



Feasibility of an Electronic Worksheet for Geometry and Measurement Based on Tri-N and Ethno-Math

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Abstract

Worksheets are one of the learning tools that must be prepared by teachers before carrying out learning. In the post-pandemic era, teachers are required to think creatively so that learning can facilitate millennial students who tend to like the digital world. This causes the need for digitalization of worksheets so that students can learn anytime and anywhere without having to bring traditional teaching tools so far. Therefore, the purpose of this study is to design an electronic worksheet based on Tri-N and Ethno-Math that is boost feasibility for geometry and measurement. The stages of this study use the design and development stages. The design stage aims to design e-worksheet products, while at the development stage, the expert validation stage is carried out on e-worksheet products. The results of this first-year research have designed the e-worksheet phase D with geometry and measurement elements. The results of the validation of the e-worksheet product showed that the content validity index was more than 0.875. Concerning these results, it can be concluded that the e-worksheet is stated to be very good in terms of visual design and organization, mathematical subject matter, aspect of Tri-N, and linguistic or language aspect. For this reason, the results of this study need to be tested on a limited scale to see the practicality of the designed products.

Keywords: e-Worksheet; Feasibility; Geometry and Measurement; Tri-N

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INTRODUCTION

Subsequent to the decline of the COVID-19 outbreak, educational institutions have gradually reinstated face-to-face instruction while continuing to accommodate online learning modalities. This transitional phase reflects a shift toward more adaptable educational systems that blend traditional classroom interaction with digital platforms. According to earlier research, teachers continue to use digital platforms to conduct virtual meetings, distribute learning materials, and oversee assignments even after they return to in-person settings (Irfan et al., 2023). Online learning, which was first implemented as an emergency response, has developed into a supplemental teaching method that is still useful in modern mathematics education (Basilaia & Kvavadze, 2020).

However, the widespread adoption of online education has exposed a number of enduring difficulties. First, differences in access and participation have been brought about by Indonesia's uneven distribution of internet infrastructure (Riani & Haryadi, 2022). Second, many parents struggle to provide sufficient resources, such as reliable internet access, enough data quotas, and suitable digital devices, which limits students' capacity to

participate fully in online education (Abuhammad, 2020; Pradana & Syarifuddin, 2021). Third, worries about learning loss have surfaced, especially because it can be challenging for teachers to determine students' proficiency levels in virtual environments (Irfan et al., 2020; Vitello et al., 2021). These issues highlight structural and pedagogical gaps that must be addressed to ensure equitable and effective learning outcomes. However, for all these challenges it poses, the pandemic has also led to positive changes in education. Teachers' digital literacy competences have improved, allowing them to experiment with and practice technology-based teaching strategies. In addition, instructional materials and learning devices are increasingly being transformed from printed formats into digital forms (Widodo et al., 2023). However, many of these materials have not yet been fully designed to align with blended learning models or project-based approaches required by the Merdeka Curriculum. Therefore, there remains a critical need to develop instructional resources that are pedagogically sound, technologically integrated, and contextually aligned with current curricular demands.

As students become increasingly comfortable with smartphones and digital tools (as one of the positive effects of the COVID-19 pandemic), the current curriculum is expected to facilitate the integration of digital teaching tools. Although the Ministry of Communication and Digital has issued a policy restricting social media use for children under 16, this situation demonstrates that the use of digital devices in learning needs to be directed toward the use of media and teaching materials that are educational and support the learning process constructively. One form of digital teaching material that can be utilized in school learning is digital worksheets. Worksheets promote students' active learning, engagement, and participation (Syahfitri & Sulaiman, 2023). The worksheet also aids teachers' instructional planning, classroom organization, and learning management (Dwijayanti et al., 2022). In addition, worksheets foster students' discovery of concepts and the development of procedural skills and scientific attitudes, and they assist teachers with the monitoring and assessment of students' achievement of learning targets (Reynolds & Gerson, 2025). This is in line with the results of a preliminary study of 40 studies related to worksheets showed that there was a strong positive impact on cognitive abilities because the effect size obtained was 1.281 (Widodo et al., 2023). This demonstrates that worksheets constitute an important component of learning because they contribute to improving students' cognitive achievement and understanding of the material. To achieve these goals, careful worksheet design is required, taking into account student characteristics, curricular objectives, and the learning context, including the development of digital and interactive worksheets. The use of digital worksheets in blended learning also has the potential to improve teaching quality, student engagement, and facilitate teachers' monitoring and feedback on student learning.

The current curriculum prioritizes the use of project-based learning to support character development according to student profiles. In this case, schools provide teachers with the freedom and independence to develop learning projects that align with the contextual characteristics of the school setting. For this reason, projects in mathematics that are aligned with the local environment, customs, and cultural background of students may function as an alternative model for implementing project-based learning in mathematics classes (Clivaz & Miyakawa, 2020). One of the existing gaps in mathematics instruction is the limited integration of cultural contexts within project-based learning activities (Acharya et al., 2021; Widdiharto et al., 2025), whereas using cultural contexts in math teaching allows for creating significant, grounded approaches, merging abstract concepts with students' real lives and socio-cultural surroundings (Prahmana et al., 2023). The use of community-based math problems, local customs, practices, and artifacts can help students acknowledge math beyond a mechanical set of procedures. Instead, students can view

mathematics as knowledge intertwined with their daily lives and unique context. Such contextual relevance and meaningfulness can sustain students' motivation and engagement in learning. Additionally, culturally responsive mathematics instruction helps affirm local knowledge and self-identity, guides students to develop understanding through familiar contexts, and establishes a pathway for more profound and long-term learning.

One of the alternative models that can be used in mathematics learning is Tri-N. It is a central teaching principle of the Tamansiswa educational framework by Ki Hadjar Dewantara (Wijayanti, 2018). Learning activities based on the Tri-N framework are structured around the main components of *Niteni*, *Nirokke*, and *Nambahi* (Hidayat et al., 2025; Latifah et al., 2024; Suroyaningsih et al., 2024; Widodo et al., 2024). *Niteni* is the process of noticing that learners use to become aware of patterns, characteristics, and structure at a multitude of levels through the lens of all their senses. For mathematics instruction, this step promotes a thoughtful consideration of examples, representations, and problem context and supports the development of conceptual understanding and analytical acuity. *Nirokke* refers to the emulation or reproduction of the demonstrated procedures, techniques, or problem solving by teachers or resources. This stage combines the cognitive, perceptual-sensory, affective functions, moral observation, and spiritual reflection in a relatively balanced way so that learning is not mechanical imitation but whose internalization has meaning. Additionally, *Nambahi* stresses the importance of refining present knowledge or of inventing something new, which may serve as a stimulant for the students' creative thought processes and the generation of new ideas. Students are encouraged to utilize a set of diverse learning resources to propel improvement of strategies, the formulation of novel solutions, and the broadening of tasks. Overall, the Tri-N framework fosters the integration of Indigenous students' engagement, the comprehension of mathematical concepts, and the implementation of creativity through the use of culturally responsive pedagogy.

Although the development of worksheets in mathematics education continues, attention to the development of quality worksheets that integrate Tri-N pedagogy and ethnomathematics, especially on geometry and measurement materials, is still relatively limited. In addition, geometry and measurement teaching is usually delivered in a procedural manner, focusing more on memorizing formulas than promoting critical and creative thinking skills. Concerning these conditions, it is necessary to develop an electronic worksheet that is compiled using the Tri-N stages and ethno-mathematics, which is expected to develop the character values in the Pancasila student profile. As in previous research, it was found that the use of worksheets has a potential effect on students' cognitive abilities (Eriana et al., 2024; Ichsan et al., 2023). However, this present research differs from prior research in applying the Tri-N concept (*Niteni*, *Nirokke*, and *Nambahi*) and the project learning concept to mathematics subjects by adapting to the characteristics of the surrounding culture. This integration constitutes the primary novelty of the present study compared with previous worksheet development studies (Eriana et al., 2024; Ichsan et al., 2023). Based on these considerations, this study aims to determine the feasibility of the product development. The product development in this study is an electronic worksheet based on Tri-N and ethnomathematics on geometry and measurement elements. In this case, feasibility is evaluated from two main aspects: validity and practicality. Validity relates to the degree to which the product's content, construction, and appearance align with learning principles, mathematical concepts, and the characteristics of the Tri-N and Ethno-Math. Meanwhile, practicality refers to the ease of use of the product by students in the learning process. Thus, analysis of product validity and practicality serves as the basis for

determining the feasibility of the developed electronic worksheets before their wider use in learning.

METHODS

Types of Research

This study employed a research and development approach based on the 4D model, which consists of four stages: define, design, develop, and disseminate (Thiagarajan et al., 1974). The define stage involves establishing and defining learning requirements through front-end analysis, student analysis, assignment analysis, concepts, and the formulation of learning objectives. The design stage is creating an initial product draft or prototype, including developing criterion-referenced tests, selecting media, selecting formats, and completing the initial design. The develop stage focuses on realizing and refining the product, involving expert appraisal and developmental testing to ensure product feasibility (validity and practicality). The final stage, dissemination, refers to the distribution and implementation of the validated product for wider use, including packaging, diffusion, and adoption. It is important to note that this study does not aim to empirically measure the effectiveness of the developed worksheet in improving students' mathematical skills. Rather, the focus of this research is to evaluate the feasibility (validity and practicality) of the product as preliminary quality indicators of its potential to improve mathematical skill in the future. Claims regarding effectiveness are positioned as prospective and require further experimental investigation in subsequent studies. Therefore, only the design and development stages are used in this study (see Figure 1).

Procedures

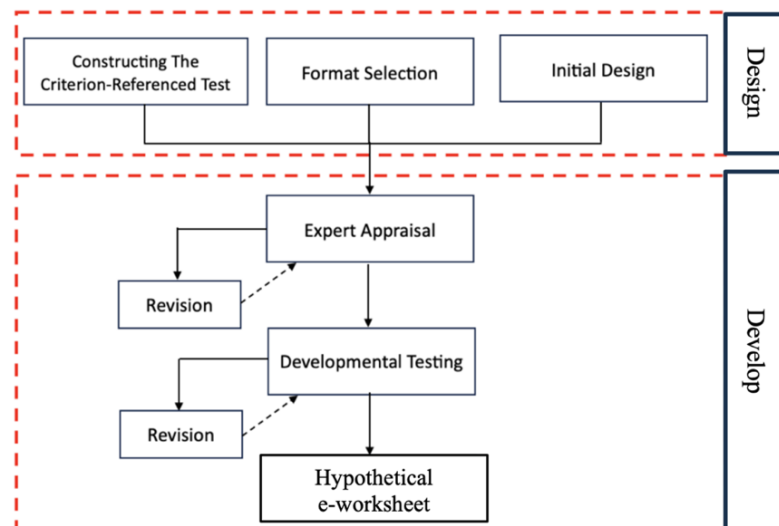


Figure 1. Procedure of Research

Based on Figure 1 shows that the design used in this study only included the design and development stages, as the research focused on the feasibility of the worksheet. In the design stage aims to design e-worksheets with Tri-N and ethno-math for geometry and measurement elements. At this stage, it is done by constructing a criterion-referenced test, which includes tests to develop Pancasila student profile values, especially critical thinking

skills and creative thinking skills. Although the 4D model, this stage was conducted implicitly through a preliminary analysis, including curriculum analysis, analysis of students' characteristics, and analysis of geometry and measurement content based on the Merdeka curriculum. The results of this initial analysis served as the basis for designing and developing the e-worksheet.

The next stage is development. This stage aims to obtain a worksheet design that is appropriate and good, ready for large-scale trials. This stage is conducted through expert assessment and development testing (Thiagarajan et al., 1974). The expert validation aims to assess the developed e-worksheet; a product validation instrument is required. In the developmental testing, the purpose is to evaluate the readability and practicality of the developed e-worksheet. The development testing phase employs a one-shot case study research design (Creswell, 2012). This design is experimental research, where the researcher provides treatment to a group of subjects, then observes the results through a post-test without a pre-test and without a comparison group (Kongkaew et al., 2020).

Participants

Based on the procedures used in this study, participants were only involved in the expert assessment and development testing phase; there were no research participants during the design phase. Participants in the expert appraisal phase were expert assessors, consisting of three university lecturers and three mathematics teachers. They acted as validators, assessing the e-worksheet. They would provide suggestions, input, and assessments for product improvements before the developmental testing and broader trials (the initial stage of dissemination). The criteria for lecturers to be validators were a doctoral degree in mathematics education, while the criteria for teachers were a minimum of a bachelor's degree and being a mathematics teacher at the junior high school level.

The development testing participants included 10 students from a private junior high school in Yogyakarta, who were selected through purposive sampling. Since the sampling was conducted purposively, the selection of participants was based on certain criteria relevant to the research objectives, such as willingness to participate in the entire series of trial activities, adequate communication skills to provide feedback on the product being developed, and active involvement in mathematics learning in the classroom. This purposive sampling approach was intended to ensure that the selected participants represented the characteristics required in the development testing phase. Consequently, the researchers can obtain more in-depth information regarding the clarity, understandability, and implementation of the product being tested. However, as the sample was not selected randomly, the results of the testing at this stage are not intended to be generalized widely, but rather to obtain initial input that is used in the process of revising and refining the product before testing on a larger scale.

Data Collection

The design stage aimed to design e-worksheets with Tri-N and ethno-math for geometry and measurement elements. This stage involved constructing a criterion-referenced test, which includes tests to develop Pancasila student profile values (specifically critical and creative thinking skills). In addition to being included in the worksheets as a form of practice, these tests were also used to obtain data on the dimensions of critical and creative thinking that will be used in the dissemination phase.

The development stage aimed to obtain a worksheet design that is fit, good and ready to be used for large-scale trials at the dissemination stage. This product is often

referred to as a hypothetical product. To obtain this hypothetical product, two activities are carried out, namely expert appraisal and developmental testing (Thiagarajan et al., 1974). In the expert validation step, the aim was to assess the e-worksheet that had been developed; a product validation instrument was needed. The compilation of the validation sheet was adjusted to the grouping of the expert team, namely, the expert team in the field of mathematics material and mathematics learning. The assessment aspects on the validation sheet include 4 aspects. They are (a) visual design and organization, (b) mathematical subject matter, (c) aspect of Tri-N, and (d) linguistic or language aspect (Widodo, 2020). The items for each indicator used to assess are presented in Table 1.

Table 1. Indicator and sub-indicator for worksheet validator

Indicator	Sub-indicators
Visual design and organization	Cover view Typography and font size Illustrator Color and appearance The appeal of worksheets Author's identity
Mathematical subject matter	Consistency between the material and learning objectives Relevance of the content to the practice exercises Comprehensiveness of the materials Conformity between Objectives and Learning Activities Systematic presentation of the material Worksheets promote students' critical thinking skills Implementation of instructional media
Aspect of Tri-N	The initial display presents the Tri-N components. The worksheet is structured according to the Tri-N stages Learning materials and activities are provided by the Tri-N The worksheet guides students through the Tri-N stages.
Linguistic or language aspect	Language usage Use of terms and symbols

In the developmental testing, the instrument used was a questionnaire designed to collect student responses to the Tri-N and ethnomathematics-based e-worksheet on geometry and measurement topics. The questionnaire administered to students consisted of 4 indicators: the appearance of the worksheet, presentation of materials, student appeal, and product usability.

Data Analysis

The data analysis techniques used in this study were adapted to the research stage being conducted. In the design stage, data analysis techniques were conducted by describing the e-worksheet design process and the instruments needed in this study. The data analysis technique used in expert appraisal activities was content validity using the Aiken method (Aiken, 1999). Content validity refers to a validity that provides evidence about the extent to which the elements of the assessment instrument are relevant and represent the constructs targeted for certain assessment purposes (Almanasreh et al., 2019). Furthermore, the data obtained from the developmental testing phase were analyzed using descriptive statistical techniques.

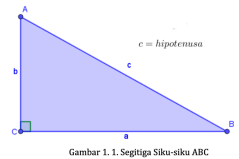
RESULTS & DISCUSSION

Results

The initial design stage of the worksheet product began with determining the structure, sequence, and scope of the main material. The design of this mathematics worksheet was generally created to improve the critical thinking skills of junior high school students, particularly the critical reasoning aspect within the Pancasila Student Profile. Therefore, this mathematics worksheet incorporates problems that encourage students to engage in critical thinking processes. In addition, the preparation of the worksheet was developed based on *niteni*, *nirokke*, and *nambahi* activities (Hidayat et al., 2025; Latifah et al., 2024; Suroyaningsih et al., 2024; Widodo et al., 2024). *Niteni* activities are activities that involve marking by paying close attention and using all the senses. *Nirokke* refers to the process of modeling or replicating what is demonstrated by teachers or other learning resources, engaging cognition, sensory perception, emotions, and spirituality in an integrated and balanced. Meanwhile, the activity of *Nambahi* is the activity of adding or reducing what has been learned to develop creativity and ideas by utilising learning resources. Several displays of worksheets based on Tri-N and Ethno-Mathematics in geometry and measurement elements can be seen in Figure 2.

A. Menemukan Teorema Pythagoras Pada Segitiga Siku-Siku

NITENI



Gambar 1.1. Segitiga Siku-siku ABC

Gambar 1.1 menunjukkan segitiga siku-siku ABC dengan sisi c merupakan sisi terpanjang. Untuk selanjutnya sisi yang terpanjang pada segitiga siku-siku disebut dengan *hipotenusa*.

Petunjuk:

1. Buatlah 3 kelompok masing-masing terdiri dari 2 sampai 3 siswa
2. Setiap kelompok menghitung luas persegi pada aktivitas 1 sampai aktivitas 3
3. Tuliskan hasil masing-masing kelompok pada aktivitas 4
4. Bandingkan jawaban kelompokmu dengan kelompok lain

Matematika Fase D: Elemen Geometri 3

NAMBAHI

Pada beberapa bilangan asli tertentu, dapat membentuk bilangan asli triple pythagoras. Sebagai contoh yaitu bilangan (3,4,5) dan (5,12,13) adalah dua contoh bilangan triple pythagoras, karena memenuhi kesamaan $3^2 + 4^2 = 5^2$ dan $5^2 + 12^2 = 13^2$.

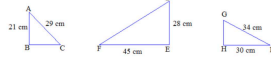
Latihan soal 1.1.

1. Di antara bilangan-bilangan berikut manakah yang merupakan bilangan triple pythagoras?

a. {7,4,25}

d. {8,15,17}
- a. {9,12,15}
- b. {24,10,26}
- e. {10,15,15}

2. Benar atau salahkah pernyataan berikut
 "Jika (a, b, c) adalah triple pythagoras, dan k adalah sebarang bilangan asli, maka $(k \cdot a, k \cdot b, k \cdot c)$ adalah juga triple pythagoras. Berikan alasanmu.
3. Gambar-gambar berikut, segitiga manakah yang termasuk segitiga siku-siku



4. Jika $3x, 4x$ dan 15 adalah bilangan-bilangan triple pythagoras, tentukanlah nilai x
5. $x, 61, 11$ merupakan bilangan triple pythagoras dengan 61 adalah bilangan terbesarnya. Tentukan nilai x .

Matematika Fase D: Elemen Geometri 10

Contoh Soal 2.12. Setelah mempelajari aktivitas 1 sampai aktivitas 7 pada bagian Niteni, kerjakanlah latihan berikut ini dengan cara menarik anak panah dari kolom paling kiri, tengah, dan kolom paling kanan sehingga terbentuk titik asal, pencerminan, dan hasil pencerminan yang benar

Titik (-2,3)

Dicerminkan

(2,-3)

Dicerminkan

(-2,3)

Dicerminkan garis

Dicerminkan garis

(2,-3)

Dicerminkan grs

Dicerminkan titik

(-3,2)

Dicerminkan garis

Dicerminkan garis

(2,3)

Dicerminkan

Dicerminkan

(6,-3)

Dicerminkan

Dicerminkan

(3,-2)

Dicerminkan

Contoh Soal 2.13. Isilah titik titik pada pencerminan berikut dengan benar.

Titik asal	Germin	Bayangan
(2,3)	Sumbu X	
(-3,1)	Sumbu Y	
.....	Garis $y = x$	(2,-4)

Matematika Fase D: Elemen Geometri 35

(a) *Niteni* activity (b) *Nambahi* activity (c) *Nirokke* Activity
 Figure 2. e-Worksheet based on Tri-N and Ethno-Math in Geometry and Measurement

The next activity at the development stage was expert validation and developmental testing. The final goal of this stage was to examine the validity of the worksheet based on Tri-N and ethno-mathematics product prototype on geometry and measurement topics both theoretically and empirically. Through this process, the developed worksheet was expected to become a hypothetical product that would be ready to be tested on a large scale in future studies.

The validation expert activity involved three lecturers of Mathematics Education and three mathematics teachers at the junior high school level. Their involvement at this stage was to serve as validators responsible for evaluating the worksheet as well as offering feedback, recommendations, and constructive critiques of the worksheet on geometry and measurement materials based on Tri-N and ethno-mathematics. The assessment of the developed worksheet based on Tri-N and ethno-math products can be seen in Table 2.

Table 2. The result of expert validation

Indicator	Sub-indicators	<i>eV</i>	Conclusion
Visual design and organization	Cover view	1.00	Valid
	Typography and font size	0.94	Valid
	Illustrator	0.83	Valid
	Colour and appearance	0.83	Valid
	The appeal of worksheets	1.00	Valid
	Author's identity	1.00	Valid
Mathematical subject matter	Consistency between the material and learning objectives	0.94	Valid
	Relevance of the content to the practice exercises	1.00	Valid
	Comprehensiveness of the materials	1.00	Valid
	Conformity between Objectives and Learning Activities	0.83	Valid
	Systematic presentation of the material	0.94	Valid
	Worksheets promote students' critical thinking skills	0.94	Valid
	Implementation of instructional media	0.83	Valid
	The initial display presents the Tri-N components.	1.00	Valid
Aspect of Tri-N	The worksheet is structured according to the Tri-N stages	1.00	Valid
	Learning materials and activities are provided by the Tri-N	0.83	Valid
	The worksheet guides students through the Tri-N stages.	1.00	Valid
	Language usage	0.83	Valid
Linguistic or language aspect	Use of terms and symbols	0.83	Valid

Based on Table 3, the prototype of the e-worksheet based on Tri-N and Ethno-math on geometry and measurement elements can be concluded as valid for visual design and organization, mathematical subject matter, aspect of Tri-N, and linguistic or language aspect. All items have a *V* Aiken validity index (*V* Aiken) of more than 0.83. Furthermore, the worksheet based on Tri-N and Ethno-Math in geometry and measurement elements was tested on a developmental testing on 10 students at a private junior high school in Yogyakarta who were selected purposively. The purpose of this trial was to obtain students' responses to the worksheet based on Tri-N and Ethno-Math in geometry and measurement elements. The results of the students' responses can be seen in Table 3.

Table 3. Proportion of Trial outcomes on Student Responses

Assessment	Percentage			
	5	4	2	1
Display	73.33	26.66	--	--
Systematic presentation of concepts	57.14	42.85	--	--
Design attractiveness	55.00	45.00	--	--
Usability	63.33	36.66	--	--
Average	62.20	37.80		

Based on Table 3, it is obtained that the students' responses to the worksheet-based Tri-N and Ethno-Math in geometry and measurement elements obtained an average of 62.28, stating that they strongly agree, and 37.79 stating that they strongly agree. Therefore, it can be concluded that the students gave a positive response to the electronic worksheet for geometry and measurement based on Tri-N and Ethno-Math. These results indicate that

the electronic worksheet is relatively practical for use in mathematical learning on geometry and measurement topics.

Discussion

The results of the initial research on a limited trial on a worksheet based on Tri-N and ethno-math for geometry and measurement elements, carried out by 6 validators, showed that the visual design and organization, mathematical subject matter, aspect of Tri-N, and linguistic or language aspect had a *V* Aiken index of more than 0.83. According to the established criteria, with six validators, the minimum acceptable *V* Aiken's is 0.73 (Aiken, 1985). Therefore, it can be concluded that the Tri-N and ethnomathematics-based worksheet for geometry and measurement content is valid in terms of its visual design and organization, mathematical subject matter, aspect of Tri-N, and linguistic or language aspect. In addition, a limited trial was conducted with 10 junior high school students selected using a purposive sampling technique; it was found that the majority of students reported that the worksheet based on Tri-N and ethno-math for geometry and measurement elements was very good in terms of display, Systematic presentation of concepts, design attractiveness, and usability.

The findings derived from the validation process and limited trials indicate that the developed worksheet prototype is appropriate for proceeding to the next phase of research, namely large-scale implementation or dissemination. The expert validation results indicated that the worksheet achieved an *V* Aiken's index exceeding 0.83, and several students gave a very good response to the developed worksheet prototype. The findings of this study suggest that the worksheet functions to actively engage students in the learning process, particularly in enhancing their communication skills, both written and oral (Basurto et al., 2024; Riyanto, 2025). In addition, the worksheet may facilitate teachers in conducting and organizing mathematics instruction more effectively. For students, the worksheet is expected to support independent adaptation to and understanding of the learning materials provided by the teacher.

The validity scores on the four aspects confirm the worksheet is both technically and pedagogically appropriate and sound. The worksheets include all stages of the Tri-N (*Niteni, Nirokke, Nambahi*) framework, which helps guide cognitive progression according to constructivist theory. In constructivist theory, students begin with observational activities such as pattern identification and then progress to modeling and replicating ideas. Subsequently, students are expected to extend and transform knowledge in a creative manner. This process is deemed to be essential in supporting the development of higher-order thinking by encouraging students to not stop at procedural thinking but to utilize reflective and generative reasoning. Thus, the worksheets not only serve as learning aids, but also function as a pedagogical framework that organizes students' thinking processes.

The integration of ethnomathematics to the geometry and measurement activities contributes to more meaningful learning experience by helping students connect abstract mathematical concepts to their cultural background. Understanding mathematics from a sociocultural viewpoint means engagement with meaningful cultural tools and practices. The worksheet, by incorporating local cultural elements into project-based activities, may bridge the gap between students' realities and formal mathematical concepts, promoting greater conceptual understanding and high-level thinking. This characteristic positions the worksheet as a culturally appropriate teaching resource consistent with the Merdeka Curriculum's focus on contextual and character-building learning. Theoretically, the integration of Tri-N pedagogy with ethnomathematics could indicate both a teaching

method and a fusion of the philosophical, cultural, and cognitive aspects of mathematics education.

Worksheets are generally considered effective in promoting student participation by allowing them to develop personalized comprehension of mathematical ideas through facilitated learning and worksheets. Students can also practice and master procedural skills via worksheets. These skills include pattern identification, problem analysis, and solution development. Furthermore, worksheets assist teachers and students by providing a framework for teaching and learning math. They offer a guide to the learning goals, activities, and evaluations. Through well-designed instructional approaches embedded in worksheets, learning becomes more focused and meaningful. This, in turn, plays an important role in supporting the development of students' higher-order thinking skills, such as critical thinking, creative thinking, reasoning, problem-solving, and the ability to evaluate and generate mathematical ideas.

These results are in line with previous studies showing that worksheets designed using a guided inquiry method in a mobile learning environment can greatly improve students' higher-order thinking skills. Previous studies have demonstrated that such worksheets designed using a guided inquiry method in a mobile learning environment theoretically and empirically support the enhancement of students' analytical skills and problem-solving skills (Artuz & Roble, 2021; Villayah & Suliyanah, 2025). Moreover, worksheets designed using an ethnomathematics approach in a STEM environment have also been found to be highly effective in developing critical thinking skills by providing meaningful cultural and interdisciplinary contexts to mathematical concepts (Syaripah et al., 2025). In addition, worksheets designed using a discovery learning approach are valid, highly practical, and effective in improving students' critical thinking skills in mathematics classrooms (Fitriyani et al., 2025; Nur'aini & Taufik, 2025).

The distinctive contribution of the current study lies in the particular learning framework that underlies the design of the worksheets. Contrary to the existing literature that mainly focuses on inquiry, STEM, and discovery learning, the current study combines the Tri-N framework and ethnomathematics in the field of geometry and measurement. The three levels of the Tri-N framework, namely *Niteni*, *Nirokke*, and *Nambahi*, are carefully embedded and structured in the learning process. Every aspect of the Tri-N framework has been refined to assist students in a sequential and constructive way so that their learning and engagement with the concepts are both organized and impactful. The combination of the Tri-N framework with ethnomathematics signals both an innovative approach to teaching and an adoption of a culturally responsive pedagogy that aligns with the local educational philosophy.

At the *Niteni* level, students enhance their analytical and contextual understanding by recognizing cultural artifacts and mathematical patterns related to geometric shapes and measuring. At the *Nirokke* level, students are promoted to guided imitation of procedures and processes, while the principles are still being internalized. Subsequently, at the *Nambahi* level, students are encouraged to develop their ideas on existing concepts, promoting creativity. With the activities sequenced in this way, the worksheet is intended to facilitate the observation, guided imitation, and creative exploration of ideas, thereby enhancing a meaningful integration of various patterns. This systematic integration not only fosters conceptual understanding but also culturally situated mathematical knowledge.

Unlike previous studies that created worksheets based on guided inquiry integrated with mobile learning (Anjani et al., 2021), STEM-based strategies (Sutarto et al., 2021), or discovery learning models (Fitriyani et al., 2025), the current study puts forward a culturally rooted and character-based learning design by incorporating the Tri-N framework with ethnomathematics. The previous studies mainly focused on the

improvement of conceptual knowledge, problem-solving skills, technology integration, or scientific inquiry skills. Nevertheless, they have not specifically integrated the local culture with a systematically organized learning process that leads students from observing to imitating and finally to independently generating ideas. This indicates the importance of a more holistic approach that not only improves cognitive outcomes but also contextualizes learning within the socio-cultural experiences of the students.

Therefore, this research work places Tri-N (*Niteni*, *Nirokke*, and *Nambahi*) at the core of the pedagogical base, intertwined with ethnomathematical themes within the geometry and measurement field to create a contextually relevant and meaningful learning experience. Along with supporting the educational process, the purpose of the worksheet is to connect the students' cultural backgrounds to the mathematical ideas. Tri-N's methodical approach guarantees the learning process is both developmental and coherent, ethnomathematics provides additional authenticity, relevance, and engagement. The worksheet, therefore, contributes to the area of mathematics education by incorporating culturally contextualized ethnomathematics into a philosophically constructed learning process.

CONCLUSION

The expert validation results showed that the mathematics worksheet obtained a *V* Aiken's exceeding 0.83, indicating that the developed product is substantially valid. Experts in mathematics education and learning evaluated the worksheet as relevant, accurate, and appropriate for mathematics instruction, including aspects of visual design and organization, mathematical content, the Tri-N approach, and language clarity. Furthermore, the student response test involving 10 students revealed that most students assigned the highest score (5), indicating a positive response to the worksheet. These findings suggest that the mathematics worksheet is easy to use, systematically presents concepts, attracts students' interest, and supports cognitive engagement. In addition, the worksheet appears to contribute to a more interactive and contextual learning environment, encouraging students' active participation in understanding mathematical concepts.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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