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Developing deep learning-based worksheets using google earth for elementary geography learning enhancement

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ABSTRACT

This study aimed to develop and evaluate a Deep Learning-based Student Worksheet (LKPD) integrated with Google Earth and WebMAGMA for teaching Indonesia's geographical location to fifth-grade elementary school students. A Research and Development approach employing the Four-D (4D) model Define, Design, Develop, and Disseminate was adopted. The worksheet was evaluated through expert validation, practicality testing involving teachers and students, and effectiveness testing using pre-test and post-test assessments. The worksheet demonstrated excellent validity (96.75%) and practicality (95%). Students' mean achievement increased from 53.18 to 86.82, with a high N-Gain (0.71), while learning mastery improved from 4% to 90%. The developed worksheet is valid, practical, and effective for enhancing elementary students' understanding of Indonesia's geographical location while supporting technology-enhanced implementation of the Merdeka Curriculum.

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Introduction

The integration of digital technology into education has accelerated the transformation of learning environments from teacher-centered approaches to student-centered practices that cultivate critical thinking, creativity, collaboration, and problem-solving competencies (Khadka et al., 2025; Safirah et al., 2024). In elementary geography education, this transformation is essential because students are expected to develop spatial thinking, environmental awareness, and conceptual understanding through meaningful learning experiences. However, geographical topics such as geographical location, topography, and natural hazards remain difficult to understand when presented through textbooks and static illustrations, leading students to rely on memorization rather than inquiry (Koba, 2025; Lindner et al., 2022). The preliminary needs analysis in this study supports this issue, showing that 78.26% of students had limited prior knowledge, 78.26% perceived the topic as difficult, and 91.30% preferred learning through digital maps. These findings highlight the need for interactive and technology-supported learning resources that facilitate authentic geographical learning.

Recent studies have identified Deep Learning as an effective pedagogical approach that promotes conceptual understanding through inquiry, collaboration, reflection, and contextual problem-solving (Al Shafian & Hu, 2024; Febriyanti & Restian, 2026). In geography education, this approach enables students to connect prior knowledge with authentic geographical phenomena, thereby strengthening spatial reasoning and long-term understanding (Wolf et al., 2010; Yang, 2026). Meanwhile, digital geospatial technologies, including GIS and Google Earth, have been widely recognized for improving students' spatial literacy, geographical reasoning,

learning motivation, and academic achievement by providing interactive visualization of real-world environments (Donaldson, 2003; Reuter, 2011a; Sumarmi et al., 2021). Nevertheless, most existing studies have examined pedagogical approaches and geospatial technologies separately, leaving limited evidence on their integrated application in elementary geography classrooms.

Previous research has also shown that digital worksheets, interactive media, and inquiry-based learning improve students' engagement, conceptual understanding, critical thinking, and problem-solving skills (Jenson et al., 2017; Reuter, 2011b; Rizou et al., 2022; Mitchell, 2010; Schubert, 2021). Likewise, Google Earth has proven effective in enhancing spatial visualization and environmental literacy through authentic geographical exploration (Bassi et al., 2015; Polšak, 2016). However, these studies generally focused on individual instructional components, while few have integrated digital worksheets, Deep Learning pedagogy, and geospatial technologies into a comprehensive instructional resource. Furthermore, research involving elementary school students and learning resources aligned with the Merdeka Curriculum remains limited, and the educational potential of integrating Google Earth with Indonesia's WebMAGMA platform has received little attention.

These limitations indicate several important research gaps. Previous studies have rarely integrated Deep Learning pedagogy, Google Earth, WebMAGMA, and the Merdeka Curriculum within a single instructional resource specifically designed for elementary geography learning. Moreover, evidence regarding the effectiveness of such integration in improving students' conceptual understanding of Indonesia's geographical location is still scarce. Addressing these gaps is important to provide learning resources that combine meaningful pedagogy, authentic geospatial visualization, and curriculum-oriented learning in elementary schools.

Accordingly, this study developed a Deep Learning-based Student Worksheet (LKPD) integrating Google Earth and WebMAGMA for teaching Indonesia's geographical location to fifth-grade elementary school students. The worksheet was designed to facilitate inquiry, spatial analysis, collaboration, contextual problem-solving, and reflective learning following the principles of Deep Learning (Kegyes et al., 2024; Parsazadeh & Cheng, 2025; Wu et al., 2025). Its novelty lies in integrating Deep Learning pedagogy, Google Earth, WebMAGMA, and the Merdeka Curriculum into a single validated instructional product, which differs from previous studies that investigated these components independently. The developed worksheet was evaluated in terms of validity, practicality, and effectiveness to provide empirical evidence of its instructional quality and contribution to technology-enhanced elementary geography education (Chosya & Takiddin, 2025; Hidayah & Wagistina, 2023; Ranjith, 2025; Widiastuti et al., 2026).

Method

This study employed a Research and Development (R&D) approach using the Four-D (4D) model proposed by Trianto, consisting of the Define, Design, Develop, and Disseminate stages. The 4D model was selected because it provides a systematic framework for developing and evaluating instructional products through iterative design, validation, implementation, and dissemination processes. The study aimed to develop a Deep Learning-based Student Worksheet (LKPD) integrating Google Earth and WebMAGMA for teaching Indonesia's geographical location to fifth-grade elementary school students in accordance with the Merdeka Curriculum. Product quality was evaluated based on three criteria: validity, practicality, and effectiveness. The field trial involved 22 fifth-grade students and two classroom teachers from SDN 09 Talamau, West Pasaman Regency, Indonesia, who were selected through purposive sampling because they had implemented the Merdeka Curriculum and possessed adequate digital learning facilities.

During the Define stage, curriculum analysis, learner analysis, and needs analysis were conducted through classroom observations, teacher interviews, and student questionnaires to identify instructional needs. Based on these findings, the worksheet was designed by integrating Google Earth and WebMAGMA with Deep Learning activities emphasizing observation, spatial analysis, collaboration, problem-solving, and reflection. In the Develop stage, the prototype was validated by experts in elementary education, Indonesian language, educational technology, and instructional evaluation using four-point Likert-scale instruments covering content, language, presentation, media design, and alignment with the Deep Learning approach. After revision, the worksheet was implemented in six learning sessions to evaluate its practicality through teacher and student questionnaires and its effectiveness using a one-group pre-test and post-test design. Finally, the Disseminate stage introduced the validated worksheet to elementary school teachers through the Teacher Working Group (Kelompok Kerja Guru) in Cluster III, Talamau District to evaluate its feasibility for broader implementation.

Data were collected using observation sheets, interview guidelines, needs analysis questionnaires, expert validation sheets, teacher and student practicality questionnaires, and learning achievement tests. Prior to implementation, the achievement test was analyzed for content validity, reliability, item difficulty, and

discrimination index to ensure its suitability for measuring students' learning outcomes. Descriptive statistics were used to calculate the validity and practicality percentages based on predetermined assessment criteria. Learning effectiveness was determined by comparing pre-test and post-test scores using normalized gain (N-Gain) analysis, while the improvement in learning mastery was used to strengthen the interpretation of the worksheet's effectiveness in supporting students' conceptual understanding of Indonesia's geographical location.

Results and Discussions

This study aimed to develop and evaluate a Deep Learning-based Student Worksheet (LKPD) integrated with Google Earth and WebMAGMA for teaching Indonesia's geographical location to fifth-grade elementary school students. The development process followed the Four-D (4D) model, including the Define, Design, Develop, and Disseminate stages. The evaluation focused on three main quality criteria: validity, practicality, and effectiveness. The results are presented sequentially, beginning with the needs analysis that informed product development, followed by expert validation, practicality testing, instrument quality analysis, and effectiveness evaluation based on students' learning outcomes. Together, these findings provide comprehensive evidence regarding the instructional quality and feasibility of the developed worksheet

Table 1. Summary of Needs Analysis for the Development of the Deep Learning-Based Worksheet

Component	Findings
Curriculum	Merdeka Curriculum, Phase C (Grade V)
Learning objective	Understanding Indonesia's geographical location using conventional and digital maps
Students with prior knowledge	21.74%
Students without prior knowledge	78.26%
Students who considered the topic difficult	78.26%
Students preferring digital maps	73.91%
Students requesting digital maps in learning	91.30%
Students with laptop/Chromebook experience	91.30%
Students preferring attractive worksheets	100%
Development implication	A Deep Learning-based worksheet integrating Google Earth and WebMAGMA was designed to facilitate contextual and interactive learning

The preliminary analysis confirmed the necessity of developing a Deep Learning-based worksheet aligned with the Merdeka Curriculum for Grade V elementary students. Most students had limited prior knowledge of Indonesian geographical concepts (78.26%) and perceived the topic as difficult (78.26%). Nevertheless, students demonstrated high digital readiness, with over 90% expressing interest in learning through digital maps and interactive worksheets. These findings supported the integration of Google Earth and WebMAGMA into the instructional design to provide contextual and technology-enhanced learning experiences.

Table 2. Summary of Expert Validation Results

Validation Aspect	Score (%)	Category
Research instruments	100	Very Valid
Material validation	94	Very Valid
Language validation	95	Very Valid
Media validation	98	Very Valid
Overall validity	96.75	Very Valid

Expert evaluation demonstrated that the developed worksheet achieved a very high level of validity across all assessment dimensions. All research instruments were considered fully valid (100%), while the instructional product obtained excellent ratings for material (94%), language (95%), and media design (98%). Only minor revisions regarding typography and language formatting were suggested before classroom implementation, confirming that the worksheet was suitable for field testing.

Table 3. Practicality Evaluation of the Developed Worksheet

Respondent	Practicality (%)	Category
Teachers	94	Very Practical
Students	96	Very Practical
Overall practicality	95	Very Practical

Following implementation in Grade V classrooms, both teachers and students evaluated the worksheet as highly practical. Teachers reported that the worksheet effectively supported classroom management, instructional time, and learning activities, whereas students perceived it as engaging, easy to use, and beneficial for understanding geographical concepts. The overall practicality score of 95% indicates that the developed worksheet is highly feasible for classroom application.

Table 4. Quality of the Learning Achievement Test

Indicator	Result
Total items developed	30
Valid items	25
Invalid items	5
Reliability coefficient	0.814 (Very High)
Easy items	7 (28%)
Moderate items	14 (56%)
Difficult items	4 (16%)
Good–Very Good discrimination	13 items (52%)
Fair discrimination	7 items (28%)
Poor–Very Poor discrimination	5 items (20%)

Item analysis confirmed that the learning achievement test possessed satisfactory psychometric quality. Twenty-five items fulfilled the validity requirements and demonstrated excellent internal consistency, with a reliability coefficient of 0.814. Most questions were classified as having moderate difficulty, while over half exhibited good to very good discrimination indices, indicating that the instrument was appropriate for assessing students' learning achievement and measuring the effectiveness of the developed worksheet.

Table 5. Effectiveness of the Deep Learning-Based Worksheet

Indicator	Result
Mean pre-test score	53.18
Mean post-test score	86.82
N-Gain	0.71 (High)
Pre-test mastery	4%
Post-test mastery	90%
Dissemination evaluation	94% (Very Good)

Students' learning achievement improved substantially after using the developed worksheet. The average score increased from 53.18 in the pre-test to 86.82 in the post-test, corresponding to a high normalized gain (N-Gain = 0.71). Learning mastery also improved considerably, increasing from only 4% before instruction to 90% after implementation. Furthermore, the dissemination evaluation conducted with elementary school teachers yielded a positive response rate of 94%, supporting the feasibility of adopting the worksheet in broader instructional settings.

The needs analysis confirmed the importance of developing a Deep Learning-based worksheet to improve students' understanding of Indonesia's geographical location. Most students had limited prior knowledge (78.26%) and perceived the topic as difficult (78.26%), although 91.30% expressed interest in using digital maps during learning. These findings indicate that students required more interactive and contextual learning resources. Integrating Google Earth and WebMAGMA addressed this need by transforming abstract geographical concepts into visual and authentic learning experiences. This finding supports previous studies showing that digital mapping technologies improve spatial understanding, learning motivation, and student engagement in geography education (Adestipa et al., 2025; Hidayat & Hermon, 2025; Vidhiasi, 2026).

The expert evaluation demonstrated that the developed worksheet achieved excellent quality, obtaining validity scores of 94% for content, 95% for language, and 98% for media, while all research instruments reached 100% validity. These results indicate that the worksheet was well aligned with curriculum objectives and fulfilled pedagogical, linguistic, and graphical standards. The high media score particularly reflects the successful integration of Google Earth and WebMAGMA into learning activities. Similar studies have reported that digital

geospatial technologies improve instructional quality by facilitating visualization and supporting inquiry-based learning in geography classrooms (Elvina et al., 2026; Nofrion et al., 2024; Saputro et al., 2023).

The worksheet was also highly practical during classroom implementation. Teachers and students rated its practicality at 94% and 96%, respectively, resulting in an overall score of 95%. Students reported high interest, ease of use, and perceived learning benefits, while teachers considered the worksheet effective in supporting classroom instruction despite requiring slightly more instructional time for digital exploration. These findings suggest that integrating technology with collaborative investigation, reflection, and contextual activities creates an engaging learning environment. This result is consistent with Fatmawati & Syafiqa, (2026); Rosa et al., (2026), which emphasizes that technology contributes most effectively to learning when combined with active pedagogical strategies rather than functioning solely as a presentation tool.

The effectiveness results demonstrated substantial improvements in students' learning achievement. The mean score increased from 53.18 to 86.82, with an N-Gain of 0.71 (high category), while learning mastery increased from 4% to 90%. These improvements indicate that the worksheet effectively supported conceptual understanding through inquiry, digital exploration, collaborative learning, and reflection. Such findings are consistent with previous studies reporting that inquiry-based learning integrated with digital geographic technologies significantly enhances students' spatial reasoning, conceptual understanding, and academic achievement (Chrishanty et al., 2025; Desramaza et al., 2026; Masfufah et al., 2026).

The overall findings demonstrate that the developed worksheet possesses strong validity, practicality, and effectiveness for elementary geography instruction. The achievement test also showed satisfactory psychometric quality, with 25 valid items and a reliability coefficient of 0.814, while dissemination activities received positive responses from teachers (94%). These results indicate that the worksheet is suitable for broader implementation in elementary schools. Nevertheless, because the study involved only one class of ff22 students, future research should employ larger samples and experimental designs to further examine the generalizability and long-term effectiveness of the developed learning resource.

Conclusions

This study successfully developed a Deep Learning-based Student Worksheet (LKPD) integrating Google Earth and WebMAGMA for teaching Indonesia's geographical location to fifth-grade elementary school students. The developed worksheet demonstrated a very high level of validity, excellent practicality, and strong effectiveness in improving students' learning outcomes. The substantial increase in post-test scores, the high normalized gain, and the significant improvement in learning mastery indicate that integrating Deep Learning pedagogy with interactive geospatial technologies promotes meaningful learning and enhances students' conceptual understanding of geographical concepts. Therefore, the developed worksheet represents an innovative and feasible instructional resource that supports the implementation of the Merdeka Curriculum while fostering active, contextual, and technology-enhanced learning in elementary geography education.

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