Lensa: Jurnal Kependidikan Fisika
Penerbit: Universitas Pendidikan Mandalika
https://e-journal.undikma.ac.id/index.php/Lensa/index

June 2025. Vol. 13, No, 1
e-ISSN: 2686-0937
pp. 48-62

Worksheet for Ethnoscience-Based Practicum Learning Supported by Simulation Tools: Design and Validation Results

Ni Nyoman Sri Putu Verawati[1,2]*, Joni Rokhmat[1,2], Ahmad Harjono[2], Muh Makhrus[2]

[1] Doctor of Science Education Study Program, University of Mataram, Mataram, Indonesia
[2] Physics Education Department, University of Mataram, Mataram, Indonesia

*Corresponding Author: *veyra@unram.ac.id*

Abstract

This study aims to develop and validate an ethnoscience-based practicum worksheet supported by virtual simulation tools to enhance culturally contextualized science learning. The integration of ethnoscience into science education responds to the need for pedagogical models that connect scientific concepts with students' local cultural knowledge, particularly in educational institution facing limited access to laboratory resources. Utilizing a research and development approach, the study was conducted through three main phases: preliminary investigation, design and construction, and evaluation and revision. The worksheet was structured to include scientific inquiry stages such as observation, hypothesis formulation, virtual experimentation, data analysis, and reflection. Expert validation was conducted using the Delphi method involving six experts in science education, ethnoscience, and educational technology. A Likert scale (1–5) instrument was used to assess content and construct validity, yielding average scores of 4.738 and 4.792 respectively, with a 95.83% agreement rate, indicating high validity and reliability. Suggestions from validators led to improvements in instructional clarity and contextual integration. The results confirm that the developed worksheet is pedagogically sound, technically feasible, and culturally relevant, aligning with 21st-century learning objectives that emphasize critical thinking, inclusivity, and digital literacy. This research offers a practical model for integrating ethnoscientific content with educational technology and contributes to the ongoing development of innovative, inclusive, and adaptive science education practices in Indonesia. Future applications may extend to diverse local contexts, supporting a more holistic and culturally grounded approach to science instruction.

Keywords: Physics learning ethnoscience; Science practicum; Virtual simulation; Instructional design; Contextual learning.

How to cite: Verawati, N. N. S. P., Rokhmat, J., Harjono, A., & Makhrus, M. (2025). Worksheet for Ethnoscience-Based Practicum Learning Supported by Simulation Tools: Design and Validation Results. *Lensa: Jurnal Kependidikan Fisika, 13*(1), 48-62. doi: https://doi.org/10.33394/j-lkf.v13i1.15783

INTRODUCTION

The integration of ethnoscience into science education has become a strategic issue receiving increasing attention in the discourse of national educational development. This approach functions not only as a pedagogical tool but also as a bridge between modern scientific knowledge and rich local cultural heritage. Within the framework of 21st-century education—which emphasizes critical thinking, creativity, and global awareness—ethnoscience contributes significantly by teaching students that science is not universal and detached from context, but rather grows and evolves within specific cultural frameworks (Alfiana & Fathoni, 2022; Rahayu & Ismawati, 2022). Local knowledge embedded in ethnoscience opens opportunities to instill indigenous values while cultivating meaningful conceptual understanding of science for students.

In addition to preserving cultural identity, ethnoscience plays a crucial role in strengthening students' self-identity, particularly in communities that have been marginalized within the dominant narrative of science education. Integrating ethnoscience into the learning process contributes not only to curriculum diversity but also enhances inclusivity and contextual relevance, making learning more aligned with students' lived experiences (Fatimah, 2023). Local knowledge, traditionally passed down orally, can be recontextualized into systematic educational practice, ensuring not only its preservation but also its enhancement as a source of scientific learning. In this sense, ethnoscience-based science education becomes a form of reconceptualizing scientific knowledge within cultural and local wisdom contexts.

However, the implementation of ethnoscience in formal science education is not without challenges. A primary concern lies in the weak representation of local cultural contexts in school science practicum activities. Practicums, which should serve as exploratory platforms for reinforcing students' conceptual understanding, are often presented in mechanistic and conventional formats that overlook cultural context (Hosana et al., 2023). As a result, students experience a disconnect, as what they learn bears little relation to their own experiences and knowledge. This issue is compounded by limited teacher understanding of contextual pedagogy and the lack of resources to support ethnoscience-based teaching practices (Rahmayanti et al., 2021).

On the infrastructural side, the lack of adequate laboratory facilities in many Indonesian schools—especially in rural and remote areas—poses a significant barrier to implementing ethnoscience-based practicum. Schools often lack the necessary tools and materials for practical science activities (Alfiana & Fathoni, 2022), thus impeding the delivery of comprehensive and meaningful learning experiences. This limitation restricts access not only to scientific tools but also to pedagogical approaches that adapt to local conditions.

To address these challenges, the use of Information and Communication Technology (ICT) offers innovative solutions in science practicum education. Virtual simulations, as part of ICT innovation, have proven to bridge the gap caused by the lack of physical laboratory facilities by providing interactive, safe, and flexible learning environments (Irsan et al., 2021; Mahmudah et al., 2023). Through these simulations, students can conduct experiments visually and interactively using digital devices, eliminating dependency on costly and inaccessible physical tools. Therefore, this technology facilitates more equitable and inclusive science learning.

Beyond solving logistical constraints, virtual simulations enrich students' learning experiences. By interacting with simulation tools, students can develop deeper conceptual understanding and enhance critical thinking and problem-solving skills (Wati et al., 2023; Indrawan & Marvida, 2023). The technology also supports discovery-based learning, allowing students to independently and engagingly explore scientific phenomena. In the context of ethnoscience learning, virtual simulations can be tailored to represent local cultural practices in scientific experimentation, thus effectively bridging traditional and modern learning paradigms.

Virtual simulation tools also expand the scope of scientific exploration for local phenomena. For example, traditional practices of processing natural resources—rich in physics and chemistry principles—can be represented through interactive software, allowing students to not only understand scientific concepts but also appreciate ancestral practices as legitimate sources of knowledge (Azizah & Fauziah, 2023). This approach enhances learning motivation, as students develop personal and emotional connections with the material.

The successful implementation of ethnoscience in science education depends heavily on the readiness and competence of educators. Teachers play a key role in designing integrative, innovative, and contextual learning. Hence, capacity building for educators in technology integration and the development of culturally relevant teaching materials becomes urgent (Ermawati et al., 2023). Training focused on ethnoscience curriculum development and the use of simulation tools must be integral to teacher professional development programs. Without active educator involvement, the integration of ethnoscience and virtual simulations cannot produce meaningful educational outcomes.

The importance of collaboration among stakeholders in supporting the transformation of ethnoscience-based science education must also be emphasized. Government agencies, educational institutions, local communities, and technology developers must work together to ensure that curricula, teaching materials, and assessment systems can sustainably accommodate ethnoscience approaches (Nisa & Nainggolan, 2024; Huda, 2020). This support may take the form of funding, affirmative policies, and the development of digital platforms that enable the integration of local cultural content into virtual science practicum simulations.

In the context of globalization and digital transformation, it is crucial that Indonesia's education system remains rooted in local culture while embracing global technological developments. Science education grounded in ethnoscience and supported by simulation technology can produce generations who are not only scientifically competent but also culturally conscious. Education, in this regard, becomes a tool for social transformation that promotes economic progress while preserving national values (Zukmadini et al., 2021).

The objective of this study is to design a science practicum worksheet based on ethnoscience and supported by virtual simulation tools, and to validate its content and structure. The validation process aims to assess the feasibility and effectiveness of the developed learning material before its implementation in formal science education. This research is expected to contribute to the provision of adaptive and innovative instructional tools aligned with the local cultural characteristics of students.

The novelty of this study lies in its integration of three core components: ethnoscience, virtual simulation, and instructional practicum worksheet design. Most prior studies have addressed either ethnoscience or simulation in isolation. This study offers a unified approach that not only develops instructional materials but also systematically tests their validity through expert evaluation. Therefore, the findings of this research are expected to serve as a critical reference for curriculum developers and practitioners in contextual, technology-based science education.

The scope of the study includes the design process of ethnoscience-based science practicum worksheets, the integration of simulation technology into practicum activities, and the validation process involving educational experts. Validation ensures that the designed worksheet is not only content-rich and technically sound but also pedagogically appropriate and culturally relevant. The study focuses on the design and validation phase and does not extend to classroom implementation or impact assessment on student learning outcomes.

Accordingly, this research seeks to address a significant gap in the literature on ethnoscience-based science education, particularly in the structured development of virtual simulation-supported practicum tools. Through the design and validation of this worksheet, it is expected that a viable model of science instruction can emerge—one that enhances the relevance, effectiveness, and sustainability of science education in Indonesia, especially in contexts of infrastructural limitations and the need for culturally contextualized learning (Mansir, 2024; Fauzi et al., 2022; Rohman & Susilo, 2019; Astuti et al., 2024).

METHODS

This study employed a research and development (R&D) approach with the primary objective of producing an instructional product in the form of a science practicum worksheet that integrates ethnoscience content and is supported by virtual simulation tools. The main focus of this research lies in the design phase and the validation of the worksheet's content validity and construct validity, to ensure the developed learning material meets the pedagogical and contextual requirements before further implementation.

The development procedure followed the Plomp model, which consists of three major stages: (1) preliminary investigation, (2) design and construction, and (3) evaluation and revision. In the first stage, an in-depth literature review was conducted regarding the integration of ethnoscience into the science curriculum, along with the use of virtual simulations as an alternative solution for practicum implementation. This stage also involved identifying science topics relevant to local knowledge and exploring simulation tools appropriate for virtual experiments. Additionally, a needs analysis was conducted through focused group discussions with science educators and education practitioners, which helped determine the expectations and constraints in implementing science practicum in various school settings.

Figure 1. The development procedure of ethnoscience-based science practicum worksheets

The second stage was the design and construction of a worksheet prototype. The worksheet was developed based on scientific learning principles, with emphasis on the connection between scientific content and local cultural practices, as well as the integration of digital simulation tools. The worksheet was structured to guide students through activities such as observation, conducting virtual experiments, data analysis, and reflective discussion on the scientific principles underlying traditional practices. Each step of the practicum activity was designed to be digitally accessible through customized simulation platforms, allowing for wider implementation in schools with limited laboratory infrastructure.

Upon completing the worksheet prototype, the study proceeded to the evaluation and revision phase through an expert validation process using the Delphi method (Chan, 2022). This method systematically gathers consensus from a panel of experts through multiple rounds of assessment and feedback. A total of six expert validators participated in the validation process: two content experts in science, two ethnoscience-based learning experts, and two educational technology specialists. These experts assessed two core aspects: content validity, which focused on the relevance of materials, integration of cultural context, and meaningfulness of practicum activities; and construct validity, which included clarity of objectives, logical sequencing of activities, and alignment with instructional design principles.

To assess these two aspects, a Likert-scale based instrument with a five-point scale (1–5) was employed, where each score represented the degree of appropriateness and feasibility of each content and construct indicator. A score of 1 indicated "not valid," while a score of 5 represented "highly valid." Experts were also invited to provide qualitative comments and suggestions for revision in each round. The quantitative data were analyzed by calculating the mean score, standard deviation (SD), and standard error of the mean (SE) for each aspect of validation. These metrics were then categorized into levels of validity: not valid, less valid, fairly valid, valid, and highly valid.

The validation process was conducted iteratively until consensus or scoring stability among experts was achieved, ensuring that the developed worksheet met quality criteria both in content and construction. The analysis of validator scores indicated strong agreement across both dimensions, and the final version of the worksheet incorporated all substantial feedback, particularly related to the clarity of instructional steps, integration of simulation tools, and alignment with ethnoscientific context. This process guaranteed that the worksheet was not only technically sound but also pedagogically robust and culturally relevant.

RESULTS AND DISCUSSION

Preliminary Investigation

The initial phase of this research began with a preliminary investigation aimed at identifying the needs, context, and theoretical foundations that would inform the design of an instructional product in the form of an ethnoscience-based science practicum worksheet supported by virtual simulation tools. This phase involved exploratory activities through literature review, curriculum analysis, and focused group discussions with science educators to define key issues and uncover opportunities for developing an innovative and contextualized learning tool.

In the context of science education in Indonesia, there is an urgent need to develop learning models that integrate local culture as part of a strategy to enhance education quality. One of the prominent approaches in recent educational literature is the integration of ethnoscience—traditional knowledge passed down through generations that has proven valuable in community practices, particularly in environmental management, food processing, herbal medicine, and traditional technologies (Hosana et al., 2023). In this regard, the design of a practicum worksheet that explicitly incorporates local wisdom is seen as a promising method to strengthen the connection between scientific content and the students' sociocultural realities.

Contextual and culturally-based learning approaches are believed to foster more meaningful learning experiences. When students learn science through examples derived from their own cultural traditions, abstract concepts become more concrete and accessible. This is supported by the findings of Fono et al. (2022) and Dilson et al. (2020), which show that embedding local knowledge in instructional design not only helps students understand science as technical knowledge but also as a reflective tool to interpret their daily lives. Moreover, such approaches enrich the learning experience and cultivate greater appreciation for local cultures.

To improve instructional effectiveness, the ethnoscience-based worksheet developed in this study was synergized with the use of virtual simulation tools. Virtual simulations enable students to explore scientific processes in a safe, efficient, and engaging digital environment. This technology emerges as a viable solution to the lack of laboratory facilities in many schools, particularly those in remote areas or those facing resource constraints (Novanda et al., 2024). FGDs with science teachers revealed that one of the primary obstacles to conducting practicum activities was the scarcity of equipment and limited time to carry out full laboratory sessions. The teachers expressed strong support for integrating virtual simulations as a suitable alternative to conventional practicum, without sacrificing the core scientific learning objectives.

The fusion of ethnoscience and digital technology is also aligned with the recommendations of Jacinda et al. (2023), who emphasize that culturally-based and technology-enhanced instruction can significantly boost student motivation and active participation. The worksheet developed in this research contains science content linked to local community activities, such as traditional herbal usage, food preservation techniques, and the working principles of simple traditional tools. All learning activities are designed to integrate simulation applications, allowing students to visualize experimental processes and engage with scientific inquiry interactively.

From a pedagogical perspective, the worksheet design also incorporates a problem-solving approach. It is structured to present students with problems derived from local cultural practices, which they solve through exploratory activities using simulation tools. This method not only develops students' critical and reflective thinking skills but also strengthens their understanding of the link between science and real-life applications (Yulitasari et al., 2023). In this scenario, students act as young scientists who critically examine traditional practices through scientific reasoning while valuing their cultural heritage.

The developed worksheet also upholds principles of inclusivity and accessibility. By integrating digital simulation tools, the product becomes accessible to students across various regions, overcoming geographical and logistical barriers. Furthermore, the inclusion of interactive instructions, video tutorials, and multimedia elements enhances its usability for learners with diverse learning styles (Akbar et al., 2022). The use of digital tools also contributes to the development of students' digital literacy—a critical skill in navigating 21st-century challenges (Darmaji et al., 2022).

The development process of the worksheet adhered to a collaborative curriculum design principle. Data collection at this stage involved science teachers, subject matter experts, and ethnoscience scholars to ensure that the content was not only academically sound but also culturally contextualized. As advocated by Sinaga et al. (2023), active stakeholder participation in the instructional design process is essential to produce relevant and applicable learning tools. Hence, a participatory approach was adopted in the preliminary phase as a key strategy for designing a product that would later undergo systematic validation.

Furthermore, this research addresses the broader need for learning models that support character education and national identity formation. By linking scientific concepts to local cultural practices, students are guided to see science not as detached from their cultural roots, but as an integral part of their lived experience. This approach supports the goals of the national education agenda, which aims to cultivate a generation that is not only academically proficient but also culturally grounded (Anggreani, 2021). When students are given the opportunity to learn through the lens of their own culture, they are better able to construct meaning, shape values, and increase their engagement in learning.

Considering the outcomes of this preliminary investigation, the development of an ethnoscience-based practicum worksheet supported by virtual simulations emerges as both a logical and strategic choice. This decision is grounded not only in the urgency of improving science education quality but also in the availability of supporting technology and the enthusiasm of educators toward contextual and innovative learning approaches. Therefore, the subsequent phase of this research focused on the design and systematic validation of the worksheet to ensure its quality, relevance, and feasibility for application in secondary-level science instruction.

Design and Construction

The second phase of this study focused on the design and construction of a science learning tool in the form of an ethnoscience-based practicum worksheet supported by virtual simulation technology. In this phase, the researchers developed a worksheet using Cidomo as a representative example of ethnoscience. Cidomo, a traditional horse-drawn carriage from Lombok, Indonesia, was selected because it reflects a local cultural practice that can be scientifically analyzed through the principles of physics, particularly Newton's Second Law concerning the relationship between force and acceleration.

The use of the Cidomo phenomenon as a case study in the worksheet aimed to bridge local cultural contexts with scientific concepts taught in the classroom. In practical terms, when a horse pulls the Cidomo, the interaction between the pulling force, the mass of the carriage, and its resulting acceleration becomes a relevant scientific context to explore the concept of acceleration resulting from applied force. This integration of local phenomena was designed to improve the relevance of science learning, strengthen students' cultural identity, and foster a contextual and meaningful scientific understanding.

The ethnoscience-based practicum worksheet was structured into six main components: Investigation, Planning, Experimentation, Results, Data Analysis and Discussion, and Conclusion.

1) The Investigation section introduces the Cidomo context and directs students to explore the effect of force on acceleration in the setting of a horse pulling a carriage. Students are guided to construct scientific questions based on their observations of this culturally grounded phenomenon.
2) The Planning section includes the learning objectives, problem statement, and hypothesis formulation. The central objective is to enable students to examine the relationship between force and acceleration using a virtual simulation. Students are encouraged to formulate their own hypotheses based on their understanding of the Cidomo example.
3) The Experimentation section involves the use of an interactive virtual simulation tool provided by the PhET platform (Forces and Motion: Basics), which allows students to conduct digital experiments related to force and acceleration in a flexible and safe virtual environment. This simulation is designed to analogically represent the mechanical function of Cidomo, helping students to relate the virtual model to a real-world traditional practice.
4) The Results section consists of three observation tables in which students record their experimental data. The first table is used to explore the effect of varying force on acceleration. The second table focuses on scenarios where the applied force remains constant but the mass varies. The third table keeps the mass constant while varying the force applied. Data collected include object type, total mass, applied force, time, velocity, and acceleration, all of which form the basis for subsequent analysis.
5) The Data Analysis and Discussion section asks students to calculate acceleration using appropriate formulas and to present their data in the form of graphs, depicting the relationships between force and acceleration and between mass and acceleration. This section is intended to strengthen students' quantitative reasoning and their ability to interpret data visually.
6) In the Conclusion section, students are encouraged to reflect on their experimental findings in relation to the Cidomo context. They are prompted to evaluate whether their initial hypotheses were supported, draw scientific conclusions, and explain the relevance of the scientific concepts learned to the local cultural practice under study.

This ethnoscience-based practicum worksheet was designed according to principles of exploratory learning, and aligns with twenty-first-century education goals that emphasize critical thinking, communication, and collaboration. The incorporation of virtual simulation enhances science practicum learning by addressing the lack of laboratory infrastructure in schools, while also enriching students' interactive and contextual learning experiences.

The selection of Cidomo as a pilot ethnoscientific case in the development of this worksheet not only provides authentic and culturally rich content for science education, but also demonstrates that traditional cultural values can be integrated with modern educational technology. This model offers potential for replication with other ethnoscientific themes across Indonesia, provided that the core principles of contextualization, experiential learning, and adaptive use of educational technology are upheld.

With a systematic structure and contextually grounded content, the ethnoscience-based practicum worksheet developed in this phase was subsequently subjected to expert validation, as described in the next stage. The design of this worksheet is expected to contribute to the development of a culturally responsive, pedagogically sound, and accessible science curriculum.

Evaluation and Revision

The evaluation and revision phase represents a critical stage in the development of instructional tools, particularly to ensure the quality and feasibility of the ethnoscience-based practicum worksheet before its implementation. During this phase, an expert validation process was conducted on the developed worksheet, which integrates the ethnoscientific context of Cidomo, using the Delphi method. The validation focused on two primary aspects: content validity and construct validity. A total of six expert validators participated in the process, consisting of professionals from the fields of science education, ethnoscience, and educational technology.

The validation employed a rating instrument based on a five-point Likert scale (1–5), where each score reflected the degree of relevance and appropriateness of each indicator. The scoring was designed to assess both the accuracy of the content and the instructional quality of the worksheet structure. A score of 1 represented "not valid," while a score of 5 indicated "highly valid." The collected validation data were analyzed quantitatively and compiled into statistical summaries including the mean (average score), standard deviation (SD), and standard error (SE) for each validator's assessment. These statistical indicators served to measure the central tendency and consistency of the validation results. The worksheet, evaluated as an integrated teaching material, was treated as a unified product in this assessment.

The results of the validation are presented in Table 1. These results demonstrate the overall judgments by the validators, reflecting both the high level of agreement and the validity of the worksheet in terms of content alignment and instructional construction. The consistently high mean scores and low standard errors indicated strong consensus among the experts, confirming that the worksheet is appropriate for use in classroom settings as part of ethnoscience-based science education.

Table 1. Validation results of the worksheet integrated as teaching material

Validator	Validation Aspect	Mean	SE	SD	Criteria
Validator 1	Content validity	4.714	0.184	0.488	Highly valid
	Construct validity	4.750	0.164	0.463	Highly valid
Validator 2	Content validity	4.857	0.143	0.378	Highly valid
	Construct validity	5.000	0.000	0.000	Highly valid
Validator 3	Content validity	4.571	0.202	0.535	Highly valid
	Construct validity	4.625	0.183	0.518	Highly valid
Validator 4	Content validity	5.000	0.000	0.000	Highly valid
	Construct validity	5.000	0.000	0.000	Highly valid
Validator 5	Content validity	4.714	0.184	0.488	Highly valid
	Construct validity	4.750	0.164	0.463	Highly valid

Validator	Validation Aspect	Mean	SE	SD	Criteria
Validator 6	Content validity	4.571	0.202	0.535	Highly valid
	Construct validity	4.625	0.183	0.518	Highly valid
Average	Content validity	4.738	0.095	0.252	Highly valid
	Construct validity	4.792	0.061	0.173	Highly valid
Overall mean score		4.767			Highly valid
Percentage of agreement		95.83%			Reliable

The assessment of content validity showed that all validators assigned high scores, with an overall mean of 4.738, a standard deviation of 0.252, and a standard error of 0.095. These figures fall into the highly valid category, indicating that the content of the ethnoscience-based practicum worksheet is highly relevant, aligns well with the science curriculum, and successfully integrates ethnoscientific elements in a meaningful way. All validators agreed that the content reflected scientifically accurate concepts and was academically sound.

Validators gave particularly positive feedback on the connection between the Cidomo phenomenon and the scientific concepts of force and acceleration, as well as the relevance of the local context featured in the worksheet. This phenomenon was considered effective in establishing a strong link between science instruction and students' real-life experiences. Several suggestions were provided to strengthen the narrative background of the ethnoscientific context in the introductory part of the worksheet so that students could more easily associate cultural practices with the scientific principles being studied.

In terms of construct validity, the validation results were also very high, with an overall mean of 4.792, a standard deviation of 0.173, and a standard error of 0.061. This too is categorized as highly valid, reflecting that the worksheet's structure and instructional sequence were well-designed, coherent, and aligned with instructional design principles. The learning activities within the worksheet were seen as capable of guiding students through the scientific process—beginning with observation, problem formulation, hypothesis development, virtual experimentation, and culminating in data analysis and reflective conclusion.

Validator 2 and Validator 4 gave perfect scores (5.000) in both aspects of validation, demonstrating full endorsement of the worksheet design. There was minimal variation in scores among validators, as shown by the low standard deviation values, which indicated a high level of consistency in expert judgment regarding the quality of the developed product. The overall average score across both validation aspects was 4.767, categorized as highly valid, with a 95.83% agreement rate, making the product statistically reliable. These findings confirm that the ethnoscience-based practicum worksheet meets the criteria for both content and construct feasibility and is ready to be implemented in classroom settings for further testing.

Feedback from the validators was addressed in the revision process, particularly in refining the instructions for experimental activities to ensure clarity and coherence. Enhancements were also made to the introductory narrative of the ethnoscientific context so students could build conceptual understanding more effectively before engaging with the simulation. Additional illustrations and improved guiding questions were also included based on expert suggestions.

The high score in content validity indicates that the material presented in the worksheet meets the standards for conceptual accuracy, curricular relevance, and the appropriateness of the ethnoscientific phenomena chosen. This evaluation is consistent with findings from Hosana et al. (2023) and Fono et al. (2022), who argue that integrating ethnoscience into instructional materials strengthens students' connection to the subject matter by situating science learning within their own lived experiences. In this case, Cidomo as a traditional mode of transportation in Lombok serves as an authentic and tangible representation of Newton's second law involving force, mass, and acceleration. This relevance prompted validators to consider the worksheet content as highly appropriate and well-targeted.

Meanwhile, the high construct validity scores show that the design, structure, and sequence of activities in the worksheet were logically and systematically arranged to support learning goals. The learning flow—from the observation of the phenomenon, to problem identification, simulation-based experimentation, and final reflection—aligns with an exploratory learning model suitable for science instruction. This matches the problem-solving approach emphasized by Yulitasari et al. (2023), in which students are trained to investigate real-world, context-based problems and draw conclusions based on empirical data gathered through investigation.

Furthermore, the integration of virtual simulation technology reinforces the instructional soundness of the worksheet. As highlighted by Irsan et al. (2021) and Mahmudah et al. (2023), simulation tools provide an effective alternative to hands-on experiments, especially in schools with limited laboratory resources. Through PhET Interactive Simulations, students were able to digitally model the motion of Cidomo, allowing them to visualize physical concepts more concretely and interactively. The validation process confirmed that this technical component not only enriched the learning experience but also strengthened the logical structure of the worksheet.

Another key insight supported through this validation is the role of ethnoscience in fostering inclusive and character-driven education. As emphasized by Fatimah (2023) and Rahmayanti et al. (2021), science education that incorporates local culture can improve scientific literacy while reinforcing students' cultural identity. Through the Cidomo case, students are not only learning abstract scientific concepts, but also recognizing traditional knowledge as a valid and valuable epistemological resource. This integration aligns with national educational goals to shape generations who are not only academically competent but also culturally grounded (Anggreani, 2021; Zukmadini et al., 2021).

Overall, the validation process confirmed that the ethnoscience-based practicum worksheet on Cidomo supported by virtual simulation is a pedagogically sound innovation that can be accepted by academic and educational practitioners. The results align with current efforts to promote a more contextual, adaptive, and inclusive science curriculum as suggested by Nisa and Nainggolan (2024) and Fauzi et al. (2022). The successful validation offers empirical support that the ethnoscience approach is not only conceptually relevant but also practically feasible in the form of a classroom-ready learning tool.

The validated worksheet on the Cidomo ethnoscientific theme can serve as a prototype for developing similar instructional tools based on other forms of local wisdom from various regions in Indonesia. Such tools can further promote science education that values cultural diversity while also embracing technological advancement in learning, in accordance with the goals of sustainable national education development (Astuti et al., 2024). These validation and revision results reinforce the credibility of the developed instructional product and provide a solid foundation for its application as a high-quality, valid, and feasible teaching material in contextual and innovative science education.

CONCLUSION

This study has successfully designed and validated an ethnoscience-based practicum worksheet supported by simulation tools, with the traditional Cidomo as the contextual foundation. The design process integrated cultural heritage with scientific concepts, emphasizing Newton's second law through a phenomenon familiar to students. Structured in an exploratory learning format, the worksheet guides students through contextualized inquiry—from observation to experimentation and reflection—while promoting critical thinking and cultural appreciation. The integration of virtual simulations addresses limitations in laboratory access and enriches the learning experience by enabling safe, interactive, and engaging scientific exploration.

The validation results confirmed that the worksheet is both pedagogically sound and culturally relevant, achieving high scores in content and construct validity with a 95.83% agreement rate. Expert feedback was used to refine the instructional components, ensuring clarity, coherence, and alignment with educational standards. These findings affirm the feasibility of applying the worksheet in classroom settings and provide a model for future instructional tools that incorporate local wisdom across diverse regions. As a result, the worksheet contributes to the advancement of science education that is inclusive, technologically adaptive, and rooted in Indonesia's cultural identity.

RECOMMENDATION

Future research should expand the application of the validated ethnoscience-based practicum worksheet in classroom environments to assess its effectiveness in enhancing student learning outcomes, engagement, and cultural awareness. Development of similar instructional tools based on other regional forms of local wisdom is also encouraged, ensuring the integration of ethnoscientific knowledge with appropriate educational technologies. Curriculum developers, teacher training institutions, and policymakers are urged to support the structured inclusion of ethnoscience in science education to promote culturally relevant, inclusive, and innovative learning practices across Indonesia.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the validators for their valuable insights and constructive feedback throughout the validation process. Appreciation is also extended to the science teachers and educational practitioners who contributed to the preliminary investigation through discussions and field input. This study was made possible with the support and collaboration of educational institutions committed to developing culturally responsive and innovative instructional materials for Indonesian science education.

REFERENCES

Akbar, Z., Margunayasa, I., & Parmiti, D. (2022). Pengembangan lembar kerja peserta didik (LKPD) IPA menggunakan Liveworksheets pada subtema 3 keseimbangan ekosistem. *Mimbar Pendidikan Indonesia*, *2*(3), 441–454. https://doi.org/10.23887/mpi.v2i3.44593

Alatas, U., Azni, F., & AS, F. (2022). Pelatihan pembelajaran e-learning Socrative pada guru PAUD Kecamatan Pamenang Kabupaten Merangin Provinsi Jambi. *Joong-Ki: Jurnal Pengabdian Masyarakat*, *1*(3), 523–533. https://doi.org/10.56799/joongki.v1i3.938

Alfiana, A., & Fathoni, A. (2022). Kesulitan guru dalam menerapkan pembelajaran IPA berbasis etnosains di sekolah dasar. *Jurnal Basicedu*, *6*(4), 5721–5727. https://doi.org/10.31004/basicedu.v6i4.3123

Anggreani, C. (2021). Pengembangan lembar kerja peserta didik (LKPD) bermuatan budaya lokal untuk anak usia dini. *Edukatif: Jurnal Ilmu Pendidikan*, *3*(6), 3500–3508. https://doi.org/10.31004/edukatif.v3i6.882

Astuti, Y., Subhiyakto, E., Umaroh, L., Sutojo, T., & Supriyanto, C. (2024). Pendampingan penggunaan media pembelajaran game edukasi "Code.org" bagi siswa SMP Ibu Kartini Semarang. *Abdimasku: Jurnal Pengabdian Masyarakat*, *7*(1), 9. https://doi.org/10.62411/ja.v7i1.1799

Azizah, A., & Fauziah, A. (2023). Peningkatan keterampilan proses sains siswa SMP melalui pendekatan model problem-based learning pada pembelajaran IPA. *Jurnal Pendidikan MIPA*, *13*(2), 525–529. https://doi.org/10.37630/jpm.v13i2.1090

Darmaji, D., Pujaningsih, F., & Tambunan, J. (2022). Kajian persepsi mahasiswa terhadap lembar kerja mahasiswa pada mata kuliah pendahuluan fisika zat padat. *Edufisika: Jurnal Pendidikan Fisika*, *7*(2), 177–184. https://doi.org/10.59052/edufisika.v7i2.22769

Ermawati, E., Komarayanti, S., & Purwaningsih, S. (2023). Implementasi pembelajaran diferensiasi dengan model PBL untuk meningkatkan literasi sains siswa kelas X.2 SMAN Rambipuji. *Biology*, *1*(2), 1–11. https://doi.org/10.47134/biology.v1i2.1957

Fanny, A. (2020). Teknologi informasi dan komunikasi pada pendidikan dasar: Tinjauan kritis dan implikasinya. *Didaktis: Jurnal Pendidikan dan Ilmu Pengetahuan*, *20*(1). https://doi.org/10.30651/didaktis.v20i1.4464

Fatimah, S. (2023). How does local wisdom in science learning? Research trend analysis through bibliometric in 2018–2023. *Social Humanities and Educational Studies (SHES) Conference Series*, *6*(3). https://doi.org/10.20961/shes.v6i3.82323

Fauzi, F., Sudirman, S., & Fahruddin, F. (2022). Pelaksanaan supervisi akademik berbasis teknologi informasi dan komunikasi (TIK). *JPAP: Jurnal Praktisi Administrasi Pendidikan*, *6*(1), 10–16. https://doi.org/10.29303/jpap.v6i1.495

Fono, D., Laksana, D., & Fono, Y. (2022). Pengembangan lembar kerja anak berbasis bahasa ibu dengan pendekatan budaya lokal Kabupaten Nagekeo tema tanaman untuk pembelajaran anak usia 5–6 tahun di TKK Olaewa Kecamatan Boawae Kabupaten Nagekeo. *Jurnal Citra Pendidikan*, *2*(4), 106–117. https://doi.org/10.38048/jcp.v2i4.928

Hosana, M., Nehra, N., Hasanah, U., Annur, S., & Sya'ban, M. (2023). Analisis kebutuhan pengembangan bahan ajar berbasis etnosains untuk meningkatkan kualitas pembelajaran dan menanamkan nilai kearifan lokal pada siswa SDN Sungai Miai 4. *Physics and Science Education Journal (PSEJ)*, 155–160. https://doi.org/10.30631/psej.v3i3.2175

Huda, I. (2020). Perkembangan teknologi informasi dan komunikasi (TIK) terhadap kualitas pembelajaran di sekolah dasar. *Jurnal Pendidikan dan Konseling (JPDK)*, *2*(1), 121–125. https://doi.org/10.31004/jpdk.v1i2.622

Indrawan, D., & Marvida, T. (2023). Kompetensi pedagogik guru dalam pemanfaatan model pembelajaran simulasi berbasis TIK. *Educative*, *1*(1), 1–7. https://doi.org/10.37985/educative.v1i1.6

Jacinda, A., Surtikanti, H., & Riandi, R. (2023). Pembelajaran berbasis etnosains pada materi biologi untuk meningkatkan prestasi belajar siswa: Kajian literatur. *AJCSEE*, *1*(1). https://doi.org/10.61511/ajcsee.v1i1.2023.142

Mahmudah, E., Ni'maturahmah, B., & Dewi, D. (2023). Utilization of information and communication technology as learning media to improve the quality of education in elementary schools. *Social Humanities and Educational Studies (SHES) Conference Series*, *6*(1), 358. https://doi.org/10.20961/shes.v6i1.71137

Mansir, F. (2024). Model pembelajaran abad 21 dalam perspektif pendidikan Islam. *CENDEKIA*, *1*(4), 132–146. https://doi.org/10.62335/f971q556

Nelson, N., & Tarigan, I. (2022). Pengembangan lembar kerja mahasiswa berbasis project-based learning pada kuliah analisis makanan dan obat program studi analis kimia. *Jurnal Eksakta Pendidikan (JEP)*, *6*(2), 136–142. https://doi.org/10.24036/jep/vol6-iss2/682

Nisa, N., & Nainggolan, T. (2024). Peran teknologi dalam peningkatan kapasitas SDM pesisir. *SENSISTEK*, 64–69. https://doi.org/10.62012/sensistek.v7i1.31653

Novanda, N., Supeno, S., & Budiarso, A. (2024). Pengembangan LKPD berbasis etnosains untuk meningkatkan kemampuan argumentasi ilmiah siswa SMP pada pembelajaran IPA. *Jurnal Pendidikan MIPA*, *14*(1), 8–18. https://doi.org/10.37630/jpm.v14i1.1435

Rahayu, R., & Ismawati, R. (2022). Efektivitas online project-based learning berbasis ethnoscience pada pembelajaran IPA terhadap keterampilan proses sains mahasiswa selama pandemi. *Jurnal Pendidikan MIPA*, *12*(4), 1065–1071. https://doi.org/10.37630/jpm.v12i4.738

Rahmayanti, S., Andayani, Y., & Idrus, S. (2021). Studi kemampuan literasi sains mahasiswa pendidikan kimia terkait etnosains Bau Nyale. *Jurnal Pijar MIPA*, *16*(3), 326–332. https://doi.org/10.29303/jpm.v16i3.2362

Rani, R. (2022). Analisis kebutuhan LKPD berbasis problem solving pada materi alat optik di SMA Negeri 6 Palangka Raya. *Jurnal Phi: Jurnal Pendidikan Fisika dan Fisika Terapan*, *3*(1), 61. https://doi.org/10.22373/p-jpft.v3i1.11042

Riskawati, R., Swandi, A., & Rahmadhanningsih, S. (2021). Pelatihan pembuatan perangkat pembelajaran berbasis laboratorium virtual dan blended learning untuk guru IPA di SMA Islam Athirah 1 Makassar. *J-Abdi: Jurnal Pengabdian Kepada Masyarakat*, *1*(6), 1231–1240. https://doi.org/10.53625/jabdi.v1i6.438

Rohman, M., & Susilo, P. (2019). Peran guru dalam penggunaan media pembelajaran berbasis teknologi informasi dan komunikasi (TIK): Studi kasus di TK Muslimat NU Maslakul Huda. *Jurnal Reforma*, *8*(1), 173. https://doi.org/10.30736/rfma.v8i1.140

Sinaga, R., Ramadhani, R., & Barus, J. (2023). Analisis kebutuhan lembar kerja pada mata kuliah bermain untuk anak usia dini. *Jurnal Usia Dini*, *9*(3), 426. https://doi.org/10.24114/jud.v9i3.55417

Suhery, L., Asnur, H., Yunita, R., & Arimadona, S. (2020). Pelatihan peningkatan kompetensi guru MTsN 1 Kota Payakumbuh dalam pengembangan media pembelajaran terintegrasi TIK. *Bernas: Jurnal Pengabdian Kepada Masyarakat*, *1*(4), 385–395. https://doi.org/10.31949/jb.v1i4.453

Wati, M., Hairah, U., Manik, F., Hidayat, I., Arabi, M., Alqarani, H., & Wijaya, M. (2023). Penerapan tool Google Workspace untuk meningkatkan efektivitas belajar mengajar di SMAN 9 Samarinda. *Inovasi Teknologi Masyarakat*, *1*(1), 29–35. https://doi.org/10.53622/intekmas.v1i1.204

Yulitasari, E., Hanifah, H., & Haji, S. (2023). Pengaruh pembelajaran berbasis masalah dengan menggunakan lembar kerja peserta didik terhadap kemampuan pemecahan masalah siswa di SMAIT IQRA Kota Bengkulu. *Didactical Mathematics*, *5*(1), 1–10. https://doi.org/10.31949/dm.v5i1.4467

Zukmadini, A., Karyadi, B., & Rochman, S. (2021). Peningkatan kompetensi guru melalui workshop model integrasi terpadu literasi sains dan pendidikan karakter dalam pembelajaran IPA. *Publikasi Pendidikan*, *11*(2), 107. https://doi.org/10.26858/publikan.v11i2.18378