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Needs Analysis to Develop Static Fluid E-Student Worksheet Integrated Problem Based Learning and Local Wisdom to Facilitate Students' Physics Learning Outcomes

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ABSTRACT

This research is motivated by the low cognitive learning outcomes of students in physics learning, especially the static fluid material. This problem shows that the learning process has not been fully able to facilitate active involvement and optimal understanding of concepts. This study aims to analyze learning needs as the basis for the development of Problem-Based Learning (PBL)-based E-Student Worksheets that are oriented towards local wisdom to improve students' cognitive learning outcomes. This research constitutes the Define stage of the 4D development model. The research subjects consisted of physics teachers and Grade XI students at SMAN 9 Mandau. Data collection techniques included questionnaires, interviews, and document analysis. The data were analyzed using a qualitative descriptive approach. The results of the study show that the cognitive learning outcomes of students in the static fluid material are still relatively low. The discussion of the results revealed that these achievements were influenced by the use of teaching materials that were not optimal in facilitating the active involvement of students, as well as the lack of material linkage with local wisdom phenomena in the surrounding environment. On the other hand, students have potential in the form of digital readiness and technological literacy that supports electronic-based learning. Based on these findings, it is concluded that the development of PBL-based E-Student Worksheets that integrate local wisdom is needed as an innovative solution to create more contextual and interactive learning that optimizes students' cognitive learning outcomes.

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INTRODUCTION

Physics education is a fundamental subject that plays a vital role in explaining various natural phenomena through basic principles. As a branch of science, physics possesses unique characteristics that distinguish it from other disciplines: it is not merely a collection of facts, but rather a human endeavor to understand the order of the universe through three primary essences: a body of knowledge, a way of investigating, and a way of thinking. Physics as a product refers to the collection of concepts, laws, and theories that have been scientifically tested; as a process, it emphasizes scientific inquiry through observation, experimentation, and drawing conclusions; and as an attitude, it reflects scientific values such as objectivity, curiosity, and openness to evidence. Without proper investigative processes and a scientific attitude, the products of physics risk becoming meaningless formula memorization for students. This is consistent with the position of Wea et al. (2021),who assert that in physics learning, teachers and students must not only focus on the product but also pay close attention to the processes and attitudes required to achieve learning objectives.

Achieving the full nature of physics in learning requires a systematically structured framework, namely the curriculum. According to Ayudia et al. (2023), the curriculum is a fundamental component that plays a critical role in the teaching and learning process, as it contains systematic methods that serve as the primary guide for teachers. The curriculum is not merely an administrative document; it is the heart of planning, implementing, and evaluating learning in schools (Rahmat & Arya, 2025). The curriculum currently implemented in Indonesia is the Independent Curriculum, which provides flexibility for both teachers and students in designing learning processes relevant to contemporary developments (Bait et al., 2025). This curriculum emphasizes a student-centered approach, encouraging students to play active roles in constructing their own understanding and potential. As a result, the learning process is expected to become more meaningful, contextual, and impactful in improving student learning outcomes (Zuflyardi et al., 2025). However, the realization of these ideals in everyday classroom practice remains a significant challenge, particularly in science subjects such as physics.

Learning outcomes serve as a critical measurement tool to determine the extent of student achievement in mastering subject matter. According to Artama et al. (2023), learning outcomes are specific abilities acquired by students after participating in the teaching and learning process, and they function as key indicators in evaluating the success of instructional activities. According to Bloom, as cited in Mahmudi et al. (2022), learning outcomes are achieved across three domains: the cognitive domain, encompassing remembering, understanding, applying, analyzing, evaluating, and creating; the affective domain, covering attitudes and values; and the psychomotor domain, relating to practical skills. Among these, the cognitive domain remains the primary focus of learning outcome assessment, as it is most directly linked to material mastery and students' thinking abilities. Superior cognitive learning outcomes indicate that students are not only capable of recalling information, but also of understanding, applying, and analyzing the concepts they have learned, thereby reflecting a deeper and more transferable level of comprehension (Qorimah & Sutama, 2022). Therefore, efforts to optimize cognitive learning outcomes are essential to ensuring that educational objectives are achieved to their fullest potential.

In practice, however, many students continue to achieve low learning outcomes, indicating that they have not yet mastered learning material to its full potential, particularly within the cognitive domain. This issue is prominently reflected in physics education, where student learning outcomes across various topics frequently remain below established competency thresholds. Based on the front-end analysis conducted at SMAN 9 Mandau, it was found that students' average formative assessment scores on the static fluid topic across four grade XI classes ranged from 43 to 61, all of which fall below the minimum competency threshold and are categorized as low to very low. This empirical condition confirms that the current instructional approach has not been effective in facilitating meaningful conceptual understanding among students.

One topic that consistently presents these challenges is static fluids. This material encompasses abstract and interrelated concepts, including Hydrostatic Pressure, Pascal's

Law, Archimedes' Principle, Surface Tension, Capillarity, and Viscosity—that are hierarchically structured and mutually reinforcing. The abstract nature of these concepts poses significant cognitive challenges, as the underlying physical phenomena such as invisible pressure transmission within fluids, intermolecular surface forces, and capillary action in narrow tubes cannot be directly observed with the naked eye. Despite their rich connections to real-world phenomena such as hydraulic systems, floating and sinking objects, water droplets on surfaces, and fluid absorption in plant roots, these contextual linkages have not been exploited effectively in current classroom instruction. This gap between abstract theory and everyday experience is a key factor contributing to students' persistent difficulties in understanding static fluid material.

A further contributing factor lies in the limitations of the teaching materials currently in use. Existing materials are predominantly limited to printed textbooks and conventional student worksheets that contain only content summaries and routine practice problems. These materials have not been designed to facilitate active student engagement, encourage inquiry, or connect learning content to students' real-life and cultural contexts. Research by Rahmat & Arya (2025) confirms that the use of appropriate teaching materials enables students to explore content independently and relate their learning to everyday contexts, which in turn positively impacts the achievement of learning outcomes. Similarly, Asrizal et al. (2022) demonstrate that teaching materials exert a significant influence on student success, as evidenced by competency achievement. These findings collectively underscore the urgency of developing teaching materials that are more contextual, interactive, and aligned with the actual characteristics and needs of students.

One promising instructional innovation to address this gap is the development of E-Student Worksheets—electronically formatted worksheets that offer greater interactivity, flexibility, and portability compared to their conventional printed counterparts (Ayuni et al., 2025; Darise et al., 2022). Unlike traditional worksheets, E-Student Worksheets can integrate multimedia elements, interactive tasks, and structured problem-solving sequences within a single digital platform, enabling a more dynamic and engaging learning experience. Worksheets in general can assist teachers in the instructional process while simultaneously guiding students in understanding material and fostering their ability to think, work, and communicate scientifically (Kosasih, 2021). Hidayati et al. (2023) further affirm that well-designed worksheets simplify the understanding of learning materials through a clear and concise structure that scaffolds students throughout their studies. The transition to electronic formats amplifies these benefits by leveraging students' existing familiarity with digital technology, as confirmed by the student analysis conducted in this study, which found that most Grade XI students at SMAN 9 Mandau regularly access smartphones and the internet for learning-related activities.

The effectiveness of E-Student Worksheets in supporting learning is further enhanced when implemented within an appropriate instructional model. In this regard, Problem-Based Learning (PBL) represents a particularly well-suited framework. PBL is an instructional approach that uses authentic, real-world problems as the starting point for learning, encouraging students to conduct investigations, analyze problems, and construct solutions through active engagement rather than passive reception of information (Handayani & Koeswanti, 2021). The primary goal of PBL is to develop students' problem-solving and critical thinking abilities, enabling them to find and apply solutions to complex, contextualized problems (Hidayati & Nabila, 2025). Within the context of static fluid learning, PBL provides a structured framework through which students can engage with real-world fluid phenomena as problem scenarios, progressively building their conceptual understanding through guided inquiry and collaborative problem solving. This approach is well aligned with the demands of the Independent Curriculum, which prioritizes active, student-centered, and contextually meaningful learning experiences.

To further deepen the contextual relevance of the learning materials, the PBL framework in this study is oriented toward local wisdom, integrating elements of the students' local environment, cultural practices, and indigenous knowledge as meaningful and authentic learning resources. The integration of local wisdom into science learning has been recognized as an effective strategy for making abstract concepts more accessible and meaningful to students by grounding them in familiar cultural contexts (Artini et al., 2025). In the Mandau region, numerous local practices and environmental phenomena are directly related to static fluid concepts, such as traditional water management systems, local fishing techniques, and everyday fluid-related tools used in the community, providing rich and authentic contexts for Problem-Based Learning scenarios. By situating abstract physics concepts within culturally familiar contexts, the learning experience becomes not only more relevant and engaging but also more effective in supporting conceptual understanding and the development of cognitive learning outcomes. This integration of local contexts enables students to connect physics concepts with real-world phenomena, thereby fostering a deeper conceptual understanding (Ningsih et al., 2026).

A review of previous research reveals that the development of worksheet-based teaching materials in physics education has demonstrated promising results. Laily (2025) found that E-Student Worksheets assisted by Live worksheets can increase student interest and learning outcomes while maintaining practical usability. Nazira et al. (2024) demonstrated that PBL-based worksheets possess high levels of validity and practicality in supporting the physics learning process. These studies affirm the potential of combining electronic worksheet formats with the PBL model in physics education. However, a critical examination of the existing literature reveals notable gaps. First, most prior studies have developed PBL-based worksheets without systematically grounding the problem contexts in students' local cultural environments, resulting in materials that, while instructionally sound, may lack the contextual authenticity necessary to maximize student engagement and meaning-making. Second, the majority of existing studies focused on validity and practicality assessments without conducting a prior, comprehensive needs analysis to empirically establish the specific learning conditions and student characteristics that the materials must address. Third, to the best of the researchers' knowledge, no prior study has developed local wisdom-oriented PBL E-Student Worksheets specifically targeting the static fluid topic at the senior high school level in the Mandau region. These gaps collectively identify a clear research opportunity and justify the present study.

The novelty and innovation of the present study lie in the development of E-Student Worksheets that simultaneously integrate three key elements: the Problem-Based Learning model as the instructional framework, local wisdom from the Riau region as the contextual basis for problem scenarios, and an electronic format that leverages students' digital readiness. This combination represents a distinctive contribution to the existing body of literature, as no prior study has systematically unified these three dimensions within a single teaching material development effort targeting static fluid concepts in senior high school physics education. The resulting materials are expected to be more contextually relevant, culturally responsive, and cognitively stimulating than conventional or previously developed worksheet-based materials.

Accordingly, before the development of such materials can proceed, a comprehensive needs analysis is required to empirically identify the existing learning conditions, instructional gaps, and students' specific needs for contextual and relevant teaching materials. Based on this rationale, the present study aims to conduct a thorough needs analysis as the foundational phase of developing local wisdom-oriented, Problem-Based Learning E-Student Worksheets to facilitate the improvement of students' cognitive learning outcomes in the static fluid topic at SMAN 9 Mandau. The findings of this study are expected to provide an empirically grounded and comprehensive picture of actual learning needs, serving as a rigorous foundation for the subsequent development of teaching materials that are contextual, culturally responsive, pedagogically sound, and meaningfully aligned with the characteristics and needs of the target students.

METHODS

This study employed the Research and Development (R&D) method using the 4D development model (Define, Design, Develop, and Disseminate) proposed by Thiagarajan, Semmel, and Semmel (1974). This model was selected because it provides systematic stages for developing instructional products, ranging from needs identification and product design to development and dissemination. However, this study was limited to the Define stage, as it aimed to identify the requirements for developing local wisdom-oriented E-Student Worksheets. At this stage, a needs analysis was conducted through five analytical components: student learning outcomes analysis, student analysis, student difficulties in static fluid material analysis, teaching material problem analysis, and learning objectives analysis. These analyses were carried out using a descriptive qualitative approach to obtain a comprehensive understanding of the existing learning conditions, students' characteristics, and the instructional needs underlying the development of the teaching materials. The study was conducted at SMAN 9 Mandau during the 2025/2026 academic year.

The research subjects consisted of three groups. The first group comprised Grade XI Physics teachers who were directly involved in the teaching and learning process and therefore possessed information regarding classroom conditions, students' characteristics, and the instructional materials used in the school. The second group consisted of all 36 students in Class XI.A4, who served as respondents to the needs analysis questionnaire. This class was selected because it represented the characteristics of the target users of the instructional materials to be developed. The third group consisted of the academic records of Grade XI students from four classes, namely XI.A1, XI.A2, XI.A3, and XI.A4. These documents were analyzed to identify students' cognitive learning outcomes in the Static Fluid topic, thereby providing baseline information on the existing learning conditions.

The procedure of this study followed the stages of the 4D development model, but its implementation was limited to the Define stage. This stage aimed to identify the requirements for developing local wisdom-oriented Problem-Based Learning (PBL)-based E-Student Worksheets to facilitate the improvement of students' cognitive learning outcomes in the Static Fluid topic. The Define stage consisted of five analytical components: student learning outcomes analysis, student analysis, student difficulties in static fluid material analysis, teaching material problem analysis, and learning objectives analysis. The initial analyses, including student learning outcomes analysis, student difficulties in static fluid material analysis, and teaching material problem analysis, were conducted to identify existing instructional problems and learning needs. Student analysis was then carried out to examine learners' characteristics and their readiness to engage in digital learning. Finally, learning objectives analysis was conducted to formulate appropriate instructional objectives based on the findings of the preceding analyses. These five analyses were conducted systematically to provide a comprehensive basis for developing instructional materials that are pedagogically sound, contextually relevant, and responsive to students' learning needs.

Data were collected through four techniques: semi-structured interviews, a questionnaire on students' characteristics, a diagnostic test, and document analysis. Semi-structured interviews were conducted with the Grade XI Physics teacher to obtain information regarding the learning process, the instructional materials used, the learning models implemented, and the challenges encountered in facilitating students' understanding of the Static Fluid topic. A questionnaire on students' characteristics was administered to all students in Class XI.A4 to identify their learning interests, motivation, dominant learning styles, and readiness to use digital technology as a learning medium. A diagnostic test was administered to identify students' learning difficulties across the Static Fluid subtopics, including Hydrostatic Pressure, Pascal's Law, Archimedes' Principle, Surface Tension, Capillarity, and Viscosity. The results of the diagnostic test were used to determine the concepts that students found difficult to understand, thereby providing a basis for developing the E-Student Worksheets. Furthermore, document analysis was conducted on the summative assessment scores of all four Grade XI classes (XI.A1, XI.A2, XI.A3, and XI.A4) to identify students' cognitive learning achievement and existing learning gaps in the Static Fluid topic.

The data were analyzed using a descriptive qualitative approach through three stages: data reduction, data display, and conclusion drawing. During the data reduction stage, the collected data were selected, classified, and focused on information relevant to the research objectives. The data display stage organized the findings according to the five analytical components of the Define stage: student learning outcomes analysis, student analysis, student difficulties in the Static Fluid topic, teaching material problem analysis, and learning objectives analysis. Finally, the findings were interpreted to identify the instructional needs for developing local wisdom-oriented, Problem-Based Learning e-Student Worksheets. Source triangulation was applied by cross-checking data from interviews, questionnaires, diagnostic tests, and document analysis to enhance the credibility of the findings.

To measure the students' proficiency in achieving learning outcomes for each sub-topic of Static Fluids, the test scores were calculated based on the marks obtained by the students using the following formula:

$$NP = \frac{R}{SM} \times 100\%$$

NP : Percentage alue sought or expected
R : Raw score obtained by the student
SM : Ideal maximum score
100 : Fixed number

Table 1. Criteria for Students' Learning Outcomes

Interval	Category
86-100	Very High
75-85	High
60-75	Enough
55-69	Low
≤ 54	Very Low

Source: (Purwanto, 2013)

RESULTS AND DISCUSSION

Results

Student Learning Outcomes Analysis

The analysis of student learning outcomes was conducted to identify the actual state of concept mastery in the field. Based on a systematic review of the summative assessment documents of Grade XI students at SMAN 9 Mandau on the static fluid topic, it was found that the cognitive learning outcomes achieved have not optimally met the mastery criteria.

The average summative assessment scores for the four Grade XI classes are presented in Table 2:

Table 2. Learning Outcomes of Static Fluid Material Students

Grade	Average Formative Assessment Score	Category
XI.A1	61	Low
XI.A2	56	Low
XI.A3	43	Very Low
XI.A4	51	Low

The results of the analysis are presented in Table 2. Overall, the findings indicate that students' cognitive learning outcomes have not yet reached the expected level of mastery in the Static Fluid topic, suggesting that the current instructional process has not effectively supported meaningful conceptual understanding. This issue was consistently observed across all Grade XI classes, indicating that it reflects a general instructional problem rather than a class-specific issue. Based on the interview with the physics teacher, although student-centered learning models such as Problem-Based Learning (PBL), Project-Based Learning (PjBL), and Discovery Learning have been implemented, their application has not been adequately supported by teaching materials that actively engage students in investigating problems, constructing concepts, and applying scientific reasoning. Consequently, students have limited opportunities to develop conceptual understanding through meaningful learning experiences. Therefore, the development of local wisdom-oriented Problem-Based Learning E-Student Worksheets is considered necessary to support active learning and improve students' cognitive learning outcomes in the Static Fluid topic.

Student Analysis

The student analysis was conducted to obtain a comprehensive understanding of Grade XI students' characteristics, learning needs, and technological readiness at SMAN 9 Mandau, as these factors are essential for designing instructional materials that are aligned with learners' needs and contextual learning conditions. Data were collected through a student questionnaire and analyzed to identify patterns related to learning interest (LI), learning attitude (LA), learning motivation (LM), learning style (LS), and the availability of digital learning facilities (DLF). The results of this analysis provide an empirical basis for the development of the proposed E-Student Worksheets and are presented in Figure 1.

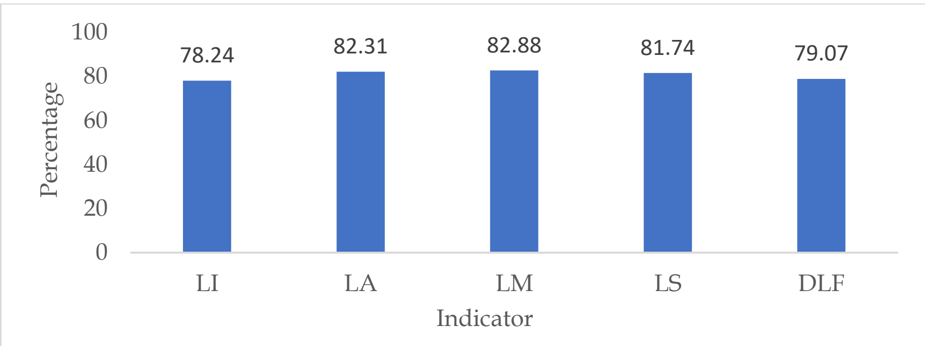

Figure 1. Characteristics of Students

The results indicate that while the majority of students demonstrate a moderate level of interest in learning Physics, they continue to experience difficulties in understanding abstract concepts without adequate instructional support. In terms of learning styles, students show a strong preference for learning activities that involve direct, hands-on engagement rather than passive reception of information. With regard to digital literacy and technology access, students are accustomed to using digital devices as part of their daily routines. Most students possess personal smartphones and have regular access to the internet, which they utilize for information retrieval, communication, and access to digital learning resources. Overall, the findings describe the learning characteristics and technological readiness of Grade XI students at SMAN 9 Mandau as the basis for the subsequent stages of the instructional material development process.

Student Difficulties in Fluid Material Analysis

The analysis of student difficulties was conducted using a diagnostic test on static fluid material, administered to 36 Grade XI.A4 students at SMAN 9 Mandau. This analysis was supported by the results of a diagnostic test administered to 36 students in Grade XI.A4 at SMAN 9 Mandau. The diagnostic test assessed students' ability to complete learning tasks related to Hydrostatic Pressure, Pascal's Law, Archimedes' Principle, Surface Tension, Capillarity, and Viscosity. The results of the task analysis are presented in Table 3.

Table 3. Students' Achievement on Learning Tasks in the Static

Sub topic	Percentage (%)	Category
Hydrostatic Pressure	42.78	Very Low
Pascal's Law	42.22	Very Low
Archimedes' Principle	43.89	Very Low
Surface Tension	50.56	Very Low
Capillarity	53.89	Very Low
Viscosity	42.78	Very Low

The results presented in Table 3 indicate that students still experienced difficulties in completing the learning tasks across all Static Fluid subtopics. These findings show that students have not yet mastered the essential learning tasks required to achieve the learning objectives of the Static Fluid topic. This indicates that the expected learning tasks have not been achieved optimally, highlighting the need for learning activities that systematically guide students in completing each learning task. Therefore, the identified learning tasks were used as the basis for organizing the sequence of learning activities in the local wisdom-oriented Problem-Based Learning (PBL) E-Student Worksheets. These tasks were arranged progressively to enable students to develop conceptual understanding systematically while achieving the intended learning objectives.

Teaching Material Problems Analysis

The analysis of teaching material problems aimed to examine the types, formats, and pedagogical adequacy of the teaching materials currently used in Physics instruction at SMAN 9 Mandau. Based on interviews with the Physics teacher, classroom instruction on the Static Fluid topic relies primarily on printed textbooks and conventional student worksheets, which mainly provide conceptual explanations and practice exercises without incorporating digital features, interactive media, simulations, or other multimedia elements to support students' conceptual understanding. To obtain a more comprehensive evaluation of the existing teaching materials, a document analysis was conducted on the student worksheets by examining their alignment with the curriculum, instructional model, learning objectives, and technology integration. The findings of this analysis were used to identify the strengths and weaknesses of the current worksheets as the basis for developing the proposed E-Student

Worksheets, and the results are presented in Table 4.

Table 4. Alignment Analysis of Existing Student Worksheets

Teaching Material Analysis Aspect	Percentage	Category
Curriculum Alignment	78%	High
Learning Model Alignment	55%	Low
Learning Outcomes Alignment	40%	Very Low
Technology Integration	34%	Very Low

The results presented in Table 4 reveal considerable disparities among the four aspects evaluated. Although the existing student worksheets demonstrate a high level of alignment with the curriculum, their alignment with the instructional model, learning objectives, and technology integration remains low. These findings indicate that the existing worksheets primarily fulfill curriculum requirements but have not yet provided adequate pedagogical support for achieving the intended learning objectives. Consequently, improvements are needed, particularly in integrating appropriate instructional strategies and digital technology to better support the learning process.

Considering that technology integration received the lowest level of alignment, a more detailed analysis was conducted to examine the technological characteristics of the existing student worksheets. This analysis compares the technological features currently available in the worksheets with the characteristics of an ideal digital student worksheet capable of supporting interactive, technology-enhanced learning. The comparison was intended to identify specific gaps in technology integration and to provide a clearer basis for the development of the proposed E-Student Worksheets. The results of this analysis are presented in Figure 2.

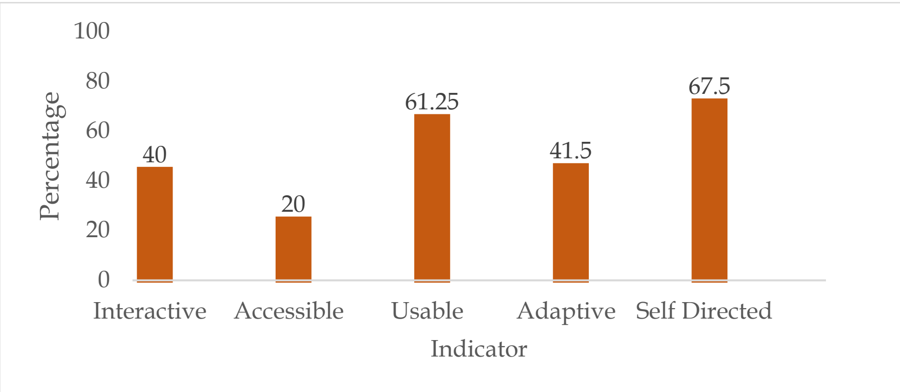

Figure 2. Analysis of the Technological Characteristics

The results indicate that the technological characteristics of the existing student worksheets have not yet met the criteria of an ideal digital learning resource. The interactive and accessible aspects are entirely absent, while the adaptive aspect remains at a low level. Although the usable and self-directed aspects demonstrate relatively higher levels of achievement, they are not supported by digital features that enable students to learn interactively, flexibly, and independently. These findings indicate that the existing student worksheets are still predominantly conventional in nature and have not optimized the integration of technology into the learning process. Therefore, the development of E-Student Worksheets should incorporate these five technological characteristics to provide a more effective, interactive, and learner-centered digital learning experience.

Learning Objectives Analysis

The learning objectives analysis was conducted to evaluate the quality of the learning objectives used in the Static Fluid topic. The analysis focused on examining the completeness of the learning objectives based on the ABCD components, namely Audience, Behavior, Condition, and Degree. This evaluation was carried out to determine whether the existing learning objectives had been formulated clearly and could effectively guide the teaching and learning process. The results of the analysis are presented in Figure 3.

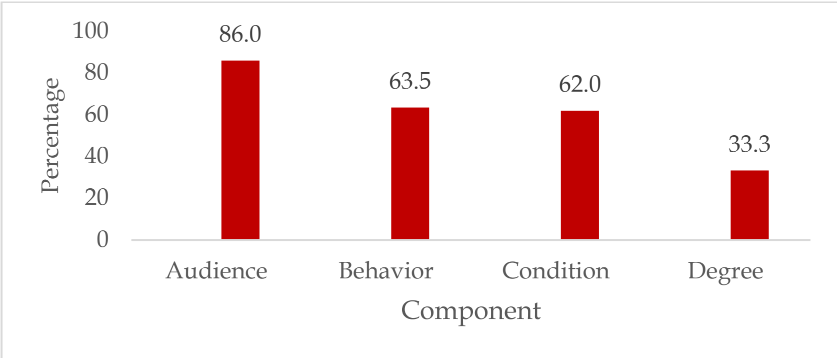

Figure 3. Analysis of Learning Objectives Based on the ABCD Components

The analysis of learning objectives based on the ABCD components indicates that the learning objectives for the Static Fluid topic have not yet fully met the essential elements of effective instructional planning. Although the Audience and Behavior components are generally well defined, the Condition and Degree components are inconsistently incorporated, reducing the clarity of expected learning contexts and performance standards. Consequently, the existing learning objectives provide limited guidance for instructional planning, learning activities, and assessment. These findings highlight the need to refine the learning objectives by systematically incorporating all ABCD components to ensure they are specific, measurable, and aligned with the intended learning outcomes.

Discussion

The findings comprehensive of this needs analysis reveal that physics instruction on the static fluid topic at SMAN 9 Mandau has not yet fully supported the optimal achievement of students' cognitive learning outcomes. Across all four grade XI classes, average formative assessment scores ranged from 43 to 61, all of which fall below the established minimum competency threshold. Conceptually, learning outcomes serve as a measurement tool used to assess the extent to which students have mastered the subject matter designed within a specific instructional context (Wirda et al., 2020). The persistently low scores observed in this study therefore indicate a fundamental gap between the intended learning objectives and the actual learning conditions in the field a gap that cannot be resolved without systematic instructional intervention, particularly in the form of more appropriate and contextually relevant teaching materials.

Further examination of the instructional conditions identified three major factors contributing to this learning gap: the limited quality of the teaching materials currently in use, the predominantly teacher-centered instructional approach, and the suboptimal implementation of innovative learning models. These findings are consistent with Putra et al. (2021),who affirm that teaching materials play a crucial role in supporting student learning achievement, and with Hadad et al. (2025), who assert that effective teaching materials must facilitate active and independent learning to avoid obstructing the achievement of established competencies. However, while these prior studies established the general importance of teaching material quality, they did not specifically examine the intersection of material limitations with local contextual factors and student digital readiness a gap that the present study addresses by situating the needs analysis within the specific instructional and cultural context of SMAN 9 Mandau.

Beyond the instructional conditions, students themselves demonstrated characteristics that strongly support the development of digital learning materials. Most students showed a preference for active, hands-on learning activities while also demonstrating considerable familiarity with digital technology in their daily lives. These characteristics indicate that the existing teaching materials limited to printed textbooks and conventional worksheets have not been designed in alignment with students' actual learning profiles. This finding reinforces the position of Marta & Ramli (2021), who argue that teaching materials must be developed in accordance with identified student characteristics, which can be systematically documented through the use of characteristic questionnaires. Nevertheless, the present study extends this perspective by demonstrating that student digital readiness, when combined with a preference for active engagement, constitutes a specific and actionable basis for developing electronic, interactive teaching materials a dimension that was not explicitly addressed in Marta & Ramli's (2021) work.

Current classroom learning activities remain dominated by routine, low-order tasks from conventional worksheets, providing limited opportunities for inquiry, critical thinking, and meaningful knowledge construction. This condition is inconsistent with the Independent Curriculum, which emphasizes student agency and higher-order thinking. Well-designed student worksheets can promote scientific thinking and authentic problem-solving (Mathluba et al., 2024). In addition, Roslina (2024) reported that student worksheets can increase active student participation while supporting the teacher's role as a facilitator. Building on these findings, the present study identifies the need for electronic student worksheets that utilize students' digital competencies, offering an empirically grounded advancement beyond previous studies on conventional printed worksheets.

Another important finding concerns the nature of the Static Fluid topic, which consists of interconnected concepts that are abstract and difficult for students to understand without appropriate contextual support. The analysis revealed that these concepts have not been meaningfully linked to real-world phenomena in current instruction, limiting students' conceptual understanding. To address this issue, this study proposes integrating local wisdom as a contextual learning resource, enabling students to connect abstract concepts with culturally familiar and observable phenomena (Artini et al., 2025). This approach extends previous worksheet development studies by using culturally specific and locally grounded contexts rather than generic real-world examples.

Taken together, these findings contribute to the literature on physics education and instructional material development by providing an empirically grounded needs analysis covering student learning outcomes, student characteristics, student difficulties, teaching material problems, and learning objectives. The findings indicate that low cognitive learning outcomes, students' digital readiness, preference for active learning, and the relevance of local wisdom provide a strong rationale for developing electronic student worksheets. Integrating local wisdom from the Mandau region into Problem-Based Learning (PBL) also extends previous studies that primarily used generic real-world contexts. Overall, these findings provide a strong empirical foundation for developing local wisdom-oriented, PBL-based e-Student Worksheets to improve students' cognitive learning outcomes and support more contextualized physics instruction.

CONCLUSION

This needs analysis shows that physics instruction on the static fluid topic at SMAN 9 Mandau has not yet effectively supported students' cognitive learning outcomes as intended by the curriculum. Learning remains teacher-centered, relying on printed materials that are not aligned with the learning model or objectives, limiting students' opportunities to understand abstract concepts through meaningful experiences. Meanwhile, students demonstrate strong interest in physics, prefer hands-on learning, and are familiar with digital technology, yet these characteristics are not reflected in existing teaching materials. These findings indicate the need for electronic teaching materials based on Problem Based Learning and local wisdom. The main contribution of this study is its integration of instructional conditions, learning objectives, teaching materials, student difficulties, and learner characteristics into a single empirical needs analysis situated within the cultural context of Riau. This provides a strong foundation for developing a local wisdom-oriented Problem Based Learning e-student worksheet to improve students' conceptual understanding.

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