections between new scientific ideas and well-known cultural symbols. This conclusion highlights the significance of teachers' reflective ability in diagnosing, adjusting, and empirically responding to feedback through a rigorous planning, acting, observing, and reflecting cycle, and it demonstrates that the failure of Cycle I was instructional rather than the result of the medium or student potential.

References

Amri, S., & Rochmah, E. (2021). Pengaruh Kemampuan Literasi Membaca Terhadap Prestasi Belajar Siswa Sekolah Dasar. *EduHumaniora Jurnal Pendidikan Dasar Kampus Cibiru*, *13*(1), 52–58. https://doi.org/10.17509/eh.v13i1.25916

Andrews, D., Van Lieshout, E., & Bhatta Kaudal, B. (2023). How, Where, And When Do Students Experience Meaningful Learning? *International Journal of Innovation in Science and Mathematics Education*, *31*(3). https://doi.org/10.30722/IJISME.31.03.003

Annisha, D. (2024). Integrasi Penggunaan Kearifan Lokal (Local Wisdom) dalam Proses Pembelajaran pada Konsep Kurikulum Merdeka Belajar. *Jurnal Basicedu*, *8*(3), 2108–2115. https://doi.org/10.31004/basicedu.v8i3.7706

Erlangga, S. Y., Poort, E. A., Winingsih, P. H., Manasikana, O., & Dimas, A. (2023). Meta-Analisis: Effect size Model Pembelajaran Berbasis Masalah pada Kemampuan Berpikir Tingkat Tinggi (HOTS) dan Pemahaman Konseptual Siswa dalam Fisika. *Compton: Jurnal Ilmiah Pendidikan Fisika*, *9*(2), 185–198. https://doi.org/10.30738/cjipf.v9i2.15685

Eveline, E., Saputro, E. F. H., & Jayanti, I. D. (2023). Modul Fisika berbasis Kearifan Lokal dengan Pendekatan Scaffolding. *Jurnal Pendidikan MIPA*, *13*(4), 911–919. https://doi.org/10.37630/jpm.v13i4.1182

Faizah, H., & Kamal, R. (2024). Belajar dan Pembelajaran. *Jurnal Basicedu*, *8*(1), 466–476. https://doi.org/10.31004/basicedu.v8i1.6735

Fatihah, H., Izzah, I., Nugraha, D. M., & Melinda, C. (2025). Pendekatan Pembelajaran Deep Learning: Sebuah Kajian Literatur Pembelajaran Meaningful, Joyful dan Mindful. *Sosio Religi: Jurnal Kajian*

Pendidikan Umum, *23*(2), 17–24. https://doi.org/10.17509/sosioreligi.v23i2.92139

Fatkhiyani, K. (2018). Pembelajaran Kimia Berbasis Proyek Bermuatan Kearifan Lokal Terintegrasi Pendidikan Karakter. *Gema Wiralodra*, *9*(2), 240–248. https://doi.org/10.31943/gemawiralodra.v9i2.32

Fitriani, A., & Santiani. (2025). Analisis Literatur: Pendekatan Pembelajaran Deep Learning dalam Pendidikan. *Kampus akademik publising Jurnal Ilmiah Nusantara (JINU)*, *2*(3), 51–57. https://doi.org/10.61722/jinu.v2i3.4357

Gupta, R., Srivastava, D., Sahu, M., Tiwari, S., Ambasta, R. K., & Kumar, P. (2021). Artificial intelligence to deep learning: machine intelligence approach for drug discovery. *Molecular Diversity*, *25*(3), 1315–1360. https://doi.org/10.1007/s11030-021-10217-3

Haditsa, H. Q. N., Isnan, I. R., Harsing, H., Supiana, S., & Qiqi, Q. Y. Z. (2025). Inovasi Kurikulum dan Teknologi Pembelajaran (Deep Learning). *EduTeach : Jurnal Edukasi Dan Teknologi Pembelajaran*, *6*(02), 134–143. https://doi.org/10.37859/eduteach.v6i02.9487

Hsu, J. L., Lo, S. M., & Sato, B. K. (2021). Defining Understanding. *The American Biology Teacher*, *83*(6), 372–376. https://doi.org/10.1525/abt.2021.83.6.372

Kasi, Y. F., Bai, D. V., Novia, N., Deporos, S. R. C., & Mababaya, A. D. (2025). Implementation of Deep Learning in School Curriculum: Perspectives of Teachers in Nagekeo Regency. *Paedagogia*, *28*(2), 320–328. https://doi.org/10.20961/paedagogia.v28i2.103377

Kivunja, C. (2014). Innovative Pedagogies in Higher Education to Become Effective Teachers of 21st Century Skills: Unpacking the Learning and Innovations Skills Domain of the New Learning Paradigm. *International Journal of Higher Education*, *3*(4). https://doi.org/10.5430/ijhe.v3n4p37

Kuswono, Sumiyatun, & Setiawati, E. (2021). Pemanfaatan Kajian Sejarah Lokal Dalam Pembelajaran Sejarah di Indonesia. *Jurnal Lentera Pendidikan Pusat Penelitian LPPM UM Metro*, *6*(2), 206–209. http://dx.doi.org/10.24127/jlpp.v6i2.1817

List, A., Campos Oaxaca, G. S., Du, H., Lee, H. Y., & Lyu, B. (2024). Critical culturalized comprehension: Exploring culture as learners thinking about texts. *Educational Psychologist*, *59*(1), 1–19. https://doi.org/10.1080/00461520.2023.2266028

Lubis, B. O., Ghofar Taufiq, Agus Salim, & Budi Santoso. (2020). Penerapan Model Iteratif pada Animasi Edukatif Pengenalan Aksara Mandailing sebagai Pelestarian Warisan Budaya Bangsa. *SATIN - Sains*

Dan Teknologi Informasi, *6*(2), 34–45. https://doi.org/10.33372/stn.v6i2.665

MacNeil, S. (2017). Tools to Support Data-driven Reflective Learning. *Proceedings of the 2017 ACM Conference on International Computing Education Research*, 299–300. https://doi.org/10.1145/3105726.3105745

Magdalena, I., Septianti, N., & Afiani, R. (2023). Pentingnya Memahami Karakteristik Siswa Sekolah Dasar. *Pembelajar: Jurnal Ilmu Pendidikan, Keguruan, Dan Pembelajaran*, *7*(1), 55. https://doi.org/10.26858/pembelajar.v7i1.12019

Maryani, I., Astrianti, C., & Erviana, V. Y. (2021). The Effect Of The Stem-Pjbl Model On The Higher-Order Thinking Skills Of Elementary School Students. *Sekolah Dasar: Kajian Teori Dan Praktik Pendidikan*, *2*(1), 110–122. https://doi.org/10.17977/um009v30i22021p110-122

Masayu Andayanie, L., Syahriandi Adhantoro, M., Purnomo, E., & Tribuana Kurniaji, G. (2025). Implementation of deep learning in education: Towards mindful, meaningful, and joyful learning experiences. *Journal of Deep Learning*, 47-56. Retrieved from https://journals2.ums.ac.id/index.php/jdl

Nasoichah, C. (2018). Aksara Batak Dalam Kebhinnekaan Nusantara. *Kebudayaan*, *11*(1), 1–10. https://doi.org/10.24832/jk.v11i1.13

Nasoichah, C., Susilowati, N., & Restiyadi, A. (2021). Rentang Masa Dan Budaya Mandailing Pada Pustaha Laklak Dan Naskah Bambu Di Bagas Godang Huta Godang, Mandailing Natal. *Berkala Arkeologi Sangkhakala*, *24*(2), 75–86. https://doi.org/10.24832/bas.v24i2.461

Öcal, S. D. (2018). *Action Research as a Tool for Reflection in Teacher Education* (pp. 190–204). https://doi.org/10.4018/978-1-5225-2963-7.ch010

Rasam, F., Sari, A. I. C., Aqil, D. I., & Karlina, E. (2025). Penguatan Kurikulum Merdeka: Perancangan Kurikulum Operasional Satuan Pendidikan (Kosp) Bagi Guru Mi Miftahul Falah. *Jurnal Pengabdian Kepada Masyarakat Batasa : Bangun Cipta, Rasa, & Karsa*, *4*(2), 1–5. https://doi.org/10.30998/pkmbatasa.v4i2.3944

Read, K. L. Q., & Ashford, J. R. (1968). A system of models for the life cycle of a biological organism. *Biometrika*, *55*(1), 211–221. https://doi.org/10.1093/biomet/55.1.211

Revunenkova, E., & Iankovskaia, A. (2024). Batak Priest Books and Techniques of Their Manufacture. *Kunstkamera*, *1*(23), 102–109. https://doi.org/10.31250/2618-8619-2024-1(23)-102-109

Safardan, E. F. (2024). Transforming Educational Quality Through Total Quality Management In The Context Of Deep Learning And The National Curriculum Framework. *International Journal of Management, Innovation, and Education*, 3(2), 038–043. https://doi.org/10.33751/ijmie.v3i2.12743

Saguni, F. (2020). Penerapan Teori Konstruktivis Dalam Pembelajaran. *Paedagogia: Jurnal Pendidikan*, 8(2), 19–32. https://doi.org/10.24239/pdg.Vol8.Iss2.46

Santi Aryanti, S., Abdulaziz, H., Mulyani Slamet, C., Laela Susanti, S., & Mardiana, D. (2025). Implementasi Pendekatan Pembelajaran Mendalam Untuk Meningkatkan Keaktifan Belajar Murid Di Sd Sayang 4 Cianjur. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 10(04), 351–361. https://doi.org/10.23969/jp.v10i04.38045

Sari, V., & Amanda, N. A. J. (2025). Teori Belajar Kognitif Dan Implikasinya Terhadap Pembelajaran. *Harapan: Jurnal Ilmu Kesehatan Dan Psikologi*, 1(2), 52–60. https://doi.org/10.70115/harapan.v1i2.172

Sihombing, H. W., Afandi, M., & Subhan, M. (2024). Faktor-Faktor yang Mempengaruhi Proses Pembelajaran. *AR-RUMMAN: Journal of Education and Learning Evaluation*, 1(2), 685–691. https://doi.org/10.57235/arrumman.v1i2.4320

Sinaga, W., & Damanik, R. (2020). Reproduction of Batak Manuscript for the Purposes of Revitalizing Local and Commercial Wisdom in Samosir Regency, North Sumatera Province. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, 3(4), 3784–3797. https://doi.org/10.33258/birci.v3i4.1443

Siregar, R. G. M., & Albina, M. (2024). Analisis Hasil Survei Refleksi Group Discussion Dalam Pengembangan Pembelajaran Kolaboratif. *QOUBA: Jurnal Pendidikan*, 1(1), 113–118. https://doi.org/10.61104/qouba.v1i1.117

Sitopu, W. F. (2020). Pengaruh Pendekatan Mindful Learning Terhadap Hasil Belajar Aqidah Akhlak Siswa Kelas VIII Di Mts Taman Pendidikan Islam Medan Tahun Ajaran 2019/2020. *Taushiah: Jurnal Hukum, Pendidikan Dan Kemasyarakatan*, 10(1), 78–78. https://doi.org/10.30743/taushiah.v10i1.271

Wang, L. (2023). The Impact of Student-Centered Learning on Academic Motivation and Achievement: A Comparative Research between Traditional Instruction and Student-Centered Approach. *Journal of Education, Humanities and Social Sciences*, 22, 346–353. https://doi.org/10.54097/ehss.v22i.12463

Wisniewski, B., Zierer, K., & Hattie, J. (2020). The Power of Feedback Revisited: A Meta-Analysis of Educational Feedback Research. *Frontiers in Psychology*, 10. https://doi.org/10.3389/fpsyg.2019.03087

Yasid, A. (2025). Deep Learning Based On Joyful Learning In Increasing Learning Motivation. *JALLA*, 1(1), 41–47. https://doi.org/10.65663/jalla.v1i1.88

Yasin, M. (2023). *Metode Joyful Learning Berbasis Lagu Dan Kreativitas Guru Dalam Meningkatkan Hafalan Nadzam Imrithi Kelas Mumtaz Pondok Tremas.* Institut Agama Islam Sunan Giri Ponorogo.