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Digital Teaching Material Transformation: Design Student Worksheets using GeoGebra Based on Local Wisdom by Pre-service Teachers

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ABSTRACT

The limited ability of teachers to design interesting digital mathematics teaching materials, as well as the context that is free from local participant wisdom, also causes misconceptions and difficulties in understanding mathematical concepts in depth for students. This study aims to analyze the ability of pre-service mathematics teachers to design student worksheets using the GeoGebra application based on local wisdom in mathematics learning. This study uses a qualitative method with a descriptive analytical approach to describe the ability of the pre-service mathematics study program to design student worksheets with Geogebra software based on local wisdom in mathematics learning. Participants in this study were in the pre-service mathematics education study program in West Java. The data collection technique used documentation in the form of student digital open material designs. The digital teaching materials designed by pre-service mathematics students are worksheets with GeoGebra software based on local wisdom. The research instruments were lecturer and teacher assessment sheets to ensure the feasibility of digital teaching materials and student response questionnaires for the practicality of the results of the digital teaching material plan used by students. The results of the study can be explained by the fact that the ability of students in the mathematics education study program to create digital open materials, namely student worksheets and GeoGebra software media, is worthy of the high category as assessed by lecturers and teachers. Meanwhile, the students' response to the socialization of digital open media design by students gave a positive response with a high category. Thus, students' digital teaching materials support meaningful mathematics learning for students with technology and local wisdom.

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A. INTRODUCTION

The development of digital technology has brought significant changes in the world of education, including in learning mathematics. The use of technology-based applications in learning allows student teachers to develop teaching materials that are more interactive, visual, and contextual (Hidayat & Marsigit, 2024). One of the learning media that can be used is student worksheets, which play an important role in increasing the effectiveness of learning and encouraging teacher creativity in creating teaching materials that suit students' needs (Sugiarni, 2021). However, the lack of creativity in designing contextual teaching materials often causes

learning to be less engaging and ineffective (Sugiarni et al., 2022). To overcome this challenge, the development of digital student worksheets based on local culture is a solution that can be applied because it not only supports the understanding of mathematical concepts but also strengthens the connection between learning and the student's environment (Sugiarni et al., 2023). In the context of technology-based learning, GeoGebra is one application that is widely used because of its ability to represent mathematical concepts dynamically and exploratively (Hevardani et al., 2024). GeoGebra allows student teachers to design student worksheets that are more interactive and visual, making it easier for students to understand mathematical concepts. Previous studies have shown that the use of GeoGebra in mathematics learning, such as in linear programs and quadratic functions, can increase student engagement and understanding (Pratama et al., 2024). In addition, interactive student worksheets-based learning models, such as live worksheets, have been tested for validity and practicality in various studies and proven to be able to improve students' concept understanding and creative thinking skills (Sugiarni et al., 2023). Therefore, the integration of technology in the development of culture-based digital worksheets is an effective strategy to improve the quality of mathematics learning while maintaining the values of local wisdom in it.

The integration of local wisdom in mathematics learning is also an important concern in creating meaningful learning experiences for students. Local wisdom reflects the cultural values and customs of local communities, which can be used as context for learning to make it more relevant and close to everyday life (Carel et al., 2018). For example, the development of local culture-based mathematics teaching materials in various regions has shown an increase in students' understanding of mathematics concepts through their cultural approach (Putra et al., 2023). One example of the application of cultural integration in mathematics learning is the use of woven motifs in teaching geometry using GeoGebra, which is proven to improve students' understanding of the concepts of flat and spatial shapes (Salifu, 2020).

Pre-service mathematics teachers as future agents of change need to be equipped with skills in designing digital teaching materials that are not only technology-based but also contextual and relevant to local culture. Past research has found that pre-service mathematics teachers often struggle to combine technology and culture in math lessons because they haven't received enough training (Çildir & Şen, 2023), even though knowing how to use tools like GeoGebra can make learning more effective (Septian et al., 2020). Pre-service mathematics teachers need support in the form of structured training and technology facilities in the classroom to become more confident in using GeoGebra as part of digital teaching materials (Yildiz & Arpaci, 2024). The successful integration of educational technology into teaching also requires pre-service mathematics teachers to have a profound understanding of the content being taught, appropriate pedagogical strategies, and the ability to optimise technology to improve the quality of learning on the material being (Zutaah et al., 2023).

Several studies have examined the integration of digital technologies by pre-service mathematics teachers. Yildiz & Arpaci (2024) highlighted the role of pedagogical-technological-content knowledge (TPACK) in shaping pre-service teachers' intention to use GeoGebra in teaching. Meanwhile, Hovik & Nolan (2024) explored how pre-service teachers design GeoGebra-based exploratory tasks and relate them to the context of secondary school students. Zutaah et al. (2023) uncovered pre-service teachers' perceptions of using GeoGebra in

geometry learning in Ghana, which showed that although GeoGebra was rated as effective, its utilisation was still limited due to lack of training and pedagogical understanding.

This research offers a new contribution to the field of mathematics education by combining digital technology and local cultural values through the design of GeoGebra-based LKS by pre-service mathematics teachers. Studies that explicitly integrate GeoGebra with local wisdom in the design of digital teaching materials by pre-service mathematics teachers are rare. Therefore, this study focuses on analysing the ability of pre-service mathematics teachers to design student worksheets using the GeoGebra application, based on local wisdom in mathematics learning. The study aims to help teachers and future math teachers use digital technology in creative ways and include local values in their teaching, focussing not just on academic knowledge but also on developing character and a well-rounded understanding of the social and cultural context (Iwani et al., 2023).

B. METHODS

This study employed a qualitative method with a descriptive-analytical approach. This approach was chosen to explore in depth the ability of pre-service mathematics teachers to design student worksheets using GeoGebra software integrated with local wisdom in mathematics instruction. The participants of this study were 20 pre-service mathematics teachers enrolled in the odd semester of the 2024/2025 academic year from a university in West Java, Indonesia. These participants had completed a course on instructional media and were assigned to develop digital teaching materials in the form of student worksheets. They were divided into five groups to collaboratively design the digital worksheets based on GeoGebra and local cultural contexts.

Data were collected through documentation, specifically by gathering pre-service mathematics teacher digital worksheet designs. These instructional materials were expected to incorporate elements of local culture within mathematical learning contexts. In addition, data were collected using assessment rubrics completed by university lecturers, school teachers, and pre-service mathematics teachers to evaluate the feasibility of the digital worksheets in terms of content accuracy, visual design, curriculum alignment, and the integration of local wisdom. To evaluate the practicality and acceptability of the worksheets from the learners' perspective, a student questionnaire was administered after they used the materials in class. The questionnaire covered aspects such as ease of use, student engagement, and the attractiveness of the worksheets in terms of technological integration and cultural relevance. Categorizing the quality of ability of pre-service mathematics teachers, researchers use a five-scale assessment in the conversion of Table 1.

Table 1. Classification of Pre-Service Mathematics Teachers Competency Levels

Interval	Levels
90% ≤ A ≤ 100%	Very high
75% ≤ B ≤ 90%	Tall
55% ≤ C ≤ 75%	Enough
40% ≤ D ≤ 55%	Low
00%≤ E ≤ 40%	Very Low

The data analysis technique followed a descriptive procedure, involving three stages: data reduction, data display, and conclusion drawing. In the data reduction stage, the researcher selected and organized relevant data from the worksheet documentation, expert evaluations (lecturers and teachers), and student responses, focusing on indicators such as feasibility, practicality, and cultural integration. In the data display stage, the reduced data were systematically presented in the form of descriptive narratives, allowing for thematic identification and interpretation. Finally, during the conclusion drawing stage, the researcher formulated key findings and conclusions regarding the capabilities of pre-service mathematics teachers in designing meaningful, contextually relevant digital worksheets using GeoGebra that reflect local cultural values.

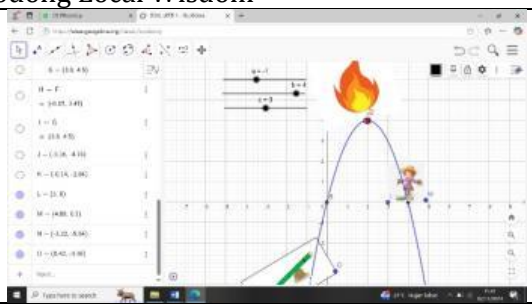
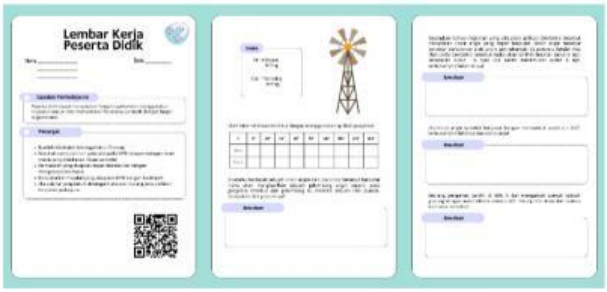
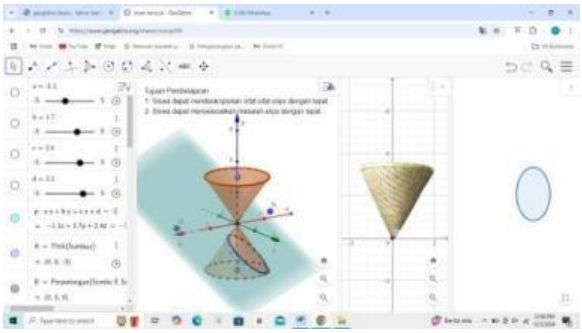
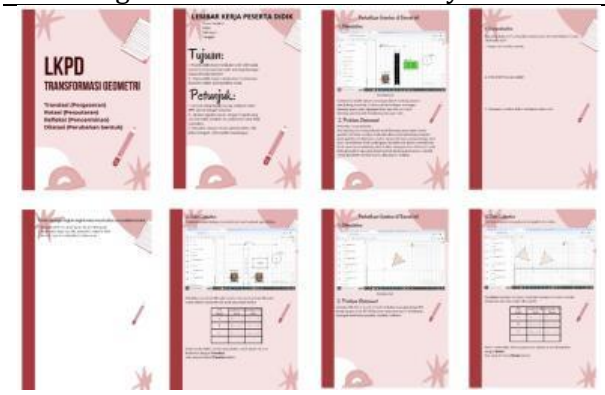
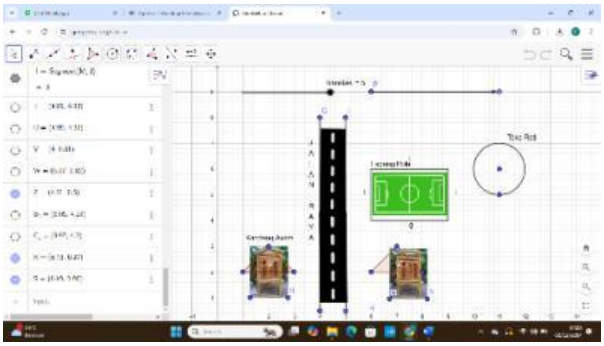
C. RESULT AND DISCUSSION

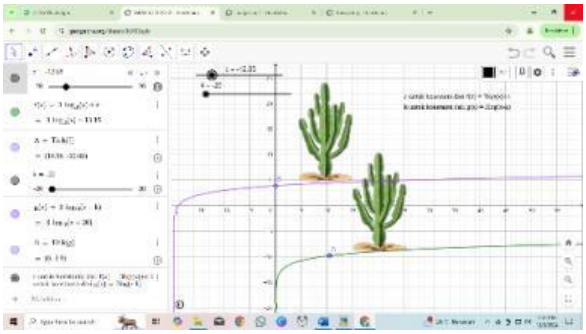
During the lecture, we divided the pre-service teachers into groups and assigned them a project to create teaching materials using GeoGebra software. We assign pre-service teachers to conduct exploration and produce teaching materials using GeoGebra software. In the first step, pre-service teachers determine the learning objectives and materials that will be included in the teaching materials by exploring the school curriculum for both junior high school and senior high school.

Pre-service teachers are faced with material problems that have been given to each group that are adjusted to the learning objectives of the school curriculum in national and international journals. Next, pre-service teachers delve into mathematics applications, such as the GeoGebra application previously developed in journals. Next, we expect pre-service teachers to contribute additional ideas for creating teaching materials that incorporate local wisdom-based mathematics applications. Pre-service teachers are also expected to understand how to make teaching materials for student worksheets with GeoGebra software that are innovative, creative, effective, efficient, and contextual in accordance with the conditions, needs, capacities, and characteristics of schools/education units and students based on learning objectives. Pre-service teachers gather and integrate knowledge about GeoGebra software and mathematics learning. Pre-service teachers are required to make decisions about each framework, design a process to determine teaching materials for student worksheets with GeoGebra software, and collaboratively access and manage information.

Lecturers act as researchers, guiding and mentoring students in a collaborative project that integrates various subjects and materials. The evaluation process is carried out continuously; students and lecturers periodically reflect on the activities that have been carried out, and teaching materials for student worksheets with GeoGebra software as a result of learning activities will be evaluated qualitatively. In general, lecturers in the project-based learning process should be facilitators, trainers, advisors, and intermediaries to get optimal results. The results of teaching materials for student worksheets with GeoGebra software are very diverse in terms of material and level of education units, as they are a product of pre-service teachers' activities. Table 2 is a display of the results of teaching materials for student worksheets with GeoGebra software in each group.

Table 2. Display of Teaching Material Results Student worksheets with Geogebra Software

Student worksheet teaching material display	**Geogebra Display**
Learning Quadratic Functions with the Context of Lodong Local Wisdom	
	
Learning Trigonometric Functions with the Local Wisdom Context of Windmills	
	
Learning Cone Slices with the Context of Asepan Local Wisdom	
	
Learning Transformation Geometry with the Context of Local Wisdom of Cianjur Pelung Chicken Coop	
	
Learning Exponents with the Context of Cactus Local Wisdom	

Student worksheet teaching material display	Geogebra Display
	

The ability of students in making teaching materials with Geogebra software seen from the assessment of lecturers, teachers and Pre-service teachers, can be seen in Table 3.

Table 3. Students' Ability to Create Teaching Materials with Software

Context	Lecturers	Teachers	Pre-service teachers	Average
Lodong game	82	91	100	91
Windmill	82	95	95	91
Asepan traditional tool	83	84	83	83
Pelung chicken coop	81	94	100	92
Cactus plant	81	96	100	92
Sum of Average Scores	82	92	96	90

Based on Table 2, the average student's ability to make teaching materials for student worksheets with Geogebra software from the lecturer's assessment is 82, or in the high category. Then the average ability of students in making teaching materials, student worksheets with Geogebra software from teacher assessment, is 92 or in a very high category. While the assessment of the final semester pre-service teachers is an average assessment of 96 or in the very high category. The average of the assessments of lecturers, teachers, and pre-service teachers is 90 and is included in the high category as well.

After the student worksheets and GeoGebra developed are given an assessment and revisions have been made according to the suggestions of lecturers, teachers, and pre-service teachers, then further at the implementation stage, student worksheets and GeoGebra are socialized to high school/vocational school students. Socialization activities begin with teaching students to operate GeoGebra and explaining the activities and components contained in GeoGebra. Furthermore, inviting students to do some learning activities presented on student worksheets, including working on problems in student worksheets and trying to operate GeoGebra, as shown in Figure 2.

Figure 2. Students Operate and Perform Activities on Student Worksheets and GeoGebra

At the end, students were given a student response questionnaire. The assessment in the student response questionnaire was then analysed to find out the data on the results of the practicality of worksheets with Geogebra in the form of a combined percentage average of 16 students as well as the practicality criteria, which are presented in Table 4.

Table 4. Student Response

No.	Indicator	Quadratic functions	Trigonometric functions	Conic wedge	Transformation geometry	Exponent function	Average
1.	Showing a happy feeling towards learning mathematics	92	81	81	85	82	84
2.	Showing a happy feeling towards learning mathematics using GeoGebra-based student worksheets	85	65	79	41	79	70
3.	Showing the ease of the student worksheet with the help of GeoGebra	87	77	67	77	80	77
Sum of Average Scores		88	75	76	77	80	79

In the table of student responses to student worksheets assisted by the Geogebra application on the first indicator showing a feeling of pleasure towards learning mathematics, the combined average of student responses was 84 or in the high category, the second indicator showing a feeling of pleasure towards learning mathematics using GeoGebra-based student worksheets obtained a combined average of student responses of 70 or in the moderate category, and the third indicator showing the ease of student worksheets with the help of GeoGebra obtained a combined average of student responses of 77 or in the high category. Based on the table above, the student worksheet material is based on the Geogebra application. Apart from the two guidelines in the high and very high categories. the combined average of student responses is 79 or in the high category.

Based on the results of the study, the ability of pre-service teachers in designing teaching materials in the form of Student Worksheets with the help of GeoGebra software was rated high

by lecturers, and very high according to the assessment of teachers and pre-service teachers in the final semester. The overall average of the three assessments was in the high category. This finding shows that student teachers have a good capacity in utilising digital technology to design teaching materials that support mathematics learning. This is in line with Robová & Vondrová (2016) who emphasise the importance of training in the use of GeoGebra in the process of designing teaching by pre-service teachers, as well as Assadi & Hibi (2020) who state that strengthening TPACK (Technological Pedagogical Content Knowledge) through integrated learning is very important in preparing pre-service teachers to face the challenges of digital learning.

This high assessment shows that students have been able to develop teaching materials that are not only technologically functional but also pedagogically relevant. Support from appropriate training and adequate technological facilities plays a significant role in this success, as emphasized by Yildiz & Arpaci (2024), who state that the confidence of pre-service teachers to use GeoGebra in teaching is greatly influenced by the availability of training and technical support. In this context, students as future agents of educational change need to be continuously empowered to create learning innovations that integrate technology with meaningful contextual approaches (Çildir & Şen, 2023).

In addition to the assessments from lecturers and pre-service teachers, students' responses to the implementation of GeoGebra-based worksheets also showed a positive tendency. Although the overall average response from students fell into the "sufficient" category in terms of emotional engagement, they expressed enjoyment in learning mathematics using GeoGebra-assisted worksheets. More notably, on the aspect of ease of use, student responses were categorized as "high," indicating that the use of GeoGebra helped simplify understanding of mathematical concepts. These findings are in line with Zengin (2017), who revealed that GeoGebra supports interactive and visual learning, thereby strengthening students' conceptual understanding in mathematics.

Further support for these findings comes from previous studies highlighting the integration of GeoGebra in culturally rich and project-based digital worksheets. For instance, Sugiarni et al. (2019) and Sarah & Rani (2020) developed e-LKS based on environmental projects and local wisdom, which not only fostered mathematical literacy but also built student character. Similarly, R. Hidayat et al. (2024) and Rohaeti & Bernard (2018) found that GeoGebra enhanced students' engagement and conceptual grasp, especially when paired with contextual learning strategies. The findings of this study resonate with these prior studies, emphasizing that incorporating local wisdom into GeoGebra-based digital worksheets can increase their relevance, usability, and pedagogical value thus contributing to meaningful learning experiences for students.

D. CONCLUSION AND SUGGESTIONS

The results showed that pre-service teacher mathematics education study programme students have a high ability to create digital teaching materials, namely student worksheets with the Geogebra application, which are considered feasible by lecturers, teachers and pre-service teacher mathematics. In addition, students also gave a high positive response to the socialisation of digital teaching media design carried out by pre-service teacher mathematics,

so that digital teaching materials can support meaningful mathematics learning for students with technology and local wisdom. These findings indicate that the integration of technology and local wisdom in mathematics education can provide interest for students. Furthermore, the use of digital teaching materials can also help pre-service teachers develop pedagogical competence in creating innovative and effective teaching materials.

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