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Development of an Electronic Contextual PJBL Worksheet for Simple Machine Analysis in Oil Palm Harvesting Movements

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Abstract The utilization of the surrounding environment as a source of science learning, particularly in oil palm plantation areas, has not yet been optimally implemented. One learning medium that enables students to interact directly with their environment is a contextual Project-Based Learning (PJBL) electronic worksheet. This study aims to develop a contextual-based electronic PJBL worksheet for analyzing simple machine principles in the human skeletal system during oil palm harvesting activities. The development procedure followed the research and development model proposed by Richey and Klein. Limited testing was conducted with ninth-grade students at SMP Evans Indonesia using questionnaires and group interviews to obtain student responses to the developed worksheet. The results indicate that the overall student response to the electronic worksheet falls within the very good category. Nevertheless, several suggestions were provided by students to improve technical features and enhance learning comfort, which were used as considerations for product refinement.

Keywords: Electronic worksheet, Project-based learning, PJBL, Contextual learning, Simple machines

INTRODUCTION

In science learning, interaction between students and their surrounding environment is essential, as the environment functions as a primary source of learning (El Zaatari & Maalouf, 2022; Sökmen, 2021). Science can be understood as a body of knowledge acquired through systematic processes of discovering phenomena that occur in daily life as part of problem-solving efforts (Romdaniyah, 2024; Nasution et al., 2023). Therefore, the learning process should emphasize real phenomena or events encountered by students in their everyday environment. Science learning is expected to provide opportunities for students to practice identifying and understanding problems that arise from their surroundings (Abdullah, 2024; Elistiana et al., 2024; Wijayaningputri & Utami, 2024). In addition, science learning at the junior high school level should be facilitated through scientific activities, such as experiments and observations, to support conceptual understanding (Yusnidar et al., 2024; Marcelina et al., 2022).

Along with rapid technological developments, students are required to adapt to 21st-century demands that emphasize the ability to understand and solve problems within their environment. Twenty-first century education is oriented toward the development of 4C skills communication, collaboration, critical thinking, and problem-solving through the effective use of technology in daily life (Fikrina et al., 2023; Nasution et al., 2023). Consequently, it is necessary to create a learning environment that facilitates students' use of technology as a tool to practice these skills, which are considered essential learning outcomes (Ağaoğlu et al., 2020).

Field observations conducted in Kota Bangun Subdistrict, Kutai Kartanegara, indicate that students have not optimally utilized their surrounding environment as a source of science learning, despite its close proximity to their daily lives. This finding is consistent with Wisanti (2021), who reported that learning activities involving practical work or observation are often avoided by teachers. Instead, students are frequently directed to complete written exercises, replacing hands-on experiences. Such teacher-centered and passive learning approaches may lead to student boredom and limit students' ability to understand scientific concepts. Therefore, engaging contextual learning is needed learning that emphasizes a holistic process so that students can better comprehend learning objectives and relate them to real-life contexts (Suhartoyo et al., 2020). Contextual and outdoor-based science learning can facilitate student-centered learning and encourage active interaction with learning resources (Sekarini et al., 2019).

Project-Based Learning (PJBL) is a learning model that emphasizes real-world problems as the starting point for collecting and integrating new knowledge through direct investigative experiences (Omelianenko & Artyukhova, 2024; Tursunova, 2024; Rehman et al., 2024). This model enables students to practice 21st-century skills and develop higher-order thinking abilities (Hujjatusnaini et al., 2022). When integrated with contextual learning, PJBL can create a learning environment that supports students in actively analyzing and solving problems relevant to their daily experiences (Fawaas et al., 2024).

In science practicum and observation activities, student worksheets play an important role in guiding students through the learning process. Worksheets can help students develop more concrete thinking skills in understanding scientific concepts (Widayanti et al., 2018). Furthermore, Rahayu et al. (2023) emphasized that integrating technology one of the key requirements of 21st-century instructional design into student worksheets can increase student engagement, particularly in activities that involve exploring their environment. Therefore, it is necessary to adapt worksheet design to make it more engaging, accessible, and relevant to students' real-life contexts.

Based on the above considerations, this study aims to develop an electronic contextual PJBL worksheet focused on analyzing simple machine principles in the human skeletal system during oil palm harvesting activities. The study also includes an initial limited evaluation involving students to assess the feasibility and readiness of the developed worksheet prior to broader implementation in science learning.

METHOD

This study employed a research and development (R&D) approach based on the product and tool development model proposed by Richey and Klein (as cited in Waruwu et al., 2023). The product developed in this study was an electronic contextual Project-Based Learning (PJBL) worksheet designed to analyze simple machine principles in human skeletal movements during oil palm harvesting activities.

Data collection techniques consisted of both indirect and direct communication methods. Indirect communication techniques involved the use of material validation instruments, media validation instruments, and student response questionnaires. Direct communication techniques were carried out through focused group discussions with ninth-grade students at SMP Evans Indonesia, which is located in the oil palm plantation area of PT Prima Mitrajaya Mandiri, Kota Bangun Subdistrict, Kutai Kartanegara District. These discussions aimed to gather qualitative feedback related to the usability and contextual relevance of the developed worksheet.

Validation Instruments

Material validation was conducted using an instrument composed of several aspects, including components, didactic elements, content feasibility, language, the contextual PJBL model, and material context coverage. The detailed blueprint of the material validation instrument is presented in Table 1.

Table 1. Blueprint of material validation instrument.

Aspect	Number of Indicators
Components	14
Didactic	4
Content Feasibility	11
Language	3
Contextual PJBL Model	4
Material Context Coverage	4

Media validation was performed using an instrument covering presentation, graphics, media engineering, and accessibility aspects. The blueprint of the media validation instrument is shown in Table 2.

Table 2. Blueprint of media validation instrument.

Aspect	Number of Indicators
Presentation	5
Graphics	6
Media Engineering	6
Accessibility	1

Both material and media validation instruments used a four-point Likert scale, with scoring categories ranging from Very Poor (1) to Very Good (4), as presented in Table 3.

Table 3. Scoring guide for validation instruments.

Category	Score
SB (Very Good)	4
B (Good)	3
K (Poor)	2
SK (Very Poor)	1

Data Analysis Technique

Product feasibility analysis was carried out based on expert judgments obtained from the material and media validation instruments. The qualitative data from expert assessments were converted into quantitative scores using the scoring guide in Table 3. The average score for each aspect was calculated using Formula (1):

$$\bar{x} = \frac{\sum x}{N}$$

where:
$\bar{x}$ represents the average score for each assessed aspect,

$\sum x$ denotes the total score obtained, and

N refers to the number of evaluators.

The resulting average scores were then interpreted according to the validity assessment criteria presented in Table 4, which categorize product validity into Very Good, Good, Not Good, and Very Not Good based on predetermined interval ranges.

Table 4. Validity assessment criteria.

Interval	Criteria
$(\overline{xi} + 3SBi) \geq \overline{x} \geq (\overline{xi} + 1.5SBi)$	Very Good
$(\overline{xi} + 1.5SBi) > \overline{X} \geq (\overline{xi})$	Good
$\overline{xi} > \overline{X} \geq (\overline{xi} - 1.5SBi)$	Not Good
$(\overline{xi} - 1.5SBi) > \overline{X} > (\overline{xi} - 3SBi)$	Very Not Good

Student Response Questionnaire

Student responses were collected using a questionnaire consisting of three main aspects: worksheet readability, material relevance and suitability, and ease of use. The blueprint of the student response questionnaire is shown in Table 5. Responses were measured using a four-point Likert scale, ranging from Strongly Disagree (1) to Strongly Agree (4), as detailed in Table 6.

Table 5. Blueprint of Student Response Questionnaire.

Aspect	Number of Indicators
Worksheet Readability	3
Material Relevance and Suitability	3
Ease of Use	3

Table 6. Student Questionnaire Scoring Guide.

Category	Score
SS (Strongly Agree)	4
S (Agree)	3
KS (Somewhat Disagree)	2
TS (Disagree)	1

Interviews

In addition to questionnaires, group interviews were conducted comprehensively with students to obtain deeper insights into their perceptions, experiences, and difficulties encountered while using the electronic worksheet. The interview data were analyzed descriptively and used as supporting information in refining and finalizing the developed product, in line with previous studies (Juselani et al., 2019).

FINDINGS AND DISCUSSION

The development of the electronic contextual Project-Based Learning (PJBL) worksheet for analyzing simple machine principles in the human skeletal system during oil palm harvesting was carried out through several stages, namely analysis, design, development, and evaluation.

Analysis Stage

At the analysis stage, expected learning achievements, competencies, and learning outcomes were identified to determine the appropriate depth of the material and to formulate learning objectives that would guide the worksheet content. In addition, students' needs in science learning were analyzed through direct and comprehensive interviews that explored their interests and expectations during the learning process. The results of this stage produced initial data related to field conditions, learning objectives, and a concept map of the material to be developed.

Design Stage

Based on the results of the analysis stage, the electronic worksheet was designed with the main topic of simple machines, focusing on the analysis of simple machine principles within the human skeletal system. Contextual learning was integrated by using oil palm harvesting movements commonly observed by students in their daily environment as objects of analysis.

The worksheet was developed using Canva, with attention given to worksheet structure, color selection, and font type and size to ensure visual clarity and attractiveness. The contextual PJBL model was embedded in the worksheet through essential questions, project planning activities, process management, and evaluation of learning experiences. All learning activities were directed toward analyzing simple machine concepts as applied to human movements during oil palm harvesting.

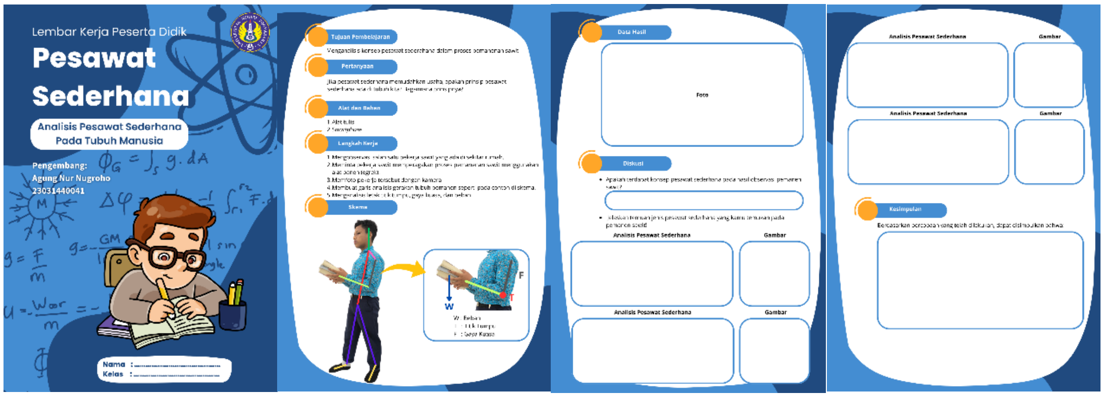

Figure 1. Display of the electronic contextual PJBL worksheet.

Development Stage

After the design was completed, the electronic contextual PJBL worksheet underwent expert validation in terms of material and media aspects. The material validation resulted in an average score of 3.72, categorized as *very good*, while media validation obtained an average score of 3.77, also categorized as *very good*. These results indicate that the developed worksheet is feasible for implementation in science learning. A summary of the validation results is presented in Table 8.

Table 8. Feasibility analysis results of the electronic contextual PJBL worksheet.

Validation	Aspect	Score ($\bar{x}$)	Average Score	Category
Material	Components	3.72	3.72	Very Good
	Didactic	3.50		
	Content Feasibility	3.75		
	Language	3.60		
	Contextual PJBL Model	3.75		
	Material Context Coverage	4.00		
Media	Presentation	3.40	3.77	Very Good
	Graphics	3.67		
	Media Engineering	4.00		
	Accessibility	4.00		

Following expert validation, the worksheet was tested with several ninth-grade students at SMP Evans Indonesia to obtain feedback for further refinement. The worksheet was accessed through Google Classroom and completed using the Canva platform. After using the worksheet, students were asked to complete a response questionnaire and participate in guided group discussions to evaluate its strengths and limitations.

Evaluation Stage

Based on the student questionnaire results, a total score of 129 was obtained, resulting in an ideality percentage of 89.58%, which falls within the *very good* category. These findings indicate that the electronic contextual PJBL worksheet received positive responses from students. Interview results further revealed that students felt comfortable, enthusiastic, and motivated when working with the worksheet.

Students noted that the worksheet was highly relevant to schools located in oil palm plantation areas, as the learning activities reflected their daily experiences and allowed them to easily identify objects for analysis. The worksheet design was perceived as visually appealing and systematically organized. In addition, students reported that the electronic format was easy and practical to use, as it could be accessed directly via smartphones. This finding supports previous studies indicating that electronic worksheets can increase learning interest and interactivity (Ramadhan & Sumarni, 2025; Sari & Yulianti, 2025; Risamasu & Pieter, 2024; Widiyani et al., 2021).

However, students suggested that certain technical features could be improved. Specifically, they recommended locking content elements within the worksheet to prevent unintended movement of components during completion. Unrestricted content movement occasionally made it difficult for students to input answers without altering the layout.

Furthermore, students suggested expanding the contextual analysis beyond oil palm harvesting movements to include other activities, such as pushing wheelbarrows, lifting harvested fruit onto trucks, trimming fronds, and collecting loose fruits. These additional contexts could enrich the variety of analytical tasks and help students develop a more comprehensive understanding of simple machine principles.

CONCLUSION

An electronic contextual Project-Based Learning (PJBL) worksheet has been developed to support the analysis of simple machine principles in the human skeletal system during oil palm harvesting activities. The developed worksheet can serve as an alternative learning medium to facilitate students' understanding of simple machine concepts, particularly for schools located in oil palm plantation areas where contextual learning opportunities are readily available. Overall, student responses to the electronic contextual PJBL worksheet fall within the *very good* category, indicating positive perceptions regarding its usability and relevance. Nevertheless, several improvements are required before the worksheet is fully implemented in classroom learning, particularly related to technical features and content refinement based on student feedback.

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