Effectiveness of realistic mathematics worksheets with balinese cultural content on fourth-grade students' learning outcomes

Kadek Yudista Witraguna*, Ni Nyoman Tri Wahyuni, Putu Ayu Septiari Dewi

UHN I Gusti Bagus Sugriwa Denpasar, Jl. Ratna No. 51, Denpasar, Bali, 80237, Indonesia
yudistawitraguna@uhnsugriwa.ac.id*

Abstract: *This study investigates the effectiveness of culturally-based Student Worksheets (LKPD) incorporating Balinese culture in improving fourth-grade students' mathematics learning outcomes. The research used a one-group pretest-posttest design with 30 students from SD Negeri 1 Kemenuh as participants. The LKPD integrated mathematical concepts with elements of Balinese culture, such as traditional dances and architecture, to create a contextual and engaging learning experience. Pretest and posttest data were analyzed using a paired sample t-test. The results revealed a significant increase in students' posttest scores (t = 18.49, p < 0.05), indicating that the cultural integration in LKPD enhanced conceptual understanding and learning motivation. These findings suggest that incorporating local culture into learning media can improve students' mathematical achievement. However, its success depends on the teacher's role in facilitating connections between cultural context and mathematical concepts.*

Keywords*: realistic mathematics, student worksheets, Balinese culture, mathematics learning outcomes*

Introduction

Mathematics plays a critical role in developing students' logical, analytical, and critical thinking skills (Kemdikbud, 2022). It equips learners with essential competencies that are applicable in daily life and across disciplines (Nurhikmayati, 2019; Siregar & Dewi, 2022). However, many elementary students still experience low mathematics learning outcomes, partly because mathematics is often perceived as difficult due to its abstract nature, which can reduce students' motivation to learn (Yeh et al., 2019). In addition, lessons are frequently delivered without real-life context, making it harder for students to relate to and understand the material.

According to Piaget's cognitive development theory, elementary school students are in the concrete operational stage, where they understand concepts better through hands-on experiences and real objects rather than abstract representations (Astuti, 2018; Zuliana et al., 2019). Ideally, mathematics instruction at this level should incorporate concrete materials and contextual examples to support comprehension. In reality, learning activities often remain teacher-centered, with limited meaningful and engaging contexts, which causes students to struggle in applying mathematical concepts to real situations.

The lack of contextual and innovative teaching approaches has been identified as a major challenge in mathematics education(Prasetyo et al., 2023; Wiryana & Alim, 2023). For example, basic operations such as addition and subtraction are frequently taught using standard algorithms without meaningful connection to students' environments. Real-life contexts, such as shopping, traditional ceremonies, or farming,are rarely used as instructional

[151]

anchors, which limits students' ability to transfer mathematical knowledge to real situations (Mandasari & Rosalina, 2021; Sidik et al., 2021).

To address these issues, contextual learning models that integrate mathematics with students' daily lives and local culture have emerged as effective alternatives (Asmara et al., 2022). This approach helps students build meaningful connections between abstract mathematical concepts and familiar experiences. In culturally rich regions like Bali, local elements such as traditional architecture, dances, and ceremonial practices can serve as valuable contexts for mathematics learning (Apsari & Abrahamson, 2024; Diputra et al., 2022; Murtiawan et al., 2020). For instance, geometry can be explored through patterns in temple structures or movements in traditional dances, enabling students to engage with the subject more intuitively and meaningfully.

One effective way to implement contextual and culture-based learning is through Student Worksheets (Lembar Kerja Peserta Didik/LKPD). Culturally integrated LKPD can guide students through structured activities that connect mathematical content to local contexts while promoting active learning (Kholifahtus et al., 2021; Ramadanti et al., 2023). In addition, LKPD supports independent learning and helps teachers organize instruction in alignment with students' developmental stages (Khatimah & Fatimah, 2023).

While previous studies have demonstrated the benefits of integrating local culture into learning, there is limited research that specifically examines the effectiveness of Balinese culture-based LKPD in mathematics education. This study seeks to fill that gap by determining the effectiveness of realistic mathematics worksheets designed with Balinese cultural contexts in improving fourth-grade students' learning outcomes. The findings are expected to contribute to the development of culturally responsive instructional materials that enhance both academic achievement and cultural appreciation.

Method

This study employed a pre-experimental method with a one-group pretest-posttest design to examine the effectiveness of realistic mathematics worksheets (LKPD) incorporating Balinese cultural content in improving mathematics learning outcomes. This design involved measuring students' performance before and after the implementation of the treatment, allowing researchers to assess the extent of change attributable to the intervention. The research was conducted at SD Negeri 1 Kemenuh and involved 30 fourth-grade students as the research sample. A saturated sampling technique was used, meaning all students in the population were included due to the small class size, enabling a comprehensive analysis.

The research instrument consisted of a learning outcome test on addition and subtraction with regrouping, developed to align with the competencies expected in fourth-grade mathematics. The test comprised 10 essay-type questions designed to assess students' conceptual understanding and problem-solving abilities. Before being administered, the instrument underwent content validation by two mathematics education specialists using a structured validation sheet covering aspects of content relevance, language clarity, and alignment with learning objectives. The instrument was then piloted with a comparable group

of students to conduct an item analysis for validity and reliability. Item validity was measured using the product–moment correlation, while reliability was calculated using Cronbach's alpha. Items that did not meet the validity criteria were revised or replaced based on expert feedback and trial results, ensuring that the final instrument was both valid and reliable for data collection.

The research procedure followed three stages: (1) pretest, administered to assess students' baseline understanding before the learning intervention; (2) treatment, where students participated in four mathematics sessions using LKPD designed with Balinese cultural contexts that included contextual problems inspired by Balinese daily life, such as traditional markets, ceremonies, and architecture, aiming to foster meaningful learning; and (3) posttest, conducted to measure changes in students' learning outcomes after the intervention.

The data were analyzed using descriptive and inferential statistics. Descriptive statistics, including mean, standard deviation, and percentage gain, were used to summarize students' performance. Inferential analysis involved a paired sample t-test using SPSS to examine the significance of the difference between pretest and posttest scores. A normality test (Shapiro–Wilk) was conducted before the t-test to ensure the data met the assumptions for parametric analysis. The significance level was set at $\alpha = 0.05$, and results with $p < 0.05$ were considered statistically significant. These results served as the basis for drawing conclusions about the effectiveness of the LKPD in improving student achievement.

Results and Discussion

This study began with the administration of a pretest to the research sample to measure the participants' initial abilities. The assessment instrument used was an essay test consisting of 10 questions designed to evaluate students' learning outcomes in addition and subtraction of whole numbers. These 10 test questions were developed based on validation and reliability results, ensuring their appropriateness and consistency as described in the abstract and research methods sections. After obtaining the pretest results, the learning process was conducted over four sessions using culturally-based Balinese realistic mathematics student worksheets (LKPD). The LKPD was specifically designed to facilitate the understanding of addition and subtraction, allowing students to grasp these operations through contextual and meaningful learning experiences. At the end of the sessions, the sample was given a posttest using the same essay test to measure their improvement in understanding. The results of the pretest and posttest were then analyzed and presented in the following table.

Tabel 1. Pretes and Postes Results

Descriptive Statistics					
	N	Min	Max	$\bar{X}$	S
Pretest	30	50	87	69,43	9,15
Posttest	30	64	95	77,33	9,70

Table 1 illustrates an increase in the average score from the pretest to the posttest, suggesting that the culturally-based Balinese realistic mathematics student worksheets (LKPD) contributed positively to students' mathematics learning outcomes. Prior to conducting the paired sample t-test to examine the significance of the difference between the average pretest and posttest scores, a normality test was performed to verify that the data met the assumptions required for parametric statistical analysis. The normality test, conducted using the Shapiro-Wilk method in the SPSS application, yielded p-values of 0.124 for the pretest and 0.084 for the posttest, both of which are greater than the significance level of 0.05. This indicates that the data were normally distributed. Consequently, the paired sample t-test was carried out using SPSS. The results of this analysis are presented below.

Table 2. Paired Samples Test Results

| | Paired Differences | | | | | | | |
| | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | t | df | Sig. (2-tailed) |
				Lower	Upper			
Posttest - Pretest	7,90	2,33	0,43	7,03	8,77	18,49	29	0,000

The results of the paired sample t-test showed a significance value (Sig.) below 0.05, which indicates rejecting the null hypothesis (H_o) and accepting the alternative hypothesis (Ha). These results demonstrate a statistically significant difference between the pre-test and post-test scores. The average post-test score increased from 69.43 in the pre-test to 77.33 in the post-test, indicating an improvement of 7.8 points in students' addition and subtraction abilities. This significant increase in test scores confirms that the use of the culturally-based Balinese realistic mathematics student worksheets (LKPD) effectively enhanced the students' learning outcomes in mathematics, particularly in understanding and performing addition and subtraction operations.

The results of the study indicate that the use of culturally-based Balinese realistic mathematics student worksheets (LKPD) has a positive impact on improving students' learning outcomes. The increase in the average posttest score compared to the pretest demonstrates that this LKPD makes mathematics learning more contextual and meaningful. In mathematics education, linking mathematical concepts to local culture helps students better understand the material by connecting it to their everyday experiences. These culturally-based worksheets align with previous research (Hadijah et al., 2019; Sulistyawati, 2020), which states that culturally relevant learning media can enhance students' motivation and conceptual understanding. Furthermore, constructivist theory emphasizes that students grasp material more easily when provided with learning experiences relevant to their lives (Dewi & Fauziati, 2021; Firdaus et al., 2023).

In addition to improving conceptual understanding, the effectiveness of culturally-based Balinese realistic mathematics student worksheets (LKPD) is also linked to the active

involvement of students in the learning process. Realistic mathematics LKPD allows students to explore concepts concretely before transitioning to abstract representations (Ananda, 2022; Septian et al., 2019). This aligns with the findings in this study, where students demonstrated increased engagement and better comprehension during learning activities using the LKPD, as observed in classroom observations and reflected in improved posttest scores. The use of real-world contexts in learning supports Bruner's learning theory, which states that understanding mathematical concepts is more effective when it begins with direct experiences before moving to the stage of symbolization (Zuliana et al., 2019). (Hendriani, 2021) emphasizes that the use of concrete media significantly increases student engagement and aids comprehension of complex material. This study's qualitative data also showed that students were more motivated and actively participated when using the LKPD, reinforcing the role of concrete, culturally relevant media in enhancing learning outcomes. Thus, the effectiveness of this LKPD lies not only in its culturally-based content but also in its active and contextual learning approach.

Although this study demonstrates that culturally-based Balinese realistic mathematics student worksheets (LKPD) can improve students' learning outcomes, its implementation still requires the teacher's role in guiding students to connect the concepts in the LKPD with real-world problems. Understanding mathematical concepts is not solely determined by the learning media used but also by the teaching strategies applied (Hadijah et al., 2019; Yulianty, 2019). One of the challenges in using this LKPD is ensuring that each student has a sufficient understanding of the cultural context embedded in the learning material. Therefore, in further implementation, teachers need to ensure that the LKPD is used flexibly and can be adapted to the characteristics and needs of students to optimize the effectiveness of learning.

Moreover, the findings of this study align with the principles of Kurikulum Merdeka, which emphasizes exploratory learning and the integration of local wisdom. Incorporating cultural elements into education not only enhances students' understanding of mathematical concepts but also fosters a stronger sense of cultural identity. This approach fosters meaningful learning by linking mathematical concepts to students' culturally relevant real-life contexts. Additionally, culturally based learning materials can increase student engagement and motivation, making mathematics feel more relevant and applicable to their daily lives.

This study also highlights the potential to expand the development of culturally based student worksheets (LKPD) beyond addition and subtraction to other mathematical topics, such as multiplication and division. Furthermore, this culturally responsive approach can be adapted for other subjects, including natural and social sciences. By incorporating cultural elements across different disciplines, learning becomes more contextualized and comprehensive. Ultimately, culturally responsive teaching emerges as a promising strategy to enhance education quality, ensuring that instructional materials are not only pedagogically effective but also personally meaningful for students.

Conclusion

The findings of this study indicate that the use of Bali culture-based Realistic Mathematics Student Worksheets (LKPD) significantly improves students' learning outcomes, as evidenced by the increase in the average posttest scores compared to the pretest and the significant results of the paired sample t-test. These results reinforce the idea that a contextual and culturally integrated approach makes learning more meaningful and relevant to students' experiences. However, the teacher's role remains crucial in guiding students to connect mathematical concepts with real-life contexts. Therefore, LKPD should be used flexibly and adapted to students' needs to achieve optimal learning effectiveness.

For further research, it is recommended to explore the application of culturally-based LKPD in other mathematical topics beyond addition and subtraction, such as multiplication and division, to assess its broader effectiveness. Additionally, future studies could investigate the long-term impact of LKPD on students' mathematical reasoning and problem-solving skills, as well as include larger and more diverse samples to enhance generalizability.

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