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Development of an Ethnomathematics-Based Student Worksheet (LKPD) Using The Bakar Batu Tradition on Three-Variable Linear Equation Systems To Support High School Students' Mathematical Conceptual Understanding

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Abstract

This study aimed to develop a student worksheet (LKPD) based on the ethnomathematics of the Bakar Batu tradition for three-variable linear equation systems (SPLTV) that meets validity, practicality, and effectiveness criteria within the research context. The study employed Research and Development using the 4-D model: define, design, develop, and disseminate. The product was developed in A4 print and digital formats. Participants were tenth-grade students at SMA Negeri 1 Dekai Yahukimo in the 2025/2026 academic year. Data were collected through expert validation, teacher and student response questionnaires, and a mathematical conceptual understanding test. Material validation reached 90.67%, media validation 94.00%, cultural validation 95.00%, and the combined score 92.73% (very valid). Practicality reached 93.33% based on teacher responses and 88.89% based on student responses (very practical). The effectiveness trial involving 20 students showed an N-gain of 0.605 (moderate). The LKPD uses Bakar Batu as a source of mathematical situations, scaffolds SPLTV modeling, and connects procedures with interpretation. The findings indicate that the LKPD is effective within the research context as an alternative SPLTV learning resource, while broader generalization requires larger samples and comparative designs.

Keywords: *ethnomathematics; Bakar Batu; student worksheet; SPLTV; mathematical conceptual understanding*

INTRODUCTION

Conceptual understanding is one of the fundamental competencies in mathematics learning. Concept mastery is not only related to obtaining correct answers, but also to the ability to explain concepts, connect various representations, identify the characteristics of a concept, and apply it in different situations (Budiarto, 2022; Fajriyah, 2018). In algebra, this ability becomes increasingly important because students must understand the relationships among symbols, variables, coefficients, constants, and mathematical representations.

Problems related to conceptual understanding are still found in mathematics learning. Students may experience difficulties in understanding and applying algebraic concepts when solving

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problems. This condition indicates the need for instructional materials that do not merely present solution procedures but also provide learning experiences that help students construct conceptual meaning.

Three-variable linear equation systems (SPLTV) constitute one of the topics requiring conceptual understanding. Students must be able to identify variables, formulate mathematical models from contextual situations, determine relationships among quantities, and solve systems of equations using appropriate methods. If learning relies only on symbolic forms, students may master procedures without understanding the relationship between mathematical models and the situations they represent.

This condition is relevant to mathematics learning at SMA Negeri 1 Dekai Yahukimo. Based on the preliminary analysis in this study, the instructional materials used had not optimally integrated local cultural contexts. In SPLTV learning, the problems provided tended to consist of numbers and symbols, limiting students' ability to connect concepts with situations close to their daily lives.

One approach that can bridge formal mathematical concepts and students' experiences is ethnomathematics (D'Ambrosio, 2001; Budiarto, 2022; Supriadi, 2021). Ethnomathematics provides opportunities to identify and use cultural activities as contexts for mathematics learning. Recent studies indicate that integrating cultural contexts into mathematics learning can strengthen the connection between local knowledge and mathematical concepts.

The Bakar Batu tradition was selected as the context because it is part of the social and cultural environment of the community in the research area (Kasenda, 2024; Tabuni, 2023; Maryati & Palobo, 2023). The Bakar Batu process involves various activities that can be reconstructed into mathematical contexts, such as grouping materials, determining quantities and prices, examining relationships among quantities, and performing distribution and calculations. These contexts enable SPLTV concepts to be presented through situations that are closer to students' experiences.

However, the presence of cultural context alone is not sufficient. The context needs to be organized into instructional materials capable of guiding students from concrete experiences toward mathematical representations. Therefore, the student worksheet (LKPD) was selected as the product to be developed because it can contain contextual information, exploratory activities, guiding questions, mathematical representations, and problem-solving exercises in a systematic manner.

This study positions the Bakar Batu tradition as the main context in SPLTV learning activities. Students are guided to identify information from cultural situations, determine variables, formulate systems of equations, solve the systems, and interpret the results. This study aimed to develop an ethnomathematics-based LKPD using the Bakar Batu tradition for SPLTV and to determine its validity, practicality, and its contribution to improving students' mathematical conceptual understanding.

METHOD

This study was a Research and Development (R&D) study using the 4-D model consisting of the Define, Design, Develop, and Disseminate stages. The model was selected because it provides a systematic sequence for identifying needs, designing products, conducting validation and trials, and disseminating products on a limited scale.

The study was conducted at SMA Negeri 1 Dekai Yahukimo, Highland Papua. The field trial participants consisted of 20 tenth-grade students. A limited trial involved 6 students with diverse ability levels to obtain preliminary information regarding the readability and ease of use of the LKPD.

The Define stage involved front-end analysis, needs analysis, curiculum and learning objective analysis, student characteristic analysis, and analysis of the Bakar Batu cultural context. The Design stage produced an initial LKPD design in print and digital formats using the Bakar Batu tradition, cultural illustrations, mathematical modeling activities, and contextual SPLTV problems. The Develop stage included expert validation, product revision, limited trials, further revision, and field trials. The Disseminate stage was conducted on a limited scale by providing the final product to mathematics teachers and the school as an alternative instructional resource for SPLTV.

Validity data were obtained through expert validation sheets and analyzed using the score percentage formula $P = (\Sigma X/\Sigma Xi) \times 100\%$. Practicality was analyzed based on teacher and student response questionnaires. Product effectiveness was descriptively examined through comparisons of pretest and posttest scores and N-Gain. N-Gain was calculated using $g = (\text{posttest} - \text{pretest})/(\text{maximum score} - \text{pretest})$. The criteria used were high ($g \geq 0.70$), moderate ($0.30 \leq g < 0.70$), and low ($g < 0.30$).

RESULTS AND DISCUSSION

1. Characteristics of the Developed Ethnomathematics-Based LKPD

The results of the Define stage indicated that students needed instructional materials capable of connecting SPLTV concepts with situations close to their daily lives. Therefore, the Bakar Batu tradition was used as the main context in the LKPD.

Table 1. Needs Analysis for LKPD Development

Aspect	Learning Condition	Development Need
Problem context	Tends to be abstract and presented as numbers/symbols	Bakar Batu situations as problem contexts
Conceptual understanding	Students tend to follow procedures	Activities for constructing and interpreting SPLTV models
Engagement	Discussion and exploration are still limited	Group activities and contextual exploration
Cultural integration	Culture has not been utilized as a learning resource	Explicit integration of the Bakar Batu tradition
Learning resources	Textbooks/general worksheets	Special ethnomathematics-based LKPD

These characteristics became the basis for designing the LKPD. The Bakar Batu context was not used merely as an illustration or introduction, but as a means of constructing mathematical

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problems. Students were guided to identify quantitative information, define variables, formulate equations, solve SPLTV, and interpret the results.

2. Validity of the Developed Ethnomathematics-Based LKPD

Validation was conducted by three validators consisting of a subject-matter expert, a media expert, and a cultural expert. The results are presented in Table 2.

Table 2. LKPD Validation Results

Validator	Score	Percentage	Category
Subject-matter expert	68/75	90.67%	Very valid
Media expert	47/50	94.00%	Very valid
Cultural expert	38/40	95.00%	Very valid

These results indicate that the LKPD had very good feasibility in terms of content, media, and culture. The highest percentage was obtained from the cultural expert at 95.00%. This finding is important because the use of cultural contexts in instructional materials requires accurate representation so that the culture employed is not oversimplified or misrepresented.

The subject-matter validation indicated that the content of the LKPD was aligned with the learning objectives and SPLTV material. Media validation showed that the design, layout, readability, illustrations, and presentation met the established criteria. Validator feedback was used to improve the appearance, clarity of instructions, accuracy of the cultural context, and alignment between activities and learning objectives.

3. Practicality of the Ethnomathematics-Based LKPD

Product practicality was assessed through responses to the use of the LKPD in learning.

Table 3. Practicality Results of the LKPD

Respondent	Number of Respondents	Percentage	Category
Teacher response	1	93.33%	Very practical
Student response	6	88.89%	Very practical

The percentages for each aspect were in the very practical category. This indicates that the LKPD was relatively easy to use and could support the implementation of learning. The high student responses also suggest that the cultural context used in the LKPD may be one factor making the instructional material more closely connected to their experiences.

4. Improvement in Mathematical Conceptual Understanding

The effectiveness of the LKPD was examined based on changes in students' mathematical conceptual understanding scores before and after using the product.

Table 4. Descriptive Statistics of Pretest and Posttest Scores

Data	Mean	SD	Minimum	Maximum
Pretest	12.10	5.38	3	22
Posttest	21.05	4.89	7	28

The mean score increased by 8.95 points, from 12.10 to 21.05. In addition to the increase in the mean score, the minimum score increased from 3 to 7 and the maximum score increased from 22 to 28. Individual N-Gain values ranged from 0.16 to 1.00, with an average of approximately 0.605, which falls into the moderate category.

Table 5. Summary of Improvement in Mathematical Conceptual Understanding

Indicator	Result
Mean pretest score	12.10
Mean posttest score	21.05
Mean improvement	8.95
Mean N-Gain	0.605
N-Gain category	Moderate

The improvement indicates a change in students' conceptual understanding after using the LKPD. The activities in the LKPD, which began with the Bakar Batu context, provided students with opportunities to identify information, represent situations mathematically, and solve SPLTV problems.

Nevertheless, the results should be interpreted cautiously. Because the trial design used a one-group pretest–posttest comparison, the score improvement cannot be definitively attributed solely to the LKPD. The findings are more appropriately stated as an improvement in conceptual understanding after using the LKPD rather than as strong causal evidence.

General Discussion

The findings show that integrating the Bakar Batu tradition into the LKPD can produce instructional materials that meet validity and practicality criteria. The high validation score for the cultural aspect highlights the importance of involving individuals who understand the cultural context in developing ethnomathematics-based instructional materials.

From a pedagogical perspective, the cultural context provides a more concrete starting point for constructing mathematical representations. Students do not immediately encounter SPLTV symbols; instead, they first understand a situation, identify quantities, determine relationships among quantities, and then translate them into equations.

These findings are consistent with recent studies on ethnomathematics, which indicate that cultural contexts can function as bridges between local knowledge and school mathematics concepts. Research on the pedagogical quality of ethnomathematics learning also emphasizes that the success of this approach depends on how cultural elements are genuinely integrated into concept-development activities rather than merely used as decorative elements in learning.

In the context of this study, the Bakar Batu tradition offers added value because it is closely connected to students' social environment. This enables students to recognize that mathematical concepts can be found in community activities. Thus, mathematics is not perceived merely as a collection of symbols and procedures, but as knowledge that can be used to understand real-life situations.

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This study has limitations. The trial was conducted in one school with a relatively small number of students and without a control group. In addition, improvement in conceptual understanding was measured using descriptive statistics and N-Gain. Further research is needed to examine the effectiveness of the LKPD using larger samples and stronger experimental designs.

CONCLUSION

An ethnomathematics-based LKPD using the Bakar Batu tradition for the topic of three-variable linear equation systems (SPLTV) was successfully developed using the 4-D model. The resulting product integrates the Bakar Batu cultural context into SPLTV mathematical modeling and problem-solving activities.

The validation results showed that the LKPD was categorized as very valid, with percentages of 90.67% from the subject-matter expert, 94.00% from the media expert, and 95.00% from the cultural expert. The product was also categorized as very practical, as indicated by a teacher response of 93.33% and a student response of 88.89%.

Students' mathematical conceptual understanding improved, as shown by the increase in the mean score from 12.10 on the pretest to 21.05 on the posttest. The mean N-Gain of 0.605 was in the moderate category. Thus, the LKPD was effective within the context of this study in supporting students' mathematical conceptual understanding. The product is characterized by its contextual nature, use of Bakar Batu as a source of mathematical situations, scaffolding for SPLTV modeling, and connection between solution procedures and interpretation. However, generalization of its effectiveness still requires studies involving larger samples and comparative research designs.

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