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Lembar Kerja Mahasiswa based on Tri N Ki Hadjar Dewantara in science education

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ABSTRACT

This study addresses the limited development of teaching materials integrating the Tri N philosophy of Ki Hadjar Dewantara (*Niteni*, *Nirokke*, and *Nambahi*) in science education, particularly for prospective elementary school teachers. The research aims to develop Tri N-based Lembar Kerja Mahasiswa (LKM) and evaluate its feasibility and effectiveness in supporting science learning. A research and development (R&D) approach was employed using the 4D model, consisting of define, design, develop, and disseminate stages. Data were collected through validation questionnaires completed by subject matter and media experts, and analyzed quantitatively. The results indicate that the developed LKM achieved a very high validity score, with an average of 93%, categorized as highly feasible. Furthermore, effectiveness testing using a t-test showed a significance value of 0.02 (< 0.05), indicating a significant improvement in student learning outcomes in the experimental group compared to the control group. These findings suggest that Tri N-based LKM is effective in promoting active, meaningful, and contextual learning, and can enhance students' understanding and engagement in science education.

INTRODUCTION

Science education for prospective elementary school teachers should ideally be designed as an interactive learning process that encourages students to actively construct conceptual understanding, develop critical thinking skills, and continuously improve their pedagogical competencies. However, in practice, science learning is still often dominated by lectures, limited question-and-answer sessions, and conventional assignments, resulting in low student participation and limited academic interaction in the classroom (Cáceres et al., 2020; Evitasari et al., 2025). This condition causes students to experience difficulties in understanding science concepts in depth, particularly when faced with tasks that require reasoning and problem-solving abilities, indicating that their critical thinking skills are still relatively low (Fani et al., 2025; Pratiwi & Doyan, 2024). One instructional tool that can support more active learning is the use of *Lembar Kerja Mahasiswa* (LKM), which provide structured guidance for students in completing learning activities and developing their cognitive abilities (Prastiti et al., 2017). Previous studies have also shown that worksheets can encourage more active student engagement in the learning process (Rambe et al., 2023).

LKM functions as a teacher's assistant in the learning process and understanding of concepts through activities. This is in line with the belief the use of LKM can make student learning more interesting (Setianingsih et al., 2018). The use of LKM in classroom learning aims to increase student independence in learning, so that the role of lecturers is only as facilitators in the classroom and students are actively involved in the learning process in the classroom. The benefit of developing LKM is that it can increase the independence of students in learning in the classroom and taking written exams (Rochmawati et al., 2018) Ki Hadjar Dewantara's thoughts on education have played an important role in the history of Indonesian education. His concepts reflect Indonesian culture. He believed that education should focus on understanding and meeting the needs of students as the main subjects. Therefore, the teacher's task is to help students develop their potential and provide knowledge. This is what is referred to as "nurturing" in learning (Budiati et al., 2018). One of the teachings used in the learning process is Tri N (*Niteni*, *Nirokke*, *Nambahi*).

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Tri N is a teaching used to foster students' creativity so that they can create new things in the world of science from an early age. This needs to be developed as a way of pursuing knowledge so that it is not merely imitation, in the sense of "plagiarism" or copying, but rather processing (Ardhyantama, 2020). According to Choiroh & Nashrullah (2021), *Niteni* is to mark by paying close attention using all the senses. Meanwhile, *Nirokke* is imitating what is taught through models/examples/role models from teachers/learning sources by involving the mind, senses, feelings/conscience, and spirituality in an integral and harmonious manner. Next is the *Nambahi* process. *Nambahi* is adding or subtracting what has been learned to develop creativity and ideas by utilizing existing learning resources. Critical thinking, as one of the higher-order thinking processes, can be used in the formation of students' conceptual systems in science, making it one of the higher-order conceptual thinking processes.

A prospective teacher has a great interest in developing emotional intelligence along with cognitive skills (cognition) and mental abilities to process information and acquire knowledge through observation, experience, and thought, as well as teaching problem solving, fostering emotions through stories, and promoting divergent thinking (Mulyaningsih et al., 2024). According to Ariadila et al. (2023) In the world of education, critical thinking skills are essential skills that must be mastered by students. Someone who has these skills will be better able to master concepts and problems presented in learning, and be able to apply these concepts to situations.

National Research Council (2012) argues that critical thinking skills are very important for students, because students who have good critical thinking skills can become critical consumers of science so that they can respond to and follow various developments that occur. Several studies on critical thinking skills in Indonesia show that students' critical thinking skills are still low. The results of a study conducted by Amrullah & Suwarjo (2018) show that the average critical thinking skills of prospective physics teachers are only 24.60 (very low). Another study conducted by shows that the average critical thinking skills of physics students are 24.29 (very low) (Azis, Ahmad Kamil, 2024). Nevertheless, most existing worksheets are generally designed only to guide procedural learning activities and have not fully integrated educational philosophies that emphasize the active construction of knowledge. In particular, the integration of the Tri N teachings of Ki Hadjar Dewantara (*Niteni, Nirokke, and Nambahi*) into the design of *Lembar Kerja Mahasiswa* in science learning for prospective elementary school teachers remains limited.

What is new in this study is that it focuses on the development and design of Ki Hadjar Dewantara's 3N-based *Lembar Kerja Mahasiswa* in integrated science learning, which has rarely been explored in academic literature. This study examines the development of 3N-based *Lembar Kerja Mahasiswa* in science learning and how *Lembar Kerja Mahasiswa* based on Ki Hadjar Dewantara's Tri N concept can improve students' critical thinking skills. This study aims to explore the practicality and effectiveness of 3N Ki Hadjar Dewantara-based *Lembar Kerja Mahasiswa* in improving the quality of science learning in higher education. By identifying the challenges and opportunities in applying these *Lembar Kerja Mahasiswa* in the classroom, this study is expected to make a significant contribution to improving teaching materials that support active and Tri N-based learning and help students develop the critical and independent thinking skills needed in the modern era. Therefore, this study aims to develop *Lembar Kerja Mahasiswa* (LKM) based on the Tri N concept of Ki Hadjar Dewantara and examine their feasibility as teaching materials in science learning for prospective elementary school teachers.

RESEARCH METHODS

This study utilizes a research and development (R&D) methodology based on the 4-D model, comprising four phases: Define, Design, Develop, and Disseminate (Si et al., 2024). During the Define stage, multiple steps are executed, including an initial analysis to identify issues in the creation of teaching materials, an analysis of students to ascertain their characteristics, a conceptual analysis to establish technical guidelines for the development of *Lembar Kerja Mahasiswa* (LKM), and the identification of learning objectives as the foundation for formulating achievement indicators. The subsequent phase is Design, which entails creating *Lembar Kerja Mahasiswa* as instructional resources to facilitate science education, informed by the outcomes of prior analyses. At this point, a draft of the

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Lembar Kerja Mahasiswa is created alongside the content to be delivered. The design process entails choosing the type and structure of the *Lembar Kerja Mahasiswa* that correspond with the content characteristics and students' requirements, in addition to crafting the presentation format such as layout, color, and font to complement the learning material (Khaeroni, 2021).

The Develop stage seeks to generate a validated LKM. This procedure entails expert validation to evaluate the appropriateness of the content and media, with the findings forming the foundation for product modifications. A small pilot test is subsequently conducted to evaluate the efficacy and applicability of the LKM in education, specifically in the use of Hadjar Dewantara's Tri N Ki method. The concluding phase is Disseminate, which entails disseminating the product for extensive utilization. Nevertheless, in this study, this stage has not been executed, as the project is still in the validation and restricted pilot testing phases. The study population comprised 120 individuals, with a sample size of 17 individuals. The data gathering method employed a LKM validation sheet to gather evaluations from specialists. This document contained a practicality assessment developed with a Likert scale, thereafter analyzed quantitatively and expressed as a percentage. This scale was developed in the format presented in table 1.

Table 1 Created in The Format Shown

Value	Number
Very Appropriate	5
Suitable	4
Fairly Suitable	3
Less Suitable	2
Not Suitable	1

The data from the validator team's assessment of the worksheet product was analyzed by finding the Aiken index coefficient. The validators provided suggestions and input for improvement, which became the basis for product revision. The interpretation of the product validity index value is shown in table 2.

Table 2 Index Value

Formula	Calculation	Category
$X > \bar{xi} + 1.8$ x	*sbi* X > 3.0	Very Suitable
$\bar{xi} + 0.6$ x *sbi* < X ≤ $\bar{xi} + 1.8$ x	Sbi 3.0 > X ≥ 2.5	Suitable
$\bar{xi} - 0.6$ x *sbi* < X ≤ $\bar{xi} + 0.6$ x	Sbi 2.5 > X ≥ 2.0	Fairly Suitable
X ≤ $\bar{xi} - 0.6$ x	2.0 ≥ X > 1.5	Less Suitable
X < 2.0	X ≤ 1.5	Not Suitable

RESULTS AND DISCUSSION

Needs Analysis and Identification of Learning Problems

The creation of *Lembar Kerja Mahasiswa* (LKM) grounded in the Tri N philosophy of Ki Hadjar Dewantara was executed utilizing the 4D (Define, Design, Develop, and Disseminate) development approach. This paradigm was selected for its methodical and structured framework in creating educational resources that align with students' requirements and learning environments. Each phase of the 4D model yielded significant insights that formed the basis for the following phases, guaranteeing that the resulting LKM is both pedagogically sound and contextually relevant.

During the define step, a thorough problem analysis was performed to ascertain the primary challenges faced in the learning process. The investigation revealed that lecturers had not effectively employed teaching aids or instructional media to enhance students' comprehension of the learning themes. The lack of supporting resources led to a teacher-centered learning process, wherein students depended predominantly on lecturers' explanations without active participation. Moreover, the educational resources accessible to students were restricted solely to the materials supplied by instructors, including lecture notes and presentation slides. This circumstance resulted in students having inadequate opportunity to individually explore concepts, so constraining their depth of understanding and critical thinking skills.

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Consequently, numerous students encountered challenges in thoroughly grasping the topics introduced in the course, especially those necessitating contextual comprehension and practical application. This scenario underscored the necessity for a novel educational resource that systematically delivers content while fostering active student engagement. Consequently, the formulation of a LKM grounded in the Tri N philosophy of Ki Hadjar Dewantara was deemed an appropriate resolution. The Tri N method, comprising *Niteni* (observing), *nirokke* (imitating), and *Nambahi* (changing or evolving), underscores a progressive and significant learning process. This method anticipates that students would actively build their understanding by observing examples, practicing imitation, and ultimately formulating new concepts or adaptations derived on their learning experiences.

A concept analysis was conducted alongside problem analysis during the define stage. The findings revealed that the material to be created in the LKM centers on ethnoscience within integrated science curricula, specifically for future elementary school educators. Ethnoscience was chosen for its integration of scientific principles with indigenous cultural knowledge, so rendering education more contextual and pertinent to students' everyday experiences. By integrating ethnoscience, students can comprehend scientific topics both conceptually and in relation to the indigenous knowledge and practices present in their area (Aprilia et al., 2025; Sotero et al., 2020).

This integration is particularly significant for aspiring elementary school teachers, as it enables them to devise and execute contextual learning in their future classes. Utilizing the established LKM, students are anticipated to acquire a more profound comprehension of integrated science topics while simultaneously cultivating the ability to relate these concepts to cultural and environmental settings. The objective of this Tri N Ki Hadjar Dewantara-based LKM is to enhance learning quality, promote student involvement, and facilitate the production of significant and contextual educational experiences.

Results from the define phase show that active student participation has not yet been promoted and that the learning process is still mostly instructor-centered. According to Amrullah & Suwarjo (2018) demonstrating that average critical thinking scores continue to be extremely low, this situation is consistent with earlier research indicating that students' critical thinking abilities in Indonesia remain relatively low. The claim that the majority of current learning materials have not yet incorporated a learning philosophy that stresses active knowledge production is further supported by the limitations of instructional resources that are only informative. The notion put out by Choiroh & Nashrullah (2021), according to which the processes of *Niteni*, *nirokke*, and *Nambahi* promote learning that goes beyond simple imitation while simultaneously developing

Instructional Design of Tri N-Based *Lembar Kerja Mahasiswa* (LKM)

Following the examination of learning issues and the identification of student demands, the research advanced to the LKM design phase as the subsequent step in the development process. This phase is essential for converting the results from the define step into a tangible and organized instructional design. During the design phase, numerous significant actions were executed methodically. The tasks encompassed the selection of suitable instructional materials, the aggregation and structuring of data pertinent to ethnoscience-oriented science education, and the development of an extensive media system.

The selection of teaching materials was executed by evaluating the content's relevance to the learning objectives, the attributes of prospective primary school teacher pupils, and the incorporation of the Tri N Ki Hadjar Dewantara approach. The selected materials were anticipated to teach scientific principles while integrating local culture knowledge, thereby facilitating contextual and meaningful learning. The data collection procedure for ethnoscience materials entailed examining several sources, including textbooks, research articles, and instances of local knowledge suitable for incorporation into science education. This stage guaranteed that the content produced in the LKM was precise, pertinent, and congruent with real-world circumstances.

Moreover, the formulation of the media framework emerged as a crucial element in this phase. The media framework was developed to rigorously delineate the comprehensive structure of the LKM, encompassing the sequencing of themes, learning activities, and the integration of the Tri N stages

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Niteni (observing), *nirokke* (imitating), and *Nambahi* (modifying). This framework functions as a guideline for structuring content to provide coherence, interactivity, and ease of comprehension for students. It delineates how each segment of the LKM facilitates the incremental development of students' comprehension and abilities.

This organized design process aims to promote active student interaction and improve conceptual understanding through the final LKM. Figure 1 depicts the architecture of the Tri N Ki Hadjar Dewantara-based LKM in integrated science learning, illustrating the general structure, components, and flow of the generated instructional media.

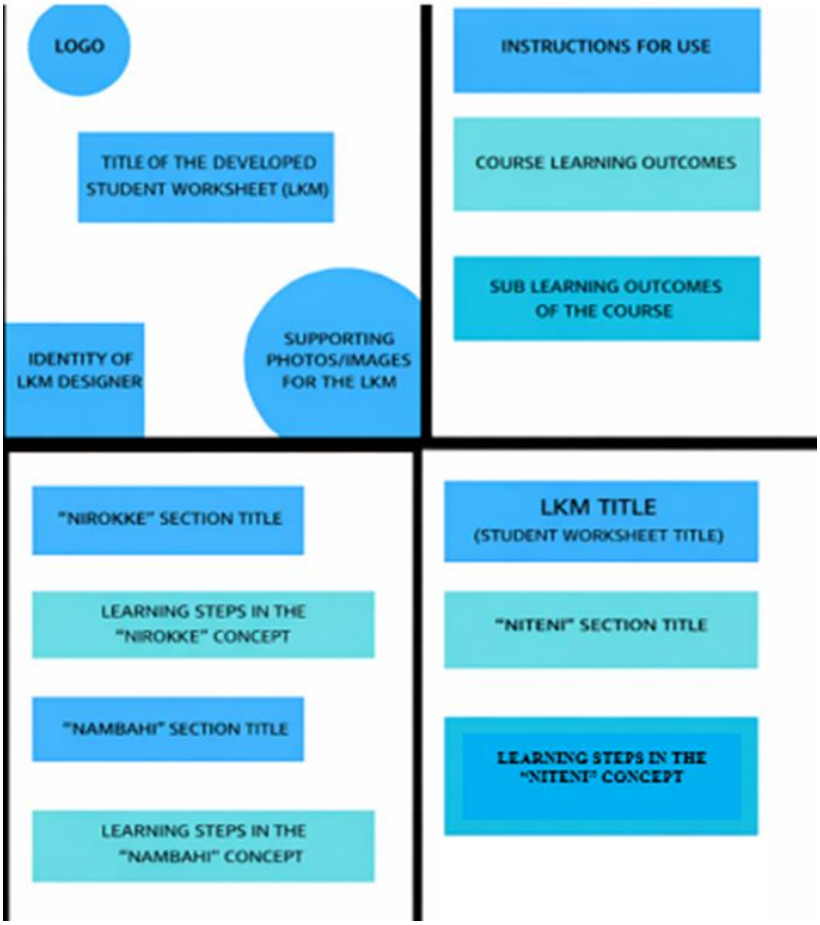

Figure 1 LKM design based on Tri N Ki Hadjar Dewantara

The illustration illustrates the design or structure of the Student Worksheet (LKM) created in accordance with Hadjar Dewantara's Tri N concept: *Niteni*, *nirokke*, and *Nambahi*. This design delineates a systematic framework for the LKM, commencing with the identity section and progressing to the core learning activities aligned with the Tri N phases. The cover section includes items such as the logo, the title of the developed LKM, the designer's identity, and supplementary photographs. This part functions as the LKM's preliminary identity, offering an overview of the content and context of the material to be examined. An appealing visual presentation seeks to enhance students' engagement with the LKM.

The subsequent section is the introduction, encompassing usage instructions, course learning outcomes, and sub-learning outcomes. This portion is essential since it instructs students on the proper utilization of the LKM and delineates the learning objectives to be attained. Clear instructions enable students to learn autonomously and intentionally. The fundamental component of the LKM is organized according to Tri N's stages. During the *Niteni* stage, pupils are instructed to observe a phenomenon or notion, as introduced through the title and learning phases inherent to the *Niteni* framework. This phase highlights observational abilities and preliminary comprehension of the subject matter. Subsequently,

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during the *nirokke* stage, pupils replicate or rehearse based on the seen examples. This seeks to enhance comprehension via firsthand experience. Ultimately, at the *Nambahi* stage, pupils are urged to cultivate or refine their gained knowledge, fostering creative and critical thinking. The figure demonstrates that the LKM design not only conveys knowledge but also incorporates an active, sequential, student-centered learning methodology. This framework is anticipated to improve conceptual comprehension and student involvement in the educational process, especially for ethoscience material in integrated science education.

According to Ariadila et al. (2023) and National Research Council (2012), who stress that critical thinking abilities are crucial for comprehending and implementing learning concepts, the LKM design promotes students to observe (*Niteni*), imitate (*nirokke*), and develop (*Nambahi*). This design supports the need for educational resources that can foster higher-order thinking skills (HOTS), rather than contradicting earlier studies. Additionally, the emphasis on future educators aligns with study by Mulyaningsih et al. (2024), which asserts that future educators must develop not only cognitive skills but also thinking, emotional, and problem-solving capacities.

Product Development and Expert Validation

The third stage is the development stage, which is adjusted to the initial design. The LKM learning tool based on Tri N Ki Hadjar Dewantara consists of seven pages. After all the material and supporting aspects were combined into one product using supporting software, namely Microsoft Office Word 2013 and Canva, the development results are presented in Figure

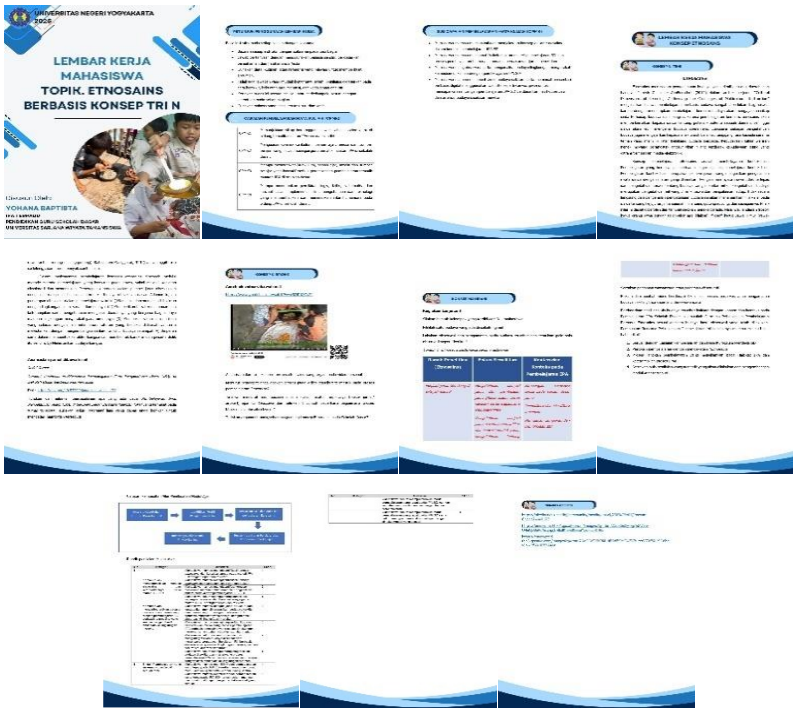

Figure 2 Tri N Ki Hadjar Dewantara-based LKM learning tools

This study used validation tests and questionnaires as data collection tools. The results of LKM validation by subject matter experts and media experts to test the feasibility of LKM use are presented in Table 3 and Table 4.

Table 3 Subject Matter Experts

Aspect	Number	Score	Maximum Score	Percentage
Content Feasibility	5	25	25	100%
Language Components	5	23	25	92%
Syntax Tri N ki hadjar Dewantara	3	15	15	100%
Total	13	63	65	96%

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The validation results from subject matter experts in table 3 indicate that the produced LKM attained an exceptional score of 96%, out of a maximum of 65. The content appropriateness obtained a flawless score of 100%, signifying that the information in the LKM is well connected with the learning objectives, pertinent to the principles of ethnoscience, and meets the needs of students. The linguistic component element achieved a score of 92%, indicating that the language utilized in the LKM is clear, communicative, and comprehensible, albeit minor enhancements are still required. Simultaneously, the Tri N Ki Hadjar Dewantara syntactical component achieved a score of 100%, signifying that the phases of *Niteni*, *nirokke*, and *Nambahi* have been exceptionally incorporated into the LKM. These results demonstrate that the LKM is exceptionally appropriate for content.

Table 4 Media Expert Table

Aspect	Number	Score	Mximum Score	Percentage
LKM Size	5	23	25	92%
LKM Cover Design	5	22	25	88%
LKM Content Design	3	14	15	93%
Total	13	58	65	90%

Based on the validation results by media experts in table 4, the LKM developed achieved a total score of 90% out of a maximum score of 65, which falls into the "highly suitable" category. Regarding the LKM's dimensions, a score of 92% was achieved, indicating that the size and format are proportionate and user-friendly. The LKM cover design received a score of 88%, meaning the cover's appearance is sufficiently attractive and representative, though it could be improved in terms of aesthetics or visual presentation. Meanwhile, the LKM content design aspect received a score of 93%, indicating that the layout, color scheme, and content presentation are well-organized and support readability and user comfort. Overall, these results indicate that the LKM is suitable for use in terms of media appearance and design.

Implementation and Evaluation of Learning Effectiveness

The experiment was conducted in two distinct classes, namely an experimental class and a control class, with the aim of comparing the learning outcomes between students who were exposed to the treatment and those who were not. The experimental class was taught using Tri N Ki Hadjar Dewantara-based worksheets, while the control class received conventional instruction without the use of these worksheets. To assess the effectiveness of the implementation of the worksheets in the experimental group, a statistical analysis was carried out using a t-test, with the support of the SPSS application to ensure accuracy and reliability in data processing.

The results of the analysis revealed that the significance value (Sig.) obtained was 0.02, which is lower than the predetermined significance level of 0.05 ($0.02 < 0.05$). This indicates that there is a statistically significant difference between the learning outcomes of the experimental class and the control class. In other words, the treatment given to the experimental class had a meaningful and measurable impact on student learning outcomes. Based on these findings, it can be concluded that the use of Tri N Ki Hadjar Dewantara-based worksheets is effective in improving the learning outcomes of students in the experimental class.

The adoption of Tri N-based LKM has a significant impact on student learning outcomes, according to the findings of the effectiveness test employing a t-test. This result is consistent with earlier studies that highlight how learning that incorporates critical and active thinking processes can enhance conceptual understanding and learning outcomes. Additionally, the idea that critical thinking abilities are essential to learning success is supported by this improvement in learning outcomes (National Research Council, 2012). Students receive, process, and create information during the *Niteni*, *nirokke*, and *Nambahi* stages, which gives learning greater significance. The results of this study support the conclusion that incorporating cutting-edge strategies like Tri N into instructional materials can be a way to enhance learning quality, especially when it comes to addressing students' weak critical thinking abilities. There is no conflict with earlier research.

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The findings of this study demonstrate that the implementation of Tri N Ki Hadjar Dewantara-based LKM significantly influences the advancement of learning, particularly in improving student involvement and academic performance. These LKMs serve as an alternate educational resource that promotes interactive, contextual, and student-centered learning. This study theoretically supports the notion that the integration of the Tri N approach can enhance critical and creative thinking skills. Moreover, for aspiring educators, these LKMs can exemplify the creation of novel learning experiences tailored to the demands of the 21st century.

CONCLUSION

The results and discussion indicate that the creation of a Student Worksheet (LKM) grounded in Hadjar Dewantara's Tri N Ki principles, utilizing the 4D model (define, design, develop, and disseminate), has been executed systematically and has yielded a product appropriate for educational use. In the define stage, it was determined that the learning approach remained teacher-centered and was deficient in instructional materials that fostered student engagement. The design phase yielded a systematic SWL design by amalgamating the stages of *Niteni*, *nirokke*, and *Nambahi*, while integrating ethnoscience to enhance contextual learning. During the development phase, validation outcomes demonstrated that the SWL was exceptionally appropriate regarding both content and media. Moreover, during the dissemination phase (efficacy testing), statistical analysis revealed a significance value of 0.02, which is less than 0.05, showing a significant difference between the experimental group and the control group. Consequently, it may be inferred that the Tri N Ki Hadjar Dewantara-based LKM is beneficial in enhancing student learning outcomes and promoting more active, meaningful, and contextual learning.

This study has notable limitations, primarily that the sample size was confined to a single institution, so the results cannot be broadly applied. Moreover, the study solely assessed learning results without a comprehensive evaluation of students' critical thinking abilities and creativity. The limited length of the trial presented a barrier in evaluating the long-term effects of Tri N-based LKM usage. Future study should incorporate a wider and more diverse sample to guarantee more representative outcomes. Furthermore, comprehensive assessments of pupils' critical thinking abilities, creativity, and emotional dimensions are essential. Subsequent research could evaluate the long-term efficacy of Tri N-based LKM and investigate its applicability across diverse subjects or educational tiers.

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