JPPIPA 11(9) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

A Needs Analysis of E-LKPD (Electronic Student Worksheets) in Dynamic Electricity Learning to Stimulate Critical and Creative Thinking Skills

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Received: April 17, 2025
Revised: June 02, 2025
Accepted: September 25, 2025
Published: September 30, 2025

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DOI: 10.29303/jppipa.v11i9.11095

Abstract: This study investigates the need for developing electronic student worksheets (e-LKPD) for teaching dynamic electricity in junior high school science. Drawing on responses from 20 science teachers in Bandar Lampung, the research identifies key instructional challenges and teachers' expectations for more effective digital learning tools. The findings reveal that conventional worksheets are often teacher-centered, lack interactivity, and do not adequately support the development of students' critical and creative thinking. Teachers strongly advocate for e-LKPDs that are interactive, contextualized, visually engaging, and enriched with features such as simulations, videos, and inquiry-based tasks. They also emphasize the importance of aligning e-LKPDs with the national curriculum, students' cognitive levels, and pedagogical strategies that promote student autonomy and collaboration. These insights point to the urgent need for e-LKPDs that are not only technologically enhanced but also pedagogically sound, capable of fostering higher-order thinking and real-world problem-solving. The study offers practical implications for instructional designers, curriculum developers, and educators seeking to improve the quality of science learning through contextual and student-centered digital resources.

Keywords: Contextual learning; Creative thinking; Dynamic electricity; E-LKPD

Introduction

The paradigm of 21st-century education demands the development of higher-order thinking skills. Critical and creative thinking are essential competencies for students to face increasingly complex global challenges (Bozkurt Altan & Tan, 2021). In the context of science education, these skills are especially crucial, as many scientific concepts—such as dynamic electricity—are abstract and cognitively demanding. Students often encounter difficulties in analyzing electric circuits, understanding the interrelationships between electrical quantities, and applying these concepts in real-life situations (Banda & Nzabahimana, 2021; Widianingrum & Ducha, 2023).

Critical and creative thinking skills in learning dynamic electricity can be operationalized through activities such as identifying and analyzing errors in electrical circuits, evaluating alternative solutions, and designing new circuit models based on specific problem contexts. In this study, *critical thinking skills* refer to students' abilities to systematically analyze information, evaluate arguments, and make reasoned judgments about electrical circuit problems. Meanwhile, *creative thinking skills* specifically refer to students' abilities to generate innovative solutions, design new models, and apply imaginative approaches to problem-solving within the context of dynamic electricity. However, these processes are unlikely to be effectively achieved if the learning materials used are not contextual or interactive. Most conventional student worksheets

How to Cite:
Wati, K. R. L., Distrik, I. W., & Viyanti. (2025). A Needs Analysis of E-LKPD (Electronic Student Worksheets) in Dynamic Electricity Learning to Stimulate Critical and Creative Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *11*(9), 620–631. https://doi.org/10.29303/jppipa.v11i9.11095

(LKPD) remain static, overly text-based, and insufficient in fostering higher-order thinking skills (Atina et al., 2025).

Electronic student worksheets (e-LKPD) present a promising solution by integrating multimedia features and innovative instructional approaches that enhance student engagement and understanding (Adelia et al., 2023). The integration of interactive media has been shown to improve retention and promote deeper cognitive engagement (Huda et al., 2025). Several studies have demonstrated that e-LKPDs based on scientific and problem-based learning approaches can significantly improve students' critical thinking skills (Novitasari & Puspitawati, 2022; Saputra et al., 2024), and that e-LKPDs offer flexible and creative learning opportunities (Budiasih et al., 2022). Nevertheless, limited research has explicitly examined how e-LKPDs may also stimulate creative thinking skills in the context of science learning, particularly on the topic of dynamic electricity.

Moreover, few studies have addressed this issue within specific local contexts, such as among junior high school science teachers in Bandar Lampung City, who teach in classrooms with unique student characteristics and curriculum implementations. In the era of the Merdeka Curriculum, which emphasizes differentiation and project-based learning, the development of e-LKPDs must be adapted to the needs of teachers and the realities of classroom practice.

A comprehensive needs analysis is therefore essential prior to the development of effective e-LKPDs. Such analysis aims to evaluate the extent to which existing worksheets meet the pedagogical demands of dynamic electricity learning and to identify opportunities for developing e-LKPDs that can simultaneously foster students' critical and creative thinking skills. Without a proper needs analysis, the risk remains that instructional media development will fail to align with curriculum goals and learners' needs.

The novelty of this research lies in its focus on analyzing the specific needs of junior high school science teachers in Bandar Lampung City regarding the development of a dynamic electricity-based e-LKPD that explicitly targets the enhancement of both critical and creative thinking skills. Few existing studies have investigated the simultaneous development of these two skills within a single e-LKPD framework for the topic of dynamic electricity.

Therefore, this study aims to identify the specific needs of junior high school science teachers in Bandar Lampung City related to the development of an e-LKPD on dynamic electricity that is effective in stimulating students' critical and creative thinking skills.

Method

This study employed a quantitative descriptive approach to analyze science teachers' needs regarding the development of e-LKPD in science instruction, specifically on the topic of dynamic electricity. This approach was chosen for its ability to systematically and objectively describe phenomena (Waruwu et al., 2025). Descriptive methods are particularly suitable for identifying patterns and trends in educational practices, providing valuable insights for curriculum development and pedagogical strategies (Ungureanu, 2024). This approach has also been proven effective in previous educational studies involving teacher needs analysis, particularly in the development of digital learning tools such as e-LKPD (Suwandani et al., 2024). This study is categorized as a survey study, in which data were collected through questionnaires distributed to junior high school science teachers.

The use of surveys in educational research is widely recognized as an effective method for obtaining relevant information from the target population (Wardah, 2018). Through the distribution of questionnaires, surveys enable researchers to systematically obtain a quantitative overview of the aspects educators need to enhance their competence and teaching effectiveness (Saefuddin, 2022). The sampling technique used was purposive sampling. This technique is commonly applied in educational research to select participants with specific characteristics relevant to the research focus, ensuring that the data obtained are rich and applicable to the research questions.

The participants in this study were selected to represent diverse characteristics of junior high school science teachers in Bandar Lampung. A total of 20 teachers took part, consisting of 9 males and 11 females. They came from various school types: 12 from public (SMP Negeri) and 8 from private schools (SMP Swasta).

In terms of teaching experience, 6 had less than 5 years, 8 had between 5 and 10 years, and the remaining 6 had over 10 years of experience. Regarding educational background, 16 held a bachelor's degree (S1), while 4 held a master's degree (S2). Participant selection also considered their availability, active use of technology in teaching, and experience in delivering instruction on the topic of dynamic electricity (Zubaidah & Munadi, 2020). These criteria were intended to ensure a comprehensive overview of teacher needs across varied instructional contexts.

The data collection technique was conducted online using Google Forms, which were distributed to respondents via WhatsApp. The use of online tools for quantitative data collection has become a common practice in contemporary educational research,

particularly after the pandemic (Arti & Rosmayanti, 2021). Online surveys are increasingly utilized due to their flexibility, ability to reach many respondents, and cost-effectiveness, which are significant advantages for large-scale educational studies (Setiawan et al., 2025).

The research instrument was a questionnaire consisting of 27 closed and open-ended items. Questionnaires are effective tools for collecting large amounts of structured data, especially in studies that assess teachers' perceptions and practices (Ranganathan & Caduff, 2023). The questionnaire was divided into three main aspects teachers' readiness in science learning, development of e-LKPD to stimulate critical and creative thinking skills, and implications for e-LKPD development.

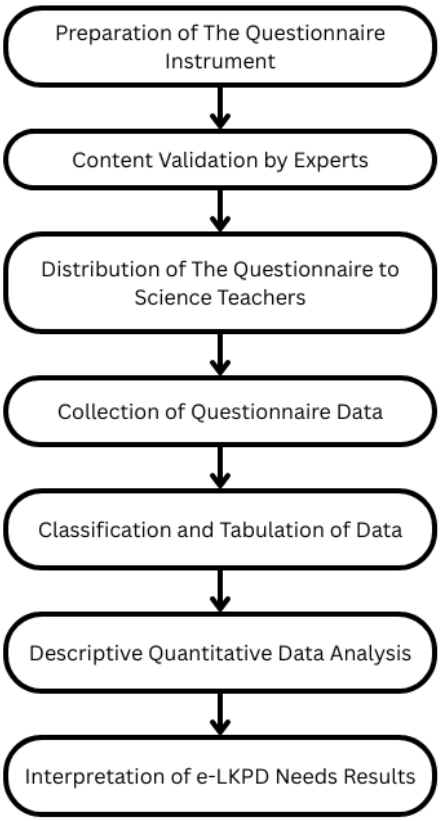

Figure 1. Flowchart

An example item under the critical thinking aspect is: "Does your teaching involve the following critical thinking activities?" with options such as: interpreting data, analyzing concepts, evaluating arguments, making inferences, and so on.

Meanwhile, the creative thinking aspect includes questions such as: "Does your teaching also foster the following creative thinking skills?" with indicators such as fluency, flexibility, originality, and elaboration. To clarify the flow of activities, the following is the research methodology flowchart in Figure 1.

Data analysis was carried out using quantitative techniques. The collected data were then analyzed using descriptive quantitative analysis. Raw data from the questionnaire responses were classified based on thematic categories. Subsequently, the frequency and percentage of each questionnaire item were calculated. The resulting percentages were then interpreted to illustrate general trends in teachers' needs and perceptions regarding the e-LKPD. The findings from this analysis served as the foundation for designing an e-LKPD that is relevant and responsive to classroom learning needs.

Result and Discussion

Needs analysis refers to the process of gathering and evaluating information to identify problems or gaps within a specific educational context, with the aim of determining appropriate solutions to achieve desired learning objectives. In this study, needs analysis was conducted to examine current issues in science instruction and explore potential solutions through the development of electronic student worksheets (e-LKPDs).

The analysis focused on three key aspects: (1) teachers' current practices and challenges in science learning, (2) teachers' perceptions on the need for e-lkpd to enhance critical and creative thinking, (3) desired features and content of the e-lkpd according to teachers, and (4) pedagogical and contextual considerations in e-LKPD development.

Teachers' Current Practices and Challenges In Science Learning

The results from Table 1 reveal that the teaching of dynamic electricity in Bandar Lampung has adopted various instructional strategies. A significant proportion of teachers reported using demonstrations (80%), group discussions (70%), and direct experiments (60%) in their teaching. These findings indicate a general shift toward student-centered learning approaches, which are in line with 21st-century science education principles. However, 90% of respondents stated that they still rely on printed textbooks as the main learning resource, and only 75% use printed LKPDs as supplementary materials. These findings demonstrate a gap between pedagogical innovation and the availability of supporting learning resources.

This pattern is consistent with previous research indicating that the absence of digital instructional media poses challenges in conveying abstract scientific concepts such as electricity (Yutia et al., 2023). Despite the pedagogical shift, the heavy reliance on conventional resources limits the ability of teachers to provide

interactive and meaningful learning experiences. As dynamic electricity involves complex and abstract phenomena, students often struggle to develop a concrete understanding without visual or interactive support.

Table 1. Questionnaire Results on Teachers' Current Practices And Challenges In Science Learning

Aspect	Response Option	Percentage (%)
Methods used to teach dynamic electricity	Lecture	65
	Demonstration	75
	Experiment	55
	Group discussion	75
Main limitations in teaching dynamic electricity	Students struggle with abstract concepts	50
	Limited laboratory equipment	45
	Lack of LKPD or learning resources	40
	Difficulty designing critical thinking questions	20
	Others	5
Main learning resources used	Textbooks	90
	Printed LKPD	75
	Digital modules	15
	Videos/Animations	25
School infrastructure supporting mobile-based e-LKPD	Highly adequate	70
	Adequate	25
	Less adequate	5
	Not adequate at all	5
Use of LKPD in learning	Yes	75
	No	25
Creating LKPD independently	Yes	55
	No	45
LKPD developed has trained critical and creative thinking skills	Not yet	100
Implementation of interactive learning	Yes	40
	Occasionally	50
	No	10
Difficulty in creating LKPD	Lack of time	100
Forms of interactive learning used	Open-ended Q&A	35
	Interactive quizzes (Kahoot, Quizizz, etc.)	20
	Digital simulations/interactive animations	30
	Active group discussion	15
	Educational games	10
	(WhatsApp/Google Classroom, etc.)	5
	Others	5
Challenges in implementing interactive learning	Limited time	55
	Lack of digital tools/facilities	5
	Inactive student participation	15
	Difficulty transforming material into interactive content	20
	Others	5

In this context, the development of electronic LKPDs (e-LKPDs) becomes highly relevant. Teachers emphasized the need for tools that can visualize abstract concepts and bridge the gap between theory and real-world applications. Interactive learning materials—such as e-LKPDs embedded with simulations, animations, and contextual case studies—can enhance conceptual understanding by presenting information in a visually engaging and cognitively stimulating manner. This is supported by Magfirah (2025) and Yusuf et al. (2024), who found that interactive learning media significantly help students in understanding abstract concepts, including dynamic electricity.

Another significant challenge reported by 60% of teachers is the students' limited understanding of basic concepts in electricity, which often stems from the abstract nature of the subject matter. As highlighted by Maričić et al. (2024); Tarihoran & Anas (2023), the integration of instructive simulations through digital platforms such as PhET can improve students' ability to

visualize and interact with electrical phenomena. These simulations help students connect theoretical knowledge with practical applications, thereby deepening their conceptual grasp of dynamic electricity.

Infrastructure does not appear to be a major barrier in implementing e-LKPD-based learning. As many as 70% of teachers stated that their school facilities are adequate for digital learning integration. However, this potential is not yet fully realized in classroom practices, as only 50% of teachers have implemented interactive digital learning activities. Moreover, interactive strategies are still limited to tools like Quizizz, Kahoot, and simple online discussions, which lack the depth and structure necessary to support critical and creative thinking development.

The main barrier to innovation, as reported by 55% of teachers, is limited time for lesson preparation and LKPD development. This aligns with findings from Yusuf et al. (2024) who observed that although digital platforms can enhance student engagement and motivation, many educators struggle with digital readiness and time constraints. As a result, most existing LKPDs are conventional in format and have not yet been optimized to foster higher-order thinking skills such as critical analysis and creative problem-solving.

Tabel 2. Questionnaire Results on Teachers' Perceptions On The Need For E-LKPD To Enchance Critical And Creative Thinking

Statement	Response Option	Percentage (%)
Importance of developing e-LKPD for dynamic electricity materials	Very important	60
	Important	30
	Fairly important	10
	Less important	0
	Not important at all	0
Challenges in using/developing LKPD	Limited time	70
	Lack of digital development training	55
	Limited school technology	45
	Difficulty in finding digital learning resources	35
	Difficulty designing critical & creative questions	50
	Lack of school support	30
Difficulty in identifying real-world cases relevant to dynamic electricity learning	Very difficult	5
	Difficult	25
	Slightly difficult	50
	Not difficult at all	20
Contextual situations relevant for inclusion in e-LKPD	Electricity use at home	65
	Electricity use in vehicles	15
	Electricity issues in the local environment	5
	Use of electrical tools in industry	15
Agreement that e-LKPD development can enhance critical and creative thinking skills	Strongly agree	60
	Agree	40
	Neutral	0
	Disagree	0
	Strongly disagree	0
School facility conditions for e-LKPD implementation	Very adequate	70
	Adequate	20
	Fairly adequate	10
	Less adequate	0
	Not adequate at all	0

Collectively, these findings emphasize the urgent need for the development of digital and pedagogically rich e-LKPDs that can address both the abstract nature of dynamic electricity and the practical constraints faced by teachers. By incorporating interactive simulations, real-world problem contexts, and activities aligned with critical and creative thinking frameworks, the e-LKPD has the potential to transform how students learn electricity in a more engaging, meaningful, and effective manner.

Teachers' Perceptions on The Need for E-LKPD to Enhance Critical and Creative Thinking

Data from Table 2 demonstrate that the majority of science teachers acknowledge the potential of e-LKPDs to enhance students' critical and creative thinking in learning dynamic electricity. A total of 85% of respondents agreed that interactive features such as simulations and animations are crucial to help students visualize electric circuits, while 80% highlighted the need for contextual problems that connect with real-life

situations. These perceptions reflect a growing awareness among teachers about the importance of contextual and problem-based learning strategies in 21st-century education.

Contextualized learning materials help students not only understand scientific principles but also apply them in real-life scenarios, thereby fostering deeper cognitive engagement. In this context, an e-LKPD that includes local examples—such as the problem of malfunctioning LED lights in homes—can make learning more relatable and relevant. Furthermore, the preference for features that stimulate student inquiry and experimentation aligns with the idea of learning by doing, which supports both creative exploration and critical reflection.

The teachers also emphasized the importance of flexibility in accessing e-LKPDs across various devices (80%), especially in schools where students have different levels of access to technology. This highlights the necessity for cross-platform compatibility in e-LKPD design, which ensures equitable access and supports continuity in learning both inside and outside the classroom. In addition, 75% of teachers agreed that e-LKPDs should include formative assessments and feedback features, which are essential for scaffolding higher-order thinking and metacognitive development (Yusuf et al., 2024).

However, despite the positive perceptions, only 55% of teachers reported having access to well-developed e-LKPDs aligned with these criteria. This suggests a gap between the ideal instructional design and the reality of digital resource availability. As noted by Yutia et al. (2023), the absence of quality digital teaching materials remains a major barrier to fostering critical and creative thinking in science classrooms.

In summary, the data suggest that science teachers are aware of the pedagogical benefits of well-designed e-LKPDs, particularly those that incorporate contextual problems, simulations, feedback mechanisms, and flexible access. These features are crucial for bridging conceptual understanding with real-world applications and for promoting student-centered learning that stimulates both critical and creative thinking.

Desired Features and Content of The E-LKPD according to Teachers

Table 3 highlights the teachers' expectations for the ideal e-LKPD design, which centers around interactivity, contextual relevance, and cognitive stimulation. One of the most emphasized features is the incorporation of multimedia elements—such as videos, animations, and computer-based simulations—to transform abstract physics concepts into comprehensible visual experiences. Research also suggests that digital worksheets equipped with video and simulation-based learning are effective in promoting contextual science learning and improving cognitive engagement among students (Alamin et al., 2024). These tools are widely believed to foster better conceptual understanding and sustained student engagement (Putra et al., 2023).

Teachers also advocate for learning materials that are rooted in real-life contexts. They expect e-LKPDs to integrate problem-based learning (PBL) scenarios that mirror everyday phenomena, enabling students to apply scientific principles in meaningful ways. Such contextualization helps foster reflective thinking and makes the learning experience more relevant and motivating for students (Affandy et al., 2024). In this regard, teachers value tasks that invite exploration and support inquiry-based learning, where students are encouraged to pose questions, formulate hypotheses, and experiment collaboratively.

Furthermore, the integration of digital media plays a crucial role in nurturing divergent thinking. Research shows that when students are exposed to dynamic and interactive digital content, their ability to think creatively and generate original ideas is significantly enhanced (Chomsun et al., 2025; Wardi et al., 2024). Reinforces this by stating that creative digital worksheets help increase cognitive flexibility, particularly when designed with open-ended, exploratory tasks. Affandy et al. (2024) similarly emphasizes that digital worksheets that simulate real scientific problems encourage students to develop solution-oriented thinking and independent reasoning—skills essential for 21st-century scientific literacy.

Moreover, respondents suggested features such as real case studies 50%. A concrete application of these features can be found in a case study involving the selection of appropriate cable types for home electrical installations, which relates to the topic of electric current and conductors. This approach supports inquiry-based and problem-solving learning models, which have been shown to effectively stimulate students' critical thinking skills (Karomah & Purnomo, 2025; Milanto et al., 2023; Qatrunada et al., 2023). Furthermore, the use of visual prompts, interactive simulations, and open-ended questions within e-LKPDs can stimulate students' creative thinking in science learning contexts (Anwar et al., 2024).

Moreover, teachers highlighted the need for e-LKPDs that are project-based assignments (40%). This approach aligns with the principles of project-based learning (PjBL), which has been proven to enhance creative thinking across educational levels (Fitriyah & Ghofur, 2021). Tearchers also need for e-LKPDs that are accessible, adaptive, and responsive to diverse student

needs. Features such as offline usability, device compatibility, and clear navigation are expected to enhance usability, especially in schools with limited technological infrastructure.

Tabel 3. Questionnaire results on desired features and content of the E-LKPD according to teachers

Statement	Response Option	Percentage (%)
The required features of e-LKPD	Interactive instructional video	70
	Digital simulations (PhET, interactive animations)	80
	Critical and creative thinking practice questions	65
	Real-life case studies	50
	Automatic feedback for student answers	45
	Project-based assignments or mini projects	40
	Augmented Reality (AR) or Virtual Reality (VR) media	25
	Online collaboration or discussion forum	30
	Interactive quizzes (e.g., Kahoot, Quizizz)	35
	Usage guide for teachers	60
	Other features (e.g., glossary)	10
The required content of e-LKPD	Virtual experiments or laboratory activities	50
	Group activities and discussions	65
	Self-assessment and learning reflection	40
	Critical thinking skills content (e.g., data analysis, evaluation)	75
	Creative thinking skills content (e.g., innovation, alternative solutions)	70
	Other content (e.g., material summary)	15
	Preferred format: Downloadable and printable PDF	35
	Preferred format: Interactive online web module	55
	Preferred format: Easily accessible mobile application	40
	Preferred format: Hybrid (print and digital)	30
	Other format (e.g., interactive e-book)	5
Agreement: e-LKPD should contain critical and creative thinking stimulation activities	Strongly agree	65
	Agree	25
	Neutral	20
	Disagree	0
	Strongly disagree	0
Importance of teacher usage guide	Very important	75
	Important	20
	Fairly important	5
	Less important	0
	Not important at all	0
Most expected interactive feature:	Electricity experiment simulation	80
	Interactive quizzes	65
	Tutorial video with quiz	60
	Student discussion forum	35
	Automatic feedback and assessment	50
	Other (e.g., teacher help chat)	10

In summary, the findings suggest that teachers envision an e-LKPD that is not only technologically rich but also pedagogically robust—integrating multimedia, inquiry-based contextual tasks, and open-ended challenges to support critical and creative thinking. The development of such e-LKPDs aligns with national science education goals to cultivate independent, reflective, and innovative learners.

Pedagogical and Contextual Considerations in E-LKPD development

The data in Table 4 highlight important pedagogical and contextual factors that teachers consider essential in the development of e-LKPDs for teaching dynamic electricity. A significant majority (80%) of teachers emphasized the need for learning materials that are aligned with the local curriculum standards and adapted to the students' cognitive levels. This alignment ensures that the e-LKPDs are not only relevant but also feasible to be integrated into existing instructional plans (Putra et al., 2023).

Tabel 4. Questionnaire Results on Pedagogical and Contextual Considerations in E-LKPD Development

Statement	Response Options	Percentage (%)
Critical thinking activity	Interpreting data and information	85
	Analyzing concept relationships	90
	Evaluating arguments or statements	75
	Making inferences or conclusions	70
	Providing reasons or explanations	80
	Student reflection and revision	60
	Generating multiple ideas (fluency)	65
	Using various approaches (flexibility)	70
	Producing original ideas (originality)	50
	Elaborating ideas	60
	Creating innovative solutions to problems	55
Frequency of stimulating critical thinking	Very often	35
	Often	45
	Sometimes	20
	Rarely	0
	Never	0
	Very often	25
	Often	40
	Sometimes	35
	Rarely	0
	Never	0
Importance of integrating critical and creative thinking activities	Very important	75
	Important	20
	Fairly important	5
	Less important	0
	Not important at all	0
Main challenge	Limited time for material preparation	70
	Lack of learning resources and supporting references	60
	Teachers' limited technological skills	50
	Limited digital facilities and devices	45
	Lack of training on e-LKPD development	55
	Difficulty designing questions that stimulate critical and creative thinking	65
Effective method	Group discussion	80
	Case studies and problem solving	70
	Experiments and simulations	60
	Project-based learning	55
	Open-ended questioning	50
	Educational games	35
	Other (e.g., multimedia learning)	10

Teachers also pointed out the importance of incorporating culturally relevant examples and local phenomena related to electricity, which can enhance students' engagement and motivation. This finding supports the principle of contextual learning, which suggests that students learn best when new knowledge is connected to their daily experiences and environment (Nasir et al., 2024; Rizki et al., 2022). For instance, discussing the electrical problems commonly faced in Bandar Lampung households can provide authentic contexts that make abstract concepts more tangible (Sutanto, 2011).

Moreover, 70% of teachers indicated that digital literacy levels among students and teachers must be considered when designing e-LKPDs. Digital readiness remains a critical challenge, as uneven access to technology and varying proficiency in digital tools can impact the effectiveness of e-learning. Thus, e-LKPD developers should ensure that the interfaces are user-friendly and that guidance is provided to both teachers and students to maximize utilization.

Time constraints during lessons were identified by 65% of respondents as a limiting factor for implementing interactive and critical thinking activities. This corroborates the earlier finding that limited instructional time reduces opportunities for in-depth exploration and student-centered learning (Hamdani et al., 2025; Nur, 2024; Widyantoro et al., 2024). To address this, e-LKPDs need to be designed with concise, focused activities that

optimize classroom time while still encouraging higher-order thinking.

Teachers further recommended the inclusion of formative assessments with instant feedback, which 75% agreed are vital for monitoring student progress and supporting self-regulation (Yusuf et al., 2024). Interactive features such as quizzes, simulations, and reflective prompts can provide timely feedback, enabling students to adjust their learning strategies effectively (Diab et al., 2024; Kaldaras et al., 2024).

Additionally, more than half of the respondents (60%) suggested that collaborative learning components be embedded within e-LKPDs to facilitate peer interaction and cooperative problem-solving. This recommendation aligns with findings by Suwandani et al. (2024), who reported that cooperative learning environments enhance critical questioning and creative idea generation among students.

In conclusion, the data indicate that the development of e-LKPDs for dynamic electricity should be grounded in pedagogical best practices and adapted to the local context. Key considerations include curriculum alignment, cultural relevance, digital accessibility, time efficiency, formative feedback, and opportunities for collaboration. Addressing these factors will increase the likelihood that e-LKPDs effectively support the development of critical and creative thinking skills in science learners.

Conclusions

The findings of this study emphasize the critical need for the development of electronic student worksheets (e-LKPD) specifically designed for the topic of dynamic electricity in science education. Analysis of teacher responses indicates that current instructional approaches are still dominated by teacher-centered strategies, limited student engagement, and a lack of structured opportunities to develop higher-order thinking skills. Teachers consistently report that existing materials fall short in stimulating critical and creative thinking, which are essential for 21st-century learners.

Moreover, teachers express strong expectations for future e-LKPDs to feature interactive, multimedia-enhanced content that is contextually linked to real-life situations. These features are not only intended to support better conceptual understanding but also to cultivate divergent thinking and cognitive flexibility. Teachers also stress the importance of inquiry-based learning, problem-solving tasks, collaborative opportunities, and formative assessments as essential pedagogical foundations. In addition, practical considerations such as user-friendly navigation, offline accessibility, and alignment with students' cognitive levels and the national curriculum are viewed as crucial to successful implementation. Therefore, the ideal e-LKPD should be designed to foster student-centered, inquiry-driven learning, integrate real-world contexts, support autonomous and collaborative exploration, and encourage both critical and creative thinking. Such an instructional tool would not only enrich the learning experience but also equip students with the cognitive tools necessary for solving complex scientific and everyday challenges.

Acknowledgment
The author team would like to express its gratitude to all parties who have been involved in this research directly or indirectly.

Authors Contributions
Kharen Riz Lambar Wati designed the study, collected and analyzed the data, and drafted the manuscript. I Wayan Distrik and Viyanti provided supervision, conceptual guidance, and critical revisions of the manuscript. All authors read and approved the final version of the manuscript.

Funding
Researchers independently funded this research

Conflicts of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper

References

Adelia, M., Widowati, A., Jumadi, J., & Lafifa, F. (2023). Uji Kelayakan Aspek Media Video Mind Mapping Berbasis Etnosains Pada Materi Zat Aditif Dan Zat Adiktif. *Jurnal Penelitian Pendidikan IPA*, *9*(2). https://doi.org/10.29303/jppipa.v9i2.1750

Affandy, H., Sunarno, W., Suryana, R., & Harjana. (2024). Integrating creative pedagogy into problem-based learning: The effects on higher order thinking skills in science education. *Thinking Skills and Creativity*, *53*, 101575. https://doi.org/10.1016/j.tsc.2024.101575

Alamin, A., Nurhanurawati, N., Rohman, F., & Perdana, R. (2024). Development of Learning E-Modules Based on Contextual Teaching and Learning on the Material of Changing the Form of Energy to Improve Students' Science Literacy. *Jurnal Penelitian Pendidikan IPA*, *10*(8). https://doi.org/10.29303/jppipa.v10i8.8323

Anwar, Y., Nurfadhilah, D., & Tibrani, M. (2024). The Effectiveness of the Project Based Learning (PjBL) Model on the Creative Thinking Skill of Students in the Human Respiration System.

Jurnal Penelitian Pendidikan IPA, *10*(2), 599–608. https://doi.org/10.29303/jppipa.v10i2.4941

Arti, E. S., & Rosmayanti, L. (2021). Evaluasi Pendidikan Jarak Jauh Mata Kuliah Flight Plan Program Studi Lalu Lintas Udara. *Langit Biru: Jurnal Ilmiah Aviasi*, *14*(03), 31–37. https://doi.org/10.54147/langitbiru.v14i03.437

Atina, A., Herlina, K., & Abdurrahman. (2025). Teachers' Perception toward e-LKPD STEM-EDP to Improve System Thinking Skills and Creative Problem Solving Skills. *Jurnal Penelitian Pendidikan IPA*, *11*(1). https://doi.org/10.29303/jppipa.v11i1.9491

Banda, H. J., & Nzabahimana, J. (2021). Effect of integrating physics education technology simulations on students' conceptual understanding in physics: A review of literature. *Physical Review Physics Education Research*, *17*(2), 023108. https://doi.org/10.1103/PhysRevPhysEducRes.17.023108

Bozkurt Altan, E., & Tan, S. (2021). Concepts of creativity in design based learning in STEM education. *International Journal of Technology and Design Education*, *31*(3), 503–529. https://doi.org/10.1007/s10798-020-09569-y

Budiasih, Y., Abdurrahman, A., Lengkana, D., Hasnunidah, N., & Aini, N. R. (2022). Studi Pendahuluan: Pengembangan e-LKPD dalam Upaya Pemahaman Keterampilan Berpikir Kreatif pada Pembelajaran Ilmu Pengetahuan Alam. *Al Jahiz: Journal of Biology Education Research*, *3*(2). https://doi.org/10.32332/al-jahiz.v3i2.6929

Chomsun, S., Pratiwi, D., & Rosa, F. O. (2025). E-LKPD Based on Socio-Scientific Issues: A Means of Developing Science Literacy and Critical Thinking In The Era Of The Independent Curriculum. *Jurnal Penelitian Pendidikan IPA*, *11*(1), 895–903. https://doi.org/10.29303/jppipa.v11i1.9973

Diab, H., Daher, W., Rayan, B., Issa, N., & Rayan, A. (2024). Transforming Science Education in Elementary Schools: The Power of PhET Simulations in Enhancing Student Learning. *Multimodal Technologies and Interaction*, *8*(11). https://doi.org/10.3390/mti8110105

Fitriyah, I. M. N., & Ghofur, M. A. (2021). Pengembangan E-LKPD Berbasis Android Dengan Model Pembelajaran Problem Based Learning (PBL) Untuk Meningkatkan Berpikir Kritis Peserta Didik. *EDUKATIF : JURNAL ILMU PENDIDIKAN*, *3*(5), 1957–1970. https://doi.org/10.31004/edukatif.v3i5.718

Hamdani, F., Nuryadi, H., & Aulia, M. (2025). Pembuatan Media Pembelajaran Interaktif IPA untuk Anak Sekolah Dasar Kelas IV Berbasis Multimedia. *Digital Transformation Technology*, *4*(2), 1260–1266. https://doi.org/10.47709/digitech.v4i2.5392

Huda, N., Waluyo, E., & Marhamah, M. (2025). Development of E-LKPD Based on Project Based Learning in IPAS Subjects to Improve Students' Critical Thinking Skills. *IJE : Interdisciplinary Journal of Education*, *3*(1). https://doi.org/10.61277/ije.v3i1.194

Kaldaras, L., Wang, K. D., Nardo, J. E., Price, A., Perkins, K., Wieman, C., & Salehi, S. (2024). Employing technology-enhanced feedback and scaffolding to support the development of deep science understanding using computer simulations. *International Journal of STEM Education*, *11*(1), 30. https://doi.org/10.1186/s40594-024-00490-7

Karomah, I. U., & Purnomo, T. (2025). Pengembangan E-LKPD Model Problem Based Learning Materi Ekosistem untuk Melatih Keterampilan Berpikir Kritis Siswa Kelas Siswa Kelas X SMA. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *14*(1), 188–201. https://doi.org/10.26740/bioedu.v14n1.p188-201

Magfirah, L. (2025). Pemanfaatan Simulasi Digital Untuk Memfasilitasi Pembelajaran Konsep Abstrak Dalam Fisika. *Jurnal Ilmiah IPA dan Matematika (JIIM)*, *2*(2), 28-33. https://doi.org/10.61116/jiim.v2i2.470

Maričić, M., Cvjetićanin ,Stanko, Anđić ,Branko, Marić ,Mia, & and Petojević, A. (2024). Using instructive simulations to teach young students simple science concepts: Evidence from electricity content. *Journal of Research on Technology in Education*, *56*(6), 691–710. https://doi.org/10.1080/15391523.2023.2196460

Milanto, S., Suprapto, N., & Budiyanto, M. (2023). The Effectiveness of Contextual Learning Using the Guided Inquiry Approach to Improve Students' Scientific Literacy Ability. *Jurnal Penelitian Pendidikan IPA*, *9*(1). https://doi.org/10.29303/jppipa.v9i1.2785

Nasir, M., Syahril, S., Ernidawati, E., & Vilmala, B. K. (2024). Penerapan KIT Listrik Dinamis Berbasis Energi Terbarukan dengan Pendekatan Steam-Kontekstual bagi Guru-Guru SMP Se Kabupaten Siak. *Lumbung Inovasi: Jurnal Pengabdian Kepada Masyarakat*, *9*(4), 1091–1102. https://doi.org/10.36312/linov.v9i4.2272

Novitasari, F., & Puspitawati, R. P. (2022). Pengembangan E-LKPD berbasis problem

solving pada materi pertumbuhan dan perkembangan untuk melatih keterampilan berpikir kritis siswa kelas XII SMA. *Jurnal Inovasi Pembelajaran Biologi*, *3*(1), 31-42. https://doi.org/10.26740/jipb.v3n1.p31-42

Nur, R. (2024). Pengembangan Multimedia Pembelajaran Interaktif IPA Berbasis Game Edukasi Android di Kelas V SD Negeri 14 Bonto-Bonto Kabupaten Pangkep. *Lempu PGSD*, *1*(1), 33–43. https://doi.org/10.70713/lempu.v1i1.3334

Putra, W. P., Gunamantha, I. M., & Sudiana, I. N. (2023). Pengembangan E-Lkpd Hots Dalam Meningkatkan Berpikir Kritis Pada Pembelajaran IPA SD. *Pendasi Jurnal Pendidikan Dasar Indonesia*, *7*(1). https://doi.org/10.23887/jurnal_pendas.v7i1.2177

Qatrunada, N., Muhiddin, N. H., & Ramlawati, R. (2023). Pengaruh E-LKPD Berbasis Problem Based Learning (PBL) terhadap Keterampilan Berpikir Kritis Peserta Didik Kelas VIII SMP Negeri 1 Pangkajene. *Seminar Nasional Pendidikan IPA*, *3*(1). https://doi.org/10.26858/semnaspendipa.v3i1.54345

Ranganathan, P., & Caduff, C. (2023). Designing and validating a research questionnaire—Part 1. *Perspectives in Clinical Research*, *14*(3), 152–155. https://doi.org/10.4103/picr.picr_140_23

Rizki, S., Mastuang, M., & M, A. S. (2022). Pengembangan Perangkat Pembelajaran Model Direct Instruction untuk Melatihkan Keterampilan Proses Sains Siswa SMA Materi Gerak Melingkar. *Jurnal Ilmiah Pendidikan Fisika*, *6*(1), 26. https://doi.org/10.20527/jipf.v6i1.3295

Saefuddin, N. F. N. (2022). Kebutuhan Para Pendidik terhadap Materi Penyuluhan Apresiasi Sastra di Kalimatan Selatan. *UNDAS: Jurnal Hasil Penelitian Bahasa dan Sastra*, *18*(2). https://doi.org/10.26499/und.v18i2.4868

Saputra, A. B., Hamidah, A., & Mataniari, R. (2024). Development of E-LKPD Based on Problem Based Learning on Excretory System Material for High Schools. *Jurnal Penelitian Pendidikan IPA*, *10*(5). https://doi.org/10.29303/jppipa.v10i5.6935

Setiawan, A., Pramadjaya, A., Permana, D., Rasyid, D., Pratama, E. M., Iqbal, F. M., & Sidan, Z. Z. (2025). Pengembangan Sistem Informasi Pembelajaran Interaktif Berbasis Cloud Untuk Meningkatkan Partisipasi Siswa Di SMKN 7 Kota Serang. *Abdi Laksana: Jurnal Pengabdian Kepada Masyarakat*, *6*(1). https://doi.org/10.32493/abdilaksana.v6i1.47057

Sutanto, E. (2011). *Pembelajaran Fisika dengan Cooperative Problem Solving dan Group Investigation Ditinjau dari Motivasi Berprestasi dan Sikap Sosial Siswa (Studi Kasus pada Materi Pembelajaran Fisika untuk Konsep Listrik Dinamis pada Siswa Kelas X SMA Negeri 1 Buluspesant*. Retrieved from https://www.semanticscholar.org/paper/Pembelajaran-Fisika-dengan-Cooperative-Problem-dan-Sutanto/589cd2959dddbe8be3e048a6bba2f9e040dfafde

Suwandani, L., Sunyono, Viyanti, & Lengkana, D. (2024). Science Learning Using e-LKPD Ethno-SiMaYang Tapis Lampung Cloth to Improve Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *10*(11). https://doi.org/10.29303/jppipa.v10i11.7984

Tarihoran, S. Y., & Anas, N. (2023). Development of STEM-Based E-LKPD on Senses System Material to Improve Creative Thinking Ability. *Jurnal Penelitian Pendidikan IPA*, *9*(5). https://doi.org/10.29303/jppipa.v9i5.3657

Ungureanu, E. (2024). Constructing Ability in the Classroom: A Descriptive Analysis of Pedagogical Practices in Primary Education. *Journal of Educational Sciences*, *49*(1), 192–204. https://doi.org/10.35923/JES.2024.1.11

Wardah, E. Y. (2018). Peranan Guru Pembimbing Khusus Lulusan Non-Pendidikan Luar Biasa (Plb) Terhadap Pelayanan Anak Berkebutuhan Khusus Di Sekolah Inklusi Kabupaten Lumajang. *JPI (Jurnal Pendidikan Inklusi)*, *2*(2), 93–108. https://doi.org/10.26740/inklusi.v2n2.p93-108

Wardi, L. Z., Wasis, W., Widodo, W., Satriawan, M., & Nisa, K. (2024). Trends and Development in Digital Learning Research for Enhancing Scientific Literacy in Physics Learning: Literature Review and Bibliometric Analysis. *Jurnal Pendidikan MIPA*, *25*(3). Retrieved from https://jpmipa.fkip.unila.ac.id/index.php/jpmipa/article/view/103

Waruwu, M., Puat, S. N., Utami, P. R., & Yanti, E. (2025). Metode Penelitian Kuantitatif: Konsep, Jenis, Tahapan dan Kelebihan. *Jurnal Ilmiah Profesi Pendidikan*, *10*(1), 917-932. https://doi.org/10.29303/jipp.v10i1.3057

Widianingrum, N., & Ducha, N. (2023). Pengembangan E-LKPD Berbasis Literasi Sains untuk Melatihkan Keterampilan Berpikir Kritis pada Materi Sistem Gerak Kelas XI SMA. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *12*(2), 311–320.

https://doi.org/10.26740/bioedu.v12n2.p311-320

Widyantoro, B., Choirina, P., Cipta, B. S. I., & Septarina, A. A. (2024). Rancang Bangun Laboratorium Virtual Media Pembelajaran Interaktif Ipa Berbasis Android Pada Siswa Minu Jatirejoyoso, Kabupaten Malang. *Biner : Jurnal Ilmiah Informatika Dan Komputer*, *3*(2), 72–79. https://doi.org/10.32699/biner.v3i2.7303

Yusuf, N. S., Al Farizi, Z., & Rusdin, M. E. (2024). (PDF) Implementasi Pembelajaran Kooperatif Tipe Student Team Achievement Division Berbasis Blended Pengembangan E-Modul Berbantuan PhET pada Materi Listrik Dinamis. *Jurnal Praktik Baik Pembelajaran Sekolah dan Pesantren*, *3*(03), 133-143 https://doi.org/10.56741/pbpsp.v3i03.696

Yutia, N., Yusnaidar, & Hasibuan, M. H. E. (2023). Development of Electronic Student Worksheets with a Scientific Approach to Static Fluids Material to Improve Critical Thinking Skills of SMAN 9 Merangin Students. *Jurnal Penelitian Pendidikan IPA*, *9*(10). https://doi.org/10.29303/jppipa.v9i10.5291

Zubaidah, D., & Munadi, M. (2020). Peran Komisi Pemilihan Umum Kabupaten Wonosobo dalam Pendidikan Politik untuk Masyarakat pada Pemilu Serentak 2019. *Unnes Political Science Journal*, *4*(2). https://doi.org/10.15294/upsj.v4i2.27155