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NEEDS ANALYSIS FOR DEVELOPING A PROBLEM-BASED LEARNING-BASED ELECTRONIC STUDENT WORKSHEET (E-LKPD) TO ENHANCE STUDENTS' CONCEPTUAL UNDERSTANDING AND SCIENCE PROCESS SKILLS ON TEMPERATURE AND HEAT

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ABSTRACT

Physics learning in the Merdeka Curriculum requires students to develop conceptual understanding and science process skills through student-centered learning. However, observations conducted at SMAN 1 Sungai Geringging revealed that physics instruction remains dominated by conventional teaching methods. Printed student worksheets have not adequately facilitated scientific inquiry, resulting in students experiencing difficulties in understanding the concepts of temperature and heat. This study aimed to analyze the need for developing a Problem-Based Learning (PBL)-based Electronic Student Worksheet (E-LKPD) to support the improvement of students' conceptual understanding and science process skills. The study employed the Research and Development (R&D) method using the 4D model and was limited to the Define stage, including front-end analysis, learner analysis, task analysis, concept analysis, and learning objective analysis. Data were collected through observations, interviews, questionnaires, and diagnostic tests and analyzed using descriptive quantitative and qualitative approaches. The findings showed that 52.2% of students experienced misconceptions, 40.9% lacked conceptual understanding, and only 6.6% demonstrated adequate conceptual understanding of temperature and heat. Furthermore, students' science process skills were generally classified as low to moderate, with the lowest score obtained for the questioning indicator (28.90%). The novelty of this study lies in providing a comprehensive needs analysis that integrates the characteristics of the temperature and heat topic, Problem-Based Learning syntax, science process skills indicators, and the Liveworksheet platform as the foundation for designing a digital E-LKPD. These findings provide empirical evidence for the preliminary design of the proposed E-LKPD and offer practical guidance for physics teachers in developing inquiry-oriented digital learning materials aligned with the objectives of the Merdeka Curriculum. The validity, practicality, and effectiveness of the proposed E-LKPD will be investigated in the subsequent stages of the development research

Keywords : Needs Analysis, E-LKPD, Problem-Based Learning (PBL), conceptual understanding, science process skills, temperature and heat.

I. INTRODUCTION

Physics education plays a fundamental role in developing students' scientific literacy because it emphasizes not only the acquisition of scientific knowledge but also the process of constructing knowledge through scientific inquiry. As a branch of science, physics enables students to understand natural phenomena through observation, experimentation, and evidence-based reasoning. Therefore, physics learning should provide meaningful learning experiences that actively engage students in investigating real-world phenomena rather than merely receiving information from teachers. Fischer and Girwidz (2021) stated that effective physics education integrates conceptual understanding with inquiry activities that encourage students to develop scientific reasoning and problem-solving skills.

The implementation of the Merdeka Curriculum further reinforces the importance of student-centered learning by emphasizing critical thinking, creativity, collaboration, communication, and science process skills. Consequently, students are expected not only to understand scientific concepts but also to apply them in explaining natural phenomena and solving authentic problems encountered in everyday life. However, classroom practices in many schools remain dominated by teacher-centered instruction, limiting students' opportunities to actively construct knowledge through scientific inquiri.

Conceptual understanding is one of the essential competencies in physics learning because it enables students to explain physical phenomena scientifically, interpret relationships among variables, and solve contextual problems. Anderson and Krathwohl (2001) defined conceptual understanding as the ability to construct meaning by integrating newly acquired knowledge with prior knowledge. Students with inadequate conceptual understanding tend to memorize formulas without understanding the underlying physical principles, which often results in misconceptions. Besides conceptual understanding, science process skills are equally important because they enable students to investigate scientific phenomena systematically. According to Özgelen (2012), science process skills include observing, classifying, questioning, formulating hypotheses, predicting, planning and conducting experiments, interpreting data, applying concepts, and communicating scientific findings. These competencies are fundamental for developing meaningful conceptual understanding through scientific inquiry.

The topic of temperature and heat provides an appropriate context for simultaneously developing conceptual understanding and science process skills because it contains several abstract concepts closely related to everyday experiences. Students are expected not only to understand concepts such as temperature, heat, specific heat capacity, heat transfer, and Black’s Principle but also to investigate these concepts through observation, experimentation, and scientific reasoning. Therefore, learning activities should facilitate inquiry processes that enable students to construct scientific knowledge actively.

Recent studies have demonstrated that digital inquiry-oriented learning environments can significantly enhance students' conceptual understanding, scientific reasoning, and science process skills by providing opportunities to investigate scientific phenomena through interactive and collaborative learning activities. The integration of digital learning technologies with inquiry-based instruction enables students to actively construct knowledge rather than passively receive information, thereby promoting deeper conceptual learning (Fischer & Girwidz, 2021; Distrik et al., 2025). In addition, the implementation of Problem-Based Learning (PBL) in digital learning environments has been reported to improve students' engagement, critical thinking, problem-solving ability, and collaboration through authentic problem investigation (Heldalia et al., 2025; Faj'ria & Fibriana, 2024). These findings indicate that integrating digital learning media with inquiry-oriented instructional models provides a promising approach for supporting meaningful physics learning.

Despite these developments, preliminary observations conducted at SMAN 1 Sungai Geringging revealed that physics instruction on the topic of temperature and heat is still predominantly delivered through conventional teaching methods. The existing printed student worksheets (LKPDs) have not effectively facilitated inquiry-based learning, students rarely participate in scientific investigations, and learning activities remain focused on theoretical explanations. Consequently, students continue to experience misconceptions and demonstrate low levels of science process skills. These findings indicate that the current instructional practices have not yet fully supported the objectives of the Merdeka Curriculum.

One potential solution to these challenges is the development of an Electronic Student Worksheet (E-LKPD) integrated with the Problem-Based Learning (PBL) model. An E-LKPD provides interactive learning experiences through videos, animations, simulations, hyperlinks, and immediate feedback, enabling students to learn more independently and actively. Meanwhile, Problem-Based Learning facilitates the development of conceptual understanding and science process skills by engaging students in solving contextual problems through scientific investigation. Previous studies have demonstrated that E-LKPDs and PBL positively influence students' engagement, collaboration, critical thinking, and problem-solving skills (Putra & Ekasari, 2018; Mispa, 2022; Choirunisa et al., 2023; Heldalia et al., 2025).

However, previous studies have mainly focused on evaluating the effectiveness of E-LKPDs or the implementation of Problem-Based Learning after the instructional materials had been developed. Only limited attention has been given to conducting a comprehensive needs analysis that simultaneously considers students' conceptual understanding, science process skills, curriculum requirements, learner characteristics, and the integration of Problem-Based Learning syntax into the design of a Liveworksheet-based E-LKPD specifically for the topic of temperature and heat. Consequently, there is still insufficient empirical evidence to guide the systematic development of digital instructional materials that are aligned with students’ learning needs and the objectives of the Merdeka Curriculum

The novelty of this study lies in providing a comprehensive needs analysis that integrates students’ conceptual understanding, science process skills, the characteristics of the temperature and heat topic, the syntax of Problem-Based Learning, and the Liveworksheet platform as the foundation for designing an inquiry-oriented digital E-LKPD. Unlike previous studies that primarily evaluated the effectiveness of existing instructional products, this study establishes empirical evidence to support the initial design of an E-LKPD that is aligned with curriculum demands, learner characteristics, and teachers' instructional needs.

Therefore, this study aims to analyze the need for developing a Problem-Based Learning (PBL)-based Electronic Student Worksheet (E-LKPD) on the topic of temperature and heat. The findings are expected to provide empirical guidance for the subsequent stages of E-LKPD development and practical recommendations for physics teachers in designing inquiry-oriented digital instructional materials that support the implementation of the Merdeka Curriculum.

II. METHOD

This study employed the Research and Development (R&D) method to analyze the need for developing a Problem-Based Learning (PBL)-based Electronic Student Worksheet (E-LKPD) on the topic of temperature and heat. The study adopted the Four-D (4D) instructional development model proposed by Thiagarajan, Semmel, and Semmel (1974), which consists of four stages: Define, Design, Develop, and Disseminate. However, this article reports only the findings of the Define stage because its primary objective was to identify the instructional needs that would serve as the foundation for the subsequent development of the proposed E-LKPD

The research was conducted at SMAN 1 Sungai Geringging, Padang Pariaman Regency, West Sumatra, Indonesia, during the second semester of the 2025/2026 academic year. The participants consisted of one physics teacher and Grade X students who were selected using a purposive sampling technique. This sampling technique was employed because the selected participants were directly involved in physics learning on the topic of temperature and heat and were therefore considered capable of providing relevant information regarding the existing learning conditions, students' learning characteristics, and the need for digital instructional materials.

The Define stage comprised five activities:

(1) Front-end analysis to identify instructional problems through classroom observations and teacher interviews;
(2) Learner analysis to examine students' characteristics, prior knowledge, learning experiences, and science process skills;
(3) Task analysis to analyze the Learning Outcomes (Capaian Pembelajaran), learning objectives, and competencies required in the Merdeka Curriculum;
(4) Concept analysis to identify the essential concepts of temperature and heat and organize them into a systematic concept map; and
(5) Learning objective analysis to formulate instructional objectives that would guide the design of the proposed PBL-based E-LKPD.

The research instruments consisted of classroom observation sheets, semi-structured interview guidelines, a student needs analysis questionnaire, and a four-tier diagnostic test. The observation sheets were used to identify the implementation of physics learning in the classroom, while the interview guidelines were employed to obtain in-depth information from the physics teacher regarding instructional practices, learning resources, and challenges encountered during instruction. The needs analysis questionnaire was administered to investigate students' characteristics, learning experiences, and perceptions regarding the development of a PBL-based E-LKPD. Meanwhile, the four-tier diagnostic test was used to identify students' levels of conceptual understanding and misconceptions related to the topic of temperature and heat.

Prior to data collection, all research instruments were developed based on the research indicators and were validated by experts in physics education to ensure their content validity, clarity, and alignment with the objectives of the study. Suggestions provided by the validators were incorporated into the final version of the instruments before they were administered to the research participants.

Data were collected through classroom observations, semi-structured interviews, questionnaire administration, document analysis, and diagnostic testing. Classroom observations were conducted during physics lessons to examine teacher and student learning activities. Semi-structured interviews with the physics teacher were conducted to obtain more comprehensive information regarding instructional needs and challenges. The questionnaire was distributed using a four-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree), to identify students' needs for digital learning materials. Document analysis was conducted by reviewing teaching modules, printed student worksheets (LKPDs), and curriculum documents used in the school.

In addition, the four-tier diagnostic test was administered to identify students' conceptual understanding and misconceptions regarding the topic of temperature and heat.

The qualitative data obtained from classroom observations, interviews, and document analysis were analyzed using the interactive model of data reduction, data display, and conclusion drawing. Quantitative data obtained from the questionnaire and diagnostic test were analyzed descriptively by calculating percentage scores for each indicator using the following equation:

$$P = \frac{f}{N} \times 100\% \quad (1)$$

where P represents the percentage score, f is the total score obtained, and N is the maximum possible score. The percentage values were interpreted according to the criteria presented in Table 1. The results of the four-tier diagnostic test were further classified into three categories: understanding the concept, misconception, and lack of conceptual understanding, based on the combination of students' answers and confidence levels.

Table 1. Criteria for Interpreting Needs Analysis Percentages

Percentage (%)	Category
76 – 100	Good
51 – 75	Sufficient
26 – 50	Poor
0 – 25	Very Poor

This study was conducted after obtaining permission from the principal of SMAN 1 Sungai Geringging. The participating teacher and students were informed about the objectives of the study, and all collected data were used solely for research purposes while maintaining the confidentiality and anonymity of the participants.

III. RESULTS AND DISCUSSION

The classroom observations conducted at SMAN 1 Sungai Geringging revealed that physics instruction on the topic of temperature and heat was still predominantly implemented through teacher-centered learning. The teacher mainly employed lectures, question-and-answer sessions, and class discussions to explain concepts, while students were expected to receive and remember the information delivered. Although printed Student Worksheets (LKPDs) had been used as supplementary instructional materials, they primarily contained practice questions and did not adequately facilitate students in investigating problems, conducting simple experiments, or constructing concepts independently

The observations further indicated that learning activities had not optimally accommodated the development of students' science process skills. Students were rarely involved in observing scientific phenomena, formulating hypotheses, designing investigations, interpreting experimental data, or communicating scientific findings. Consequently, classroom learning tended to emphasize conceptual memorization rather than conceptual construction through scientific inquiry. According to the interviewed physics teacher, limited instructional time and the absence of interactive digital teaching materials were among the major constraints in implementing inquiry-oriented learning. These findings indicate that the current instructional practices have not yet fully supported the implementation of the Merdeka Curriculum, which emphasizes student-centered learning, inquiry, and higher-order thinking skills.

Students' conceptual understanding was analyzed using a four-tier diagnostic test to identify their levels of conceptual understanding, misconceptions, and lack of conceptual understanding regarding the topic of temperature and heat. The results demonstrate that misconceptions remain the dominant learning problem encountered by students.

As presented in Figure 1, 52.2% of the students experienced misconceptions, 40.9% lacked conceptual understanding, and only 6.6% demonstrated adequate conceptual understanding. These findings indicate that most students had not yet developed scientifically accepted conceptions regarding temperature and heat. Instead, they tended to rely on intuitive reasoning derived from everyday experiences rather than scientific explanations

. **Figure 1.** Distribution of Students' Conceptual Understanding Levels

The predominance of misconceptions suggests that many students possessed prior conceptions that conflicted with accepted scientific principles. Analysis of students' responses indicated several common misconceptions. Many students assumed that heat and temperature represent the same concept, believing that an object with a higher temperature always contains more heat than an object with a lower temperature. Some students also believed that metal objects are naturally colder than wooden objects because their temperatures are lower, rather than understanding that metals merely possess higher thermal conductivity. These misconceptions have frequently been reported in physics education research and remain among the most persistent misconceptions in thermal physics because students often interpret thermal phenomena using everyday experiences instead of scientific reasoning (Yeo & Zadnik, 2001).

The high proportion of students categorized as lacking conceptual understanding indicates that many learners experienced difficulties in connecting new scientific concepts with their existing knowledge. Consequently, students tended to memorize formulas and definitions without understanding the underlying physical principles. Such learning conditions limit students' ability to explain physical phenomena scientifically and to apply conceptual knowledge in unfamiliar situations. Similar findings were reported by Putra and Ekasari (2018), who found that misconceptions related to temperature and heat remain one of the most common conceptual difficulties encountered by senior high school students.

The dominance of misconceptions in this topic may also be explained by the abstract characteristics of thermal concepts. Concepts such as heat transfer, thermal equilibrium, and internal energy cannot be directly observed, making them difficult for students to understand without experimental investigations or appropriate visualizations. When classroom instruction relies primarily on lectures and textbook explanations, students are more likely to retain their initial conceptions rather than reconstruct them through scientific inquiry. This condition highlights the importance of learning environments that encourage students to actively investigate scientific phenomena and evaluate their own understanding.

These findings are consistent with previous studies reporting that meaningful learning experiences, inquiry-based activities, and contextual problem-solving play important roles in facilitating conceptual change. Therefore, instructional materials should not merely provide explanations and practice exercises but should also engage students in investigating authentic problems, discussing scientific evidence, and constructing concepts collaboratively. In this context, the proposed Problem-Based Learning (PBL)-based Electronic Student Worksheet (E-LKPD) has the potential to support students' conceptual understanding by integrating contextual problems, inquiry activities, interactive learning resources, and guided reflection. Nevertheless, because this study was limited to the Define stage of the Four-D development model, the effectiveness of the proposed instructional product has not yet been evaluated and should be investigated in subsequent research.

Students' science process skills were analyzed using eleven indicators, namely observing, classifying, questioning, formulating hypotheses, predicting, planning experiments, using tools and materials, conducting experiments, interpreting data, applying concepts, and communicating. The results of the preliminary analysis are presented in Table 2.

As presented in Table 2, the overall achievement of students' science process skills was relatively low across all indicators. The highest percentage was observed in the observing indicator (50%), whereas the questioning indicator obtained the lowest percentage (28.90%). The remaining indicators ranged from 36.32% to 46.09%, indicating that students had not yet mastered the essential skills required for scientific inquiry. The low performance across most indicators suggests that students had limited opportunities to engage in inquiry-oriented learning activities during physics instruction. Classroom observations revealed that learning was still predominantly teacher-centered, with teachers explaining concepts directly while students mainly listened, took notes, and completed routine exercises. Consequently, students rarely participated in activities requiring them to formulate scientific questions, develop hypotheses, design investigations, analyze experimental evidence, or communicate scientific findings. Such learning conditions limit students' opportunities to construct scientific knowledge through direct investigation.

Table 2. Results of the Preliminary Analysis of Students' Science Process Skills

Indicator	Percentage (%)
Observing	50
Classifying	40,62
Questioning	28,90
Formulating hypotheses	45,70
Predicting	36,32
Planning experiments	43,55
Using scientific instruments and materials	44,01
Conducting experiments	40,62
Interpreting data	36,71
Applying concepts	36,32
Communicating findings	46,09

Among all indicators, questioning demonstrated the lowest achievement. This finding indicates that students were not yet accustomed to generating scientific questions based on observations or real-life phenomena. Instead, they tended to wait for explanations from the teacher before attempting to solve a problem. This condition is likely influenced by conventional instructional practices that emphasize information delivery rather than inquiry and problem-solving. According to Özgelen (2012), questioning is one of the fundamental science process skills because it initiates scientific investigations and encourages students to think critically about natural phenomena. Without sufficient opportunities to ask questions, students may experience difficulties in developing higher-order thinking and scientific reasoning.

Similarly, the relatively low achievement in the indicators of predicting, interpreting, and applying concepts suggests that students experienced difficulties in connecting theoretical knowledge with real-world situations. These competencies require students not only to understand scientific concepts but also to apply them when explaining physical phenomena or predicting the outcomes of experiments. The findings imply that classroom learning had not yet effectively facilitated conceptual application through meaningful learning experiences.

The interview with the physics teacher further supported these findings. The teacher explained that the printed Student Worksheets (LKPDs) were primarily used as supplementary exercises after classroom explanations and had not yet facilitated investigative activities or collaborative problem-solving. Furthermore, the teacher stated that limited instructional time and the lack of interactive digital instructional materials were major obstacles to implementing inquiry-based learning. Consequently, students had limited opportunities to develop science process skills through observation, experimentation, and reflective discussion.

The findings obtained from classroom observations, conceptual understanding analysis, science process skills analysis, and teacher interviews consistently demonstrate the need to develop more interactive instructional materials that actively engage students in the learning process. The current instructional materials primarily emphasize concept explanation and routine exercises, whereas they provide limited opportunities for students to investigate scientific phenomena, solve contextual problems, and construct concepts independently.

Students also expressed a positive response toward the development of digital instructional materials that integrate interactive learning activities. They expected learning resources that include visualizations, simulations, contextual problems, immediate feedback, and collaborative activities capable of supporting independent learning. These expectations are consistent with the objectives of the Merdeka Curriculum, which encourages meaningful learning experiences and the development of higher-order thinking skills.

The needs analysis also indicates a clear relationship between classroom instructional practices, students' conceptual understanding, and their science process skills. Teacher-centered instruction limits students' opportunities to explore scientific ideas independently, contributing to the persistence of misconceptions and the relatively low achievement of science process skills. Therefore, future instructional materials should provide structured learning activities that encourage students to investigate problems, formulate explanations, test hypotheses, and communicate scientific findings.

Based on these findings, the proposed Problem-Based Learning (PBL)-based Electronic Student Worksheet (E-LKPD) has the potential to address the instructional needs identified in this study. By integrating contextual problems, inquiry activities, interactive multimedia, and guided investigations, the proposed instructional material is expected to provide richer learning experiences that support conceptual construction and the development of science process skills. Nevertheless, it should be emphasized that the present study was limited to the Define stage of the Four-D development model. Therefore, the proposed E-LKPD has not yet been developed or evaluated, and its validity, practicality, and effectiveness should be investigated in subsequent stages of the development research.

The findings of this study demonstrate that students' conceptual understanding and science process skills remain at relatively low levels, indicating that current instructional practices have not yet fully supported meaningful physics learning. The classroom observations, diagnostic test results, science process skills analysis, and teacher interviews consistently revealed that learning activities were still predominantly teacher-centered. Under such conditions, students tended to receive information passively rather than actively constructing scientific knowledge through observation, investigation, and problem-solving.

The high proportion of misconceptions identified in this study suggests that students experience difficulties in reconstructing their prior conceptions into scientifically accepted concepts. Misconceptions related to temperature and heat are widely recognized as persistent learning problems because these concepts are abstract and are often interpreted using students' everyday experiences. Without opportunities to investigate physical phenomena directly, students tend to retain intuitive explanations that conflict with scientific concepts. Consequently, instructional approaches that emphasize memorization of formulas and teacher explanations alone are insufficient to facilitate conceptual change. Similar conclusions have been reported by Yeo and Zadnik (2001), who emphasized that conceptual understanding of thermal physics requires learning experiences that encourage students to confront and reconstruct their existing conceptions through scientific investigation.

The relatively low achievement of students' science process skills further indicates that classroom learning has not yet provided sufficient opportunities for students to practice scientific inquiry. Skills such as questioning, formulating hypotheses, interpreting evidence, and communicating scientific findings can only develop when students are actively engaged in scientific investigations. In this study, the questioning indicator obtained the lowest score, suggesting that students were not accustomed to initiating scientific inquiry independently. According to Özgelen (2012), questioning serves as the foundation of scientific investigation because it stimulates curiosity, critical thinking, and evidence-based reasoning. Therefore, learning environments should intentionally provide opportunities for students to formulate questions, investigate problems, and evaluate scientific evidence collaboratively.

These findings reinforce previous studies emphasizing that inquiry-oriented learning and Problem-Based Learning (PBL) provide more meaningful learning experiences than conventional teacher-centered instruction. Through authentic contextual problems, students are encouraged to identify relevant information, formulate hypotheses, conduct investigations, analyze evidence, and communicate solutions collaboratively. Such learning activities not only facilitate conceptual understanding but also support the development of science process skills that are essential for scientific literacy in the twenty-first century. Previous studies published in Pillar of Physics Education have similarly reported that digital learning materials integrating Problem-Based Learning and interactive learning media can create more active and meaningful learning environments (Afrilia Putri, 2025; Mispa et al., 2022).

The needs analysis conducted in this study indicates that the existing printed Student Worksheets (LKPDs) have not yet optimally facilitated inquiry-oriented learning. Both classroom observations and teacher interviews revealed that the worksheets mainly functioned as supplementary exercises following teacher explanations, providing limited opportunities for students to investigate problems independently or construct scientific concepts through collaborative learning. Students also expressed the need for digital instructional materials incorporating contextual problems, simulations, visualizations, and immediate feedback. These findings indicate that future instructional materials should not merely present learning content but should also facilitate students' active engagement throughout the learning process.

Based on these findings, the proposed Problem-Based Learning (PBL)-based Electronic Student Worksheet (E-LKPD) has the potential to address the instructional needs identified during the Define stage. By integrating authentic problems, guided inquiry activities, interactive multimedia, and collaborative learning tasks, the proposed instructional material is expected to create more meaningful learning experiences that support conceptual construction and science process skills development. Nevertheless, because this study was limited to a preliminary needs analysis, no conclusions can yet be drawn regarding the validity, practicality, or effectiveness of the proposed E-LKPD. These aspects should be examined during the subsequent Design, Develop, and Disseminate stages of the Four-D development model.

The findings of this study provide several practical implications for physics teachers and instructional material developers. First, teachers should provide students with more opportunities to investigate contextual problems, formulate scientific questions, conduct simple experiments, and communicate scientific findings during classroom learning. Such learning experiences are essential for developing conceptual understanding and science process skills simultaneously. Second, digital instructional materials should be designed to support inquiry-oriented learning by integrating interactive multimedia, simulations, contextual problems, and immediate feedback. Finally, the implementation of a Problem-Based Learning (PBL)-based Electronic Student Worksheet (E-LKPD) may support teachers in facilitating more student-centered learning that aligns with the objectives of the Merdeka Curriculum.

This study was limited to the Define stage of the Four-D development model and focused on identifying instructional needs through classroom observations, interviews, questionnaires, and diagnostic tests. Consequently, the proposed Problem-Based Learning (PBL)-based Electronic Student Worksheet (E-LKPD) has not yet been designed, validated, or evaluated in terms of its practicality and effectiveness. In addition, the study involved participants from only one senior high school, limiting the generalizability of the findings to other educational contexts. Future studies should continue the development process through the Design, Develop, and Disseminate stages to evaluate the validity, practicality, and effectiveness of the proposed instructional product in supporting students' conceptual understanding and science process skills.

IV. CONCLUSION

This preliminary needs analysis indicates that physics learning on the topic of temperature and heat at SMAN 1 Sungai Geringging still encounters several instructional challenges, including teacher-centered learning practices, limited use of interactive instructional materials, and insufficient opportunities for students to develop conceptual understanding and science process skills through inquiry-oriented activities. These findings demonstrate the need for developing a Problem-Based Learning (PBL)-based Electronic Student Worksheet (E-LKPD) that is aligned with students' characteristics, the nature of temperature and heat concepts, and the objectives of the Merdeka Curriculum. However, because this study was limited to the Define stage of the Four-D development model, the proposed E-LKPD has not yet been developed or evaluated. Therefore, the findings of this study provide a foundation for subsequent product development, while future research should continue the Design, Develop, and Disseminate stages to evaluate the validity, practicality, and effectiveness of the proposed PBL-based E-LKPD.

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