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Bridging the Gap by Integrating Google for Education in Physics Learning: Mixed Method Approach

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ABSTRACT
The integration of Information and Communication Technology (ICT) in the learning process is a crucial factor in enhancing educational effectiveness, particularly in fostering 21st-century skills, such as critical thinking, collaboration, and information literacy. This study aimed to identify the needs of students and teachers for developing Google for Education–based digital teaching materials to support physics learning in a private junior high school in Indonesia. Employing a mixed-methods approach, data were collected through questionnaires, interviews, and observations involving 60 students and two physics teachers. Findings from various data collection techniques, including surveys, interviews, and observations, indicate that current learning media is lacking in innovation, with students expressing a desire for more engaging and interactive digital teaching materials that can be accessed anytime and anywhere. Google for Education-based digital teaching materials hold significant potential for application in Physics education, aiding students in achieving the competencies required in the 21st century.

KEYWORDS
Google; teaching materials; digital; physics learning.

INTRODUCTION

The integration of Information and Communication Technology (ICT) into the learning process is recognized as a critical factor in enhancing the effectiveness of education. ICT tools facilitate a dynamic learning environment that can lead to improved student engagement and achievement and increased teacher effectiveness (Downie et al., 2021). Educational institutions that leverage digital resources, such as Learning Management Systems, can provide e-learning opportunities that meet the evolving needs of society and the education sector (McKnight et al., 2016). From a teacher's perspective, Majid et al. (2026) similarly found that user experience is a key determinant of a national instructional platform's success in supporting self-directed learning and competency improvement. However, ICT integration is not without its challenges. Teachers may face obstacles such as a lack of resources, time, and technical support, which can hinder the effective use of ICT in the classroom (Gündoðdu, 2023; Sariyatun et al., 2018). A recent study by Kalymova et al. (2026) further underscores the importance of strengthening teachers' digital competence through the integration of e-learning and artificial intelligence technologies. Moreover, despite the availability of ICT resources and skills to use them, there is often a gap in the actual utilization of these tools in teaching, particularly in subjects such as science education (Budiarto et al., 2024; Taole, 2024). In conclusion, while ICT integration is crucial for modernizing the teaching-learning process and aligning it with global educational standards, it requires strategic planning, professional development, and support for teachers to overcome the barriers to its effective use (Ndiangui & Koklu, (2024).

Furthermore, at present, there is a focus on learning that concentrates on achieving 21st-century skills. Collectively, these studies emphasize the importance of acquiring proficiency in 21st-century competencies for junior high school students, including critical thinking, collaboration, and information literacy. Karuna et al. (2022) highlighted the moderate achievement of these competencies among students in underdeveloped areas, suggesting a need for targeted strategies to enhance these skills. Similarly, Wang et al. (2018) and Thoib (2021) emphasized the importance of critical thinking for student development and proposed teaching models to cultivate these skills effectively. In contemporary education, the role of digital learning media is crucial in supporting the development of 21st-century skills.

Various studies have shown that the use of information technology in learning media can change the learning paradigm to be more centered on the learner, which is key to developing 21st-century skills (Subagia et al., 2023).

It is indisputable that digital learning media play a crucial role in fostering the development of 21st-century skills, such as critical thinking, communication, collaboration, and creativity. The integration of technology in education has revolutionized conventional teaching methods, facilitating learner-focused approaches that cater to a wide range of learning preferences and abilities, thereby enhancing critical thinking and problem-solving skills (Ismail et al., 2018; Makarova & Makarova, 2018). In elementary science education, interactive digital media significantly improves students' understanding of scientific concepts and critical thinking,

which are essential for navigating modern complexities (Kartikasari et al., 2018). Additionally, digital media promote effective communication and teamwork among students and educators and vital skills for today's workforce (Piriyasurawong, 2019). The Internet's global connectivity allows students to engage in advanced global experiences and networks, further boosting their collaborative and communicative abilities (Cohen et al., 2016).

In addition, research by Dulun and Lane (2023) and Negoro et al. (2023) highlight the importance of critical thinking skills, digital literacy, information literacy, and mastery of information and communication technology as integral components of 21st-century learning. The development of digital learning media, such as e-modules, contextual websites, and Android-based applications, has also proven effective in enhancing 21st-century skills. Studies by Hadianto and Festiyed (2020) showed that physics e-modules based on Project Based Learning can provide multimedia content that supports the development of students' skills. Likewise, Purbasari et al. (2026) demonstrated that a socially collaborative e-learning model adapted to local community contexts can support more meaningful, technology-based learning. Therefore, the use of innovative and relevant digital learning media can significantly contribute to the development of 21st-century student skills.

The improvement of critical thinking skills among Indonesian students has become a major focus in the field of education. Various studies have been conducted to identify the factors that influence students' critical thinking ability. For instance, research by Perdani et al. (2023) and Amaliyah et al. (2023) highlights the impact of learning models and scientific approaches on students' critical thinking skills. Moreover, studied by Indrawati (2021) showed that the use of instructional media such as videos and guided inquiries can enhance students' critical thinking skills. Therefore, efforts to improve students' critical thinking skills should be based on the development of appropriate learning models and application of instructional media. In line with this, research by Gunawan et al. (2019) and Çoban and Göksu (2022) emphasized the importance of innovative learning models such as inquiry-based learning and the use of virtual laboratory media to improve students' critical thinking skills. Additionally, Har et al. (2019) highlighted the role of technology in science education and the development of digital-based learning media to enhance concept understanding. Therefore, the integration of technology and the development of innovative learning media can be a solution to improve students' critical thinking skills in Indonesia.

Early observations indicate that the dominant teaching method still consists primarily of one-way lectures by teachers, whereas the use of technology-based learning media is extremely limited. This suggests that the approach to learning does not fully utilize the potential of digital technology to make the learning process more interactive and engaging. The use of ICT-based learning media can increase student engagement and help them better understand the material. The limited use of ICT in this type of learning also indicates the need for innovation and for teachers to improve their capacity to integrate technology into the learning process to meet the needs of digital-age students.

Based on initial findings from field research and analysis of the utilization of ICT in the learning process, it appears that the integration of ICT is still not optimal. One form of optimization is the application of digital teaching materials through the Google Education platform. The platform has immense potential for utilization in the learning process. As is widely acknowledged, the effectiveness of Google's educational resources, notably Google Classroom, in fostering learning environments across diverse educational settings has been extensively documented. In Malaysia, Google Classroom has been adopted to improve linguistic accuracy among ESL learners, demonstrating its effectiveness as a practical application in English language education (Valverde-Macias & Llerena-Izquierdo, 2022). Similarly, in Nigeria, Google Classroom is lauded for its versatility and user-friendly interface, contributing to positive teaching and learning outcomes, and shaping the future of online education (Ajileye & Ajileye, 2023).

However, the adoption of Google Workspace for Education, which includes Google Classroom, is challenging. Educational leaders in Indonesia have identified issues such as mindset changes, technological barriers, and resource constraints, necessitating strategies such as enhanced training and collaboration among teachers to overcome these obstacles (Sismanto et al., 2024). These findings are echoed in the broader context of digital technology education, where fostering digital literacy and addressing the digital divide are crucial for leveraging technology in schools (Erwin & Mohammed, 2022). In summary, Google Education tools have significant potential to enhance learning in schools by providing accessible, collaborative, and personalized educational experiences.

Despite the growing body of research highlighting the potential of Google for Education to support engagement, collaboration, and critical thinking in learning (Setiahati et al., 2022; Azzahra et al., 2023; Alim et al., 2019; Yunus et al., 2020), important gaps remain. Existing studies have largely focused on the adoption, implementation challenges, and effectiveness of Google-based tools, particularly related to technological barriers, digital literacy, and resource constraints (Sismanto et al., 2024; Erwin & Mohammed, 2022). However, limited attention has been given to needs-driven evidence as a foundation for developing Google for Education–based digital teaching materials, especially through the integration of both students' and teachers' perspectives.

Moreover, little is known about what instructional design requirements can be derived from context-specific needs analysis to support junior secondary physics learning. Addressing this gap, the present study adopts a comprehensive mixed-methods needs analysis using questionnaires, interviews, and observations to generate evidence-based insights into the needs and characteristics of students and teachers. The study aims to identify these needs as a foundation for developing relevant and context-responsive digital teaching materials to support physics learning. Accordingly, this study addresses the following research questions: (1) What are students' and teachers' needs for Google for Education–based digital teaching materials in

junior secondary physics learning? (2) What instructional design requirements can be derived from the identified needs to support the development of such digital teaching materials?

LITERATURE REVIEW

Digital learning media and its effectiveness in improving student learning outcomes

Digital learning media have become an essential tool in physics education, providing students with interactive and engaging ways to learn and understand complex concepts. As technology becomes increasingly available in education, educators must incorporate digital learning media into their teaching strategies to improve student learning outcomes (Socrates & Mufit, 2022). Studies have shown that digital tools such as Adobe Flash, websites, e-modules, and interactive tools can improve students' comprehension and interest in physics by enabling dynamic interaction with the material (Arief et al., 2022; Downie et al., 2021). Problem-based learning using interactive learning media has also proven to be highly effective, significantly improving students' problem-solving skills, as evidenced by increased post-test scores and moderate N-Gain categories (Yuningtyas et al., 2023). Digital educational materials, have broadened the potential applications of novel information technologies in education, aiding in the understanding, reinforcement, synthesis, and evaluation of knowledge and abilities (Alenezi & Akour, 2023). Teachers should integrate formative assessments and student feedback opportunities to optimize the advantages of digital learning resources.

In addition, a thorough analysis based on research results is required for the use of digital learning media in the context of physical learning. As in the study by Scully et al. (2021) the utilization of technology as a learning medium is one of the innovative steps taken to improve the quality of education in Indonesia so that it can compete at the global level. Moreover, research by Long et al. (2022) shows that the application of physics learning media based on Augmented Reality is effective in improving students' understanding of physics concepts, demonstrating the potential of innovative approaches to improving the quality of learning. Similarly, research by Fesol and Salehuddin (2022) shows that the use of AR in game-based learning can make learning physics easier to understand and more enjoyable for students. Several studies have shown the role of digital learning media in physics learning, which has been empirically proven to facilitate student learning, with implications that students can achieve previously established competencies.

Google for Education and its benefits in learning

Google for Education is a comprehensive suite of tools and resources designed to enhance students’ and educators’ learning experiences by integrating technology into the classroom (Subagia et al., 2023). This platform includes services like Google Classroom, Google Meet, and a variety of collaborative tools through Google Workspace for Education, such as Google Docs, Sheets, and Slides (Kassim & Kassim, 2021). These tools facilitate a more interactive and engaging learning experience by enabling easy access to resources, efficient assignment management, and enhanced communication between students and educators.

Thus, the benefits of learning activities are substantial. Students can engage more interactively with their coursework through features such as real-time editing and commenting, which promotes active learning and immediate feedback (Gupta et al., 2020). Teachers can streamline administrative tasks, such as grading and attendance, freeing up more time for personalized instruction and support (Jeong, 2016). Additionally, accessibility of these tools ensures that all students, regardless of their background or learning style, have equal opportunities to participate and succeed. Technology integration also helps prepare students with the digital skills needed for the modern workforce, fostering critical thinking, creativity, and collaboration (Budiarto et al., 2024).

Research has highlighted several key benefits of Google for Education in learning activities. For instance, a study Shamim et al. (2024) indicated that Google Classroom significantly improves student engagement and organization, leading to better academic outcomes. The platform's integration with various Google tools enables real-time collaboration and feedback, which are crucial for developing critical thinking and teamwork skills. Furthermore, Google Meet supports remote and hybrid learning models, which has become increasingly important in the wake of the COVID-19 pandemic. According to a report by Mithhar et al. (2021), the use of video conferencing tools, such as Google Meet, has positively impacted student motivation and participation in virtual classrooms. Another advantage was the promotion of digital literacy. By regularly using Google Workspace for Education, students have become adept at utilizing cloud-based technologies, which are essential skills in today's digital world. By integrating these tools, teachers can create dynamic and interactive learning environments that improve academic performance and prepare students for future challenges and opportunities. Thus, Google for Education is instrumental in equipping students with essential 21st-century skills.

METHOD

Research Design

A mixed-methods approach was chosen as the research method. One of the models adopted was the explanatory model (McKim, 2017). In this model, data are collected in both qualitative and quantitative forms (Shannon-Baker, 2016). This explanatory model allows researchers to combine and compare data from both types, thereby providing a more comprehensive and in-depth understanding of the phenomena being studied. This approach is particularly useful for explaining quantitative findings through qualitative data, offering a broader context and insight into the research results.

Figure 1.

Sequential Explanatory Design

Research Subject

In this study, quantitative data collection will involve 60 students from the private junior high school in Indonesia, located in Surakarta City as subjects of the research. The school was chosen purposively because it had adequate technological facilities, demonstrated readiness for integrating digital learning, and provided an appropriate context for examining the need for Google for Education–based digital teaching materials. In addition, the school's willingness to support the study and the availability of teachers and students as participants made it a suitable setting for conducting this needs analysis.

The data collection technique employed was a needs analysis questionnaire adapted from previous research Alqahtani (2019) and Lisana and Suciadi (2021), where the instruments and multiple-choice questions from the aforementioned study were customized to meet the specific needs of this research. Qualitative data collection was conducted in September 2023 with a sample size of two physics teachers consisting of two individuals. Purposive sampling was used, which considered the research objectives (Sugiyono, 2018). A two-person sample was deemed sufficient because it was selected using purposive sampling, which ensured the relevance and representativeness of the sample. These teachers possessed specialized expertise and in-depth knowledge relevant to the research topic, enabling the collection of high-quality and in-depth data.

Data Collection Instruments and Techniques

The data collection method employed in this study utilizes interviews and observations with the aid of instruments such as an interview guide and observation sheet (Sukmadinata, 2012), adapted from similar studies conducted by Habibi et al (Habibi et al., 2022) and Nugroho and Hermasari (Nugroho & Hermasari, 2023). Qualitative data were utilized to enhance and supplement quantitative data. Subsequently, the instrument used to collect data in this mixed-method study is shown in these table.

The interview protocol and classroom observation sheet used in this study are provided in Appendix A and Appendix B for transparency and replicability. Before data collection, the research instruments were subjected to content validation through expert judgment by an Advisory Lecturer with a doctoral background in education to ensure the relevance, clarity, and appropriateness of each instrument item (Perdana et al., 2021). The questionnaire instrument was further reviewed for internal consistency to support its reliability for data collection. In addition, the trustworthiness of qualitative data was strengthened through methodological triangulation by comparing findings derived from questionnaires, interviews, and classroom observations. These procedures were undertaken to enhance the validity and reliability of the study findings.

Table 1.

Instrument Grid of Questionnaire for Need Analysis

Aspect	Number of Questions/Statements
Student Enjoyment and Interest	2
Availability and Use of Learning Materials	4
Teaching Methods and Learning Media	5
Student Understanding and Ability	3
Student Opinions and Needs	3
Learning Facilities	1
Total	18

adapt from Habibi et al. (2022) and (Nugroho & Hermasari, 2023)

Table 2.

Interview Grid with Teachers

Aspect	Number of Questions
Curriculum Implementation and Development	3
Preparation and Teaching Methods	2
Learning Material Development	2
Use of Teaching Materials and Media	5
Learning Implementation	4
Learning Evaluation	3
Classroom Management	2
Learning Facilities	1
Total	23

adapt from Habibi et al. (2022) and (Nugroho & Hermasari, 2023)

Table 3.

Learning Process Observation Sheet Grid

Aspect	Number of Indicators
Giving Motivation	1
Mastery of Teaching Materials	1
Material Integration with Problem Based Learning Approach	1
Use of Learning Media	2
Class management	1
Giving Feedback	2
Total	8

adapt from Habibi et al. (2022) and (Nugroho & Hermasari, 2023)

Data Analysis

The collected data are analyzed using different approaches based on the type of data. For quantitative data, an analysis will be performed to describe the percentage of the results obtained (Lestari et al., 2021). This descriptive approach allows researchers to provide a general overview of the trends and patterns present in the quantitative data. On the other hand, for qualitative data, the analysis will be conducted using Bogdan and Biklen's model (Habibi et al., 2022). The analysis process involved several crucial steps, such as data reduction, sub-theme identification, and searching for relationships between sub-themes. Data reduction was performed by filtering out relevant information from the raw data to eliminate unnecessary information. Following this, the researcher will identify sub-themes that emerge from the reduced data, followed by an analysis of the relationships between these sub-themes to gain a deeper understanding of the phenomenon being studied (Cresswell et al., 2003). By using both these analytical approaches, researchers can present a comprehensive and in-depth study from both quantitative and qualitative perspectives.

Ethical Considerations

Ethical considerations were addressed throughout the study to ensure the protection of participants. Prior to data collection, permission to conduct the study was obtained from the school administration, and participation was voluntary for both students and teachers. Informed consent was obtained from participants, and they were informed of the purpose of the study, the confidentiality of their responses, and their right to withdraw at any stage without consequence. To protect participant privacy, the identity of the school and all participants was anonymized in reporting the findings. In addition, the collected data were used solely for research purposes and handled confidentially throughout the study.

RESULT

Implementation of Physics Learning in Prive Junior High School

One of the methods used in the needs analysis stage was the interview method. Interviews were conducted verbally with physics teachers in a junior high school. The results of these interviews will serve as a benchmark for student and teacher needs for innovative Google-based educational materials in a digital format as well as other factors that may affect them. The following is a summary of the interview results with physics teachers at a private junior high school in Indonesia:

In recent years, teachers have observed that students tend to be more passive in their participation in the learning process. However, teachers can address low student activity levels by providing quizzes or questions related to the subject matter at the end of the learning process. During the learning process, teachers tend to use one-way lecturing methods because, according to the teachers, physics lessons should always be interspersed with assignments so that students do not forget how to do so and understand how to apply formulas, not just memorize questions. Thus far, the cognitive performance of students in answering practice questions and assignments can be categorized as fairly good, with a balance between students

who can answer practice questions correctly and those who are still unable to do so. From the interviews, it was identified that teachers use media for learning in the form of textbooks, PowerPoint slide presentations, and the internet. In addition, the teaching materials used by teachers are still not based on ICT, but only in the form of printed materials for teachers' needs to deliver the material to students. In several additional questions given by the interviewer, teachers generally agreed that critical thinking skills are one of the most important skills or abilities that students should possess. In addition, teachers also agree that to improve students' critical thinking skills, more than just instructional methods based on lectures or assignments are needed, and tools are needed to deliver subject matter materials that can provide a more optimal stimulus to improve students' critical thinking skills.

According to the physics teacher who served as a resource in this study, they fundamentally agreed with the innovation of digital teaching materials to facilitate students' understanding of course materials. Problem-based learning approaches is one approach that need to be applied in the learning process in the hope of providing optimal stimuli to enhance critical thinking skills in students. One attempt to achieve this is to implement and actualize innovation in the form of integration between Google for Education-based digital teaching materials and problem-based learning approaches to solve issues in the form of critical thinking skills in students. The physics teacher agrees with the product development plan, which is digital teaching material based on Google for Education in a format that is integrated with problem-based learning approaches in physics education to enhance critical thinking skills.

To facilitate a more systematic interpretation of the interview results, a coding process was conducted that combined various findings into several main categories. Table 4 includes categories, direct quotes from the teacher, and codes that reflect the identified main theme or topic.

Interviews with subject teachers strengthened the results of this session. In addition, the technique of data collection through observation of learning was applied in this session. The observations lasted for four meetings. The descriptive results of the observations showed several things that became the focus of the researcher, namely, the limited use of learning media, which only relied on textbooks and the Internet. This is unfortunate because digital technology such as smartphones, laptops, and computers could have been optimized to support the learning process.

The results also showed some important aspects related to the use of learning media in the classroom. During this session, there was no special observation that showed the teacher's efforts to motivate students. The teacher delivered the physics subject matter using learning media in the form of books, print materials, and the Internet. So far, teachers have not encountered any problems in delivering the material, except during the COVID-19 pandemic. However, the teaching method is still dominated by lectures, and the teacher has not yet used electronic modules for learning, particularly at the beginning of the lesson. Although digital learning media were used, the media were obtained from the Internet without making it

themselves. The school has some facilities that can be optimized for learning, such as computer laboratories and practical electronics laboratories. Students were allowed to use smartphones during learning with the permission of the subject teacher.

Table 4.

Interpretation of Interview Results with Teachers

Category	Quote	Code
Participation and Teaching Methods	*"Teachers have observed that in recent years, students tend to be more passive in participating in the learning process."* *"Teachers tend to use one-way lecture methods delivered by the teacher and assignments."*	Low Student Participation and Lecture Method
Students' Cognitive Performance	*"Students' cognitive performance in answering practice questions and assignments can be categorized as adequate."*	Students' Cognitive Performance
Media and ICT Use	*"Teachers use learning media in the form of textbooks, PowerPoint presentation slides, and the internet."* *"The teaching materials used by the teachers are still not ICT-based."*	Conventional Learning Media and Lack of ICT Use
Critical Thinking Skills and Innovation of Teaching Materials	*"Critical thinking ability is one of the most important skills that students must possess."* *"The physics teachers who were the resource persons in this study essentially agreed with the innovation of digital teaching materials."*	The Importance of Critical Thinking and Support for Digital Teaching Material Innovation
Learning Approaches and Integration of Digital Teaching Materials	*"The use of a problem-based learning approach is one of the approaches that needs to be implemented."* *"Implementing and realizing innovation in the form of integration between digital teaching materials based on Google for Education."*	Problem-Based Approach and Integration of Digital Teaching Materials
Innovation Objectives	*"For solutions in the form of students' critical reasoning abilities."*	Goals of Critical Thinking Innovation

The lack of optimal use of digital technology is expected to be addressed by the development of digital learning products. Thus, it is hoped that collaboration between technology and student-focused learning approaches can stimulate students' critical thinking skills. Therefore, innovative and modern media learning and the ability to adopt the latest approaches are needed to create alternative learning media that can facilitate students' achievement of the required competencies.

Analysis of Existing Teaching Materials Used in Physics Learning

During classroom instruction, educators often face challenges in managing both students and the learning environment, which may hinder the achievement of instructional goals. Effective classroom management requires teachers to regulate student behavior and optimize the physical environment by organizing and utilizing available learning facilities. Student responses indicated that teachers generally provided sufficient time, appropriate feedback, and clear content delivery. However, most students reported that the learning resources and references remained inadequate and outdated. Many also agreed that independent tasks supported by e-learning platforms equipped with chat, forums, and streaming features would better facilitate interaction with peers and teachers. The evaluation of teaching materials at a private junior high school in Indonesia therefore focused on identifying strengths and weaknesses of currently used resources, aligned with Intended Learning Outcomes (ILOs) and Basic Competencies (BCs), to determine relevant content required in physics instruction. The information that was successfully collected from the distribution of questionnaires regarding books used by students regarding physics lessons is presented in table 5.

Table 5.

Results of Student Questionnaire Regarding the Teaching Materials Used

No	Item	Yes (n)	Yes (%)	No (n)	No (%)
1	Alignment with teacher's book	25	83.3%	5	16.7%
2	Relevant to students' needs	9	30.0%	21	70.0%
3	Suitable to students' characteristics	3	10.0%	27	90.0%
4	Easy to read and understand	13	43.3%	17	56.7%
7	Information clarity	26	86.7%	4	13.3%
8	Appropriate language use	30	100%	0	0%
9	Content presentation clarity	18	60.0%	12	40.0%
10	Image clarity	9	30.0%	21	70.0%
11	Attractive design and appearance	14	46.7%	16	53.3%
12	Ability to improve critical thinking	6	20.0%	24	80.0%

The descriptive findings indicate that although most students (83.3%) acknowledged alignment between student and teacher textbooks, only 30.0% perceived the materials as suitable for their learning needs, and merely 10.0% considered them compatible with students' characteristics. While linguistic aspects are highly satisfactory (100% reported correct language use; 86.7% reported clear information), pedagogical effectiveness remains limited, as only 43.3% stated that the books were easy to understand and 60.0% perceived content presentation as clear.

Visual and design quality also emerged as weaknesses, with only 30.0% perceiving image clarity and 46.7% finding the design appealing. Critically, only 20.0% of students believed the textbooks enhanced critical thinking, whereas 80.0% reported otherwise. These findings suggest

that although structurally and linguistically adequate, the current textbooks are pedagogically insufficient, visually less engaging, and limited in supporting higher-order thinking. Therefore, more innovative, interactive, and digitally oriented learning materials are urgently required to better support physics learning and 21st-century skills development. After identifying the use of the current instructional materials, the following section presents the results of identifying students' needs for the development of Google Education-based digital learning materials to support physics learning at private junior high school in Indonesia. The questionnaire was distributed to several classes, with 60 students as respondents.

The distribution of this questionnaire is important because in the development of educational digital materials based on Google Education, it is crucial to consider the level of student development, both cognitively and affectively, and to address the problems faced by students to achieve certain competencies. By developing materials that consider the characteristics and needs of students according to their field of study, it is hoped that the provision of stimuli for critical thinking skills can be optimized, resulting in higher critical thinking abilities for students. The results of the questionnaire distributed to the students are presented in Table 6.

Table 6.

Analysis of Student Needs for Digital Learning Materials Based on Google Education

No	Item	Yes (n)	Yes (%)	No (n)	No (%)
1	Physics learning has been enjoyable	43	72.11%	17	27.89%
2	Physics is one of students' favorite subjects	39	64.18%	21	35.82%
3	Availability of textbooks is sufficient (1 book per student)	54	90.30%	6	9.70%
4	Current textbooks improve critical thinking skills	7	11.36%	53	88.63%
5	Need for Google Education–based digital materials	58	96.50%	2	3.50%
6	Agree to apply Google Education–based materials in Physics learning	55	90.90%	5	9.10%

According to Table 6, it can be determined that physics instruction has been considered enjoyable by a significant majority of students, with 72% of respondents answering "yes" and 27.89% answering "no." Additionally, 64.18% of students stated that they enjoyed physical instruction. However, some students still find it difficult to understand, even though the school provides textbooks for each student. A total of 88.63% of the students acknowledged that the provided books did not enhance their critical thinking skills, while only 11.36% felt helped.

The urgency for media innovation is strongly reflected in students' expressed needs. An overwhelming 96.5% of students reported the need for Google Education–based digital materials, and 90.9% agreed on their application in physics learning. These figures demonstrate not only acceptance but also readiness and enthusiasm toward technology-integrated learning

environments. The high level of student agreement also indicates strong potential for successful adoption, feasibility of implementation, and positive expectation toward enhanced interactivity, accessibility, and learning engagement.

Collectively, these results suggest that although students enjoy physics learning, conventional textbooks are insufficient to support competency achievement based digital materials are highly relevant and urgently needed to enhance learning quality, foster student engagement, and support the development of essential 21st-century skills.

DISCUSSION

Drawing on observations made during several class activities while the physics lesson was in progress, as well as interviews with two physics teachers, it was possible to identify the overall findings of the interviews. This showed that during classroom activities, the teachers still dominated the delivery of the material because they used a lecture method when presenting one-directional learning materials, although some lessons were also interspersed with quizzes and assignments. The interview findings were further reinforced by observations made in several other classes, although the learning process was already good, with the teacher providing motivation at the beginning of each session to keep the students motivated. However, from the observations, it was observed that the teachers had not yet been able to optimize the use of instructional media and facilities available or owned by the school, considering that printed books were still used by physics teachers during the learning process without accompanying teaching aids.

Based on the two sources of data collected, it is evident that ICT-based teaching materials in Google for Education have not been developed, and the use of teaching approaches such as lecture methods still tends to be one-way. In the current era of technological and informational advancements, the presence of ICT-based learning resources and materials has become a necessity for educational institutions (Alqahtani, 2019). Furthermore, Google is not only utilized as a search engine for information, but through platforms such as Google for Education, it can facilitate learning more optimally with various formats and types of applications that can be used during the learning process, such as Google Classroom, Google Slides, Google Sites, and Google Meet (Setiahati et al., 2022; Gupta et al., 2020). In line with this, the integration of ICT in learning activities will undoubtedly have a positive impact on enhancing students' skills, as evidenced by research conducted by Hasanah et al. (2021) which concludes that the utilization of learning applications such as Google Meet and Google Classroom-based LMS can be one of the facilities used to enhance 21st-century students' skills.

The utilization of Google platforms for Education, such as Google Classroom, has significantly contributed positively to students' learning outcomes. Research conducted by Abdullah et al. (2022) showed that Google Classroom enhances students' learning outcomes, interest, motivation, and fosters a creative mindset. Similarly, Alim et al. (2019) highlighted the effectiveness of Google Classroom in improving students' skills, competencies, disciplines, and

self-directed learning through digital instructional materials. These findings align with research conducted by Zakaria (2023), which showed that students have higher levels of motivation when Google Classroom is integrated into their learning environment. Collectively, these studies demonstrate that leveraging Google for Education tools, in the form of digital teaching materials, positively influences students' learning experiences, engagement, motivation, and academic performance.

It is evident that Google, through its various applications, can positively influence the learning process; however, its utilization among students has not yet reached an optimal level. This conclusion is supported by survey results distributed to students, which indicate a strong desire for digital learning materials based on Google Education as an alternative to adapt to advancements in information technology and 21st-century learning. Nearly all students, specifically 96.5% of the respondents, agreed with this need. Furthermore, 90.9% of students showed enthusiasm for the implementation of Google Education-based digital learning materials in their studies. The development of a physics learning module on measurement, supported by Google Sites, exemplifies how case-based learning can be effectively integrated into the curriculum to enhance students' understanding of complex concepts (Korobova et al., 2019). Additionally, Google services facilitate the creation of a virtual educational environment tailored to individual student needs, promoting the use of digital technology in physics education and encouraging student engagement in learning activities (Hofer et al., 2018). Overall, these advancements illustrate how Google for Education and related digital technologies are transforming physics instruction, making it accessible, engaging, and effective.

Apart from being vital for teachers to provide ease for students in achieving learning objectives, it is also important to remember that teachers must be able to facilitate students in mastering the various skills required in the 21st century. According to the current curriculum implemented and carried out in some schools in Indonesia, one of the skills that should be given to students is the ability to think critically (Yamin et al., 2021). This competence or skill is certainly in line with what is required of students in the 21st century to be competitive in the future (Karuna et al., 2022).

The achievement of learning goals and 21st-century supporting skills can essentially be attained through a series of learning processes that are truly integrated in the optimal utilization of ICT. Therefore, the combination of innovative and modern teaching materials can be an alternative choice of learning resources that is fundamental in creating such a dynamic learning atmosphere (Djamas et al., 2018). The integration of ICT into the learning process can be realized by presenting digital teaching materials based on Google for Education, which have not been previously developed in schools. The implementation of innovation through the integration of ICT into the learning process also aims to prepare human resources that can compete in the global era and be literate in technology (Sutiani et al., 2021). Thus, in addition to achieving learning goals conceptually, students will be equipped with important skills in the 21st century.

To optimize the development and use of digital learning materials, a comprehensive needs analysis is essential as a foundation for ensuring alignment between instructional design, learner characteristics, and classroom demands. Previous studies have emphasized that needs analysis contributes not only to improving students' understanding of subject matter and engagement, but also to guiding the development of learning materials that are pedagogically relevant and context responsive (Budiarto et al., 2021; Rejekiningsih et al., 2023). This is particularly important because traditional teaching materials often fail to foster critical thinking due to their tendency to emphasize content transmission, provide limited opportunities for inquiry and authentic problem solving, and lack explicit scaffolding for higher-order thinking processes. Conventional teaching materials often show limitations in fostering students' critical thinking because they tend to emphasize content transmission and factual mastery rather than inquiry, reasoning, and reflective problem solving (Djamas et al., 2018). In many cases, such materials are structured around linear explanations and routine exercises that prioritize memorization over opportunities for students to analyze evidence, evaluate alternatives, or construct arguments. They also frequently provide limited support for authentic problem-based tasks and lack explicit scaffolding that guides learners through higher-order thinking processes, such as questioning, monitoring understanding, and reflecting on solutions.

In contrast, studies have shown that well-designed digital learning media can support more interactive, problem-oriented, and feedback-rich learning environments that strengthen students' critical thinking and engagement (Yuningtyas et al., 2023; Alenezi & Akour, 2023; Budiarto et al., 2024). Accordingly, conducting needs analysis through field analysis, curriculum review, technology selection, and ongoing evaluation becomes crucial not only to identify students' and teachers' needs, but also to generate evidence-based design requirements for digital teaching materials that meaningfully address the weaknesses of conventional resources and support more effective physics learning.

Research indicates that digital teaching materials based on Google for Education have not been developed and utilized by teachers, especially for physics in junior high school. Based on the analysis of various perspectives and the need to balance technological advancements with the acquisition of 21st-century competencies, it has been identified that innovative digital teaching materials are necessary to support the teaching of Physics in Christian Junior High School. Therefore, digital teaching materials based on Google for Education have great potential for application in physics learning activities at the junior high school level. The integration of this technology is anticipated to assist students in developing critical thinking skills that are essential. Learning that utilizes ICT tools, such as Google Classroom and other applications within the Google for Education ecosystem, not only facilitates access to interactive and engaging learning materials, but also encourages students to actively participate in the learning process. As a result, students can gain a deeper understanding of the analytical skills necessary for studying physics. Furthermore, the use of this technology enables teachers to provide quicker and more effective feedback as well as foster collaboration among students, all of which contribute to

enhancing critical thinking abilities and improving student learning outcomes. Although this research has successfully demonstrated the great potential of using digital teaching materials based on Google for Education in teaching physics in junior high school, there are some limitations to this research. This study is limited to observations and interviews with two teachers; therefore, it does not include a broader perspective.

CONCLUSION

This study has shown that research can effectively address the research problem and align with the research purpose, which is to identify opportunities for innovative digital teaching materials using Google for Education as a learning tool for physics in junior high school. Findings from the questionnaire, interviews, and descriptive observations revealed that the current learning materials lack innovation. Many students express a desire for more innovative digital learning resources, and Google for Education-based materials shows promise in meeting this demand. These results suggest that needs analysis should not be viewed merely as a preliminary stage, but as a basis for deriving instructional design implications, particularly for developing digital teaching materials that integrate problem-based learning, interactivity, and flexible access through the Google for Education ecosystem. Thus, this study provides a foundation for educators and researchers to design context-responsive digital learning materials that support more meaningful and innovative physics instruction. Future research endeavors can build on this study to develop innovative learning strategies using Google as a platform to enhance both theoretical and practical learning activities. Additionally, teachers can leverage the findings of this study to enhance their proficiency in creating digital teaching materials, considering that students are already adept at using technology-based devices.

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APPENDIX

Appendix A. Interview Protocols for Teachers

This interview protocol was designed to explore teachers' perceptions regarding the need for Google for Education–based digital teaching materials in physics learning.

No	Aspect	Guiding Questions
1	Curriculum Implementation and Development	How is the current physics curriculum implemented in classroom practice?
2	Curriculum Implementation and Development	What challenges do you face in aligning instruction with curriculum objectives?
3	Curriculum Implementation and Development	To what extent does the current curriculum support the integration of digital teaching materials?
4	Preparation and Teaching Methods	How do you usually prepare for physics instruction?
5	Preparation and Teaching Methods	What teaching methods are commonly used to promote students' critical thinking?
6	Learning Material Development	How are teaching materials currently selected or developed?
7	Learning Material Development	What limitations exist in the current teaching materials used in physics learning?
8	Use of Teaching Materials and Media	What types of teaching materials are commonly used in your instruction?

9	Use of Teaching Materials and Media	How often do you use digital media to support learning?
10	Use of Teaching Materials and Media	What challenges do you face when integrating digital tools into physics learning?
11	Use of Teaching Materials and Media	How could Google for Education support classroom learning?
12	Use of Teaching Materials and Media	What features would be important in Google for Education–based materials?
13	Learning Implementation	How is student participation typically facilitated during physics lessons?
14	Learning Implementation	How are problem-solving or inquiry activities implemented?
15	Learning Implementation	What challenges arise in maintaining student engagement?
16	Learning Implementation	How could digital teaching materials improve classroom interaction?
17	Learning Evaluation	How do you currently assess students' learning outcomes?
18	Learning Evaluation	How is critical thinking assessed in your instruction?
19	Learning Evaluation	How could digital teaching materials support assessment processes?
20	Classroom Management	What classroom management challenges occur during physics learning?
21	Classroom Management	How might digital learning materials help address these challenges?
22	Learning Facilities	Are existing school facilities sufficient to support digital learning implementation?
23	Learning Facilities	What additional facilities or support are needed for Google for Education integration?

Appendix B. Learning Process Observation Sheet

This observation sheet was used to document classroom learning practices and identify instructional conditions relevant to the development of digital teaching materials.

No	**Observed Indicator**	**Observation Focus**	**Rating Scale***
1	Giving Motivation	Teacher provides motivation and stimulates student interest at the beginning of learning	1–4
2	Mastery of Teaching Materials	Teacher demonstrates accurate and sufficient mastery of physics content	1–4
3	Integration with Problem-Based Learning	Teacher connects material with problem-solving or contextual inquiry activities	1–4
4	Use of Learning Media	Teacher uses appropriate instructional media	1–4
5	Use of Learning Media	Students actively engage with learning media used	1–4

6	Class Management	Teacher manages learning activities and classroom interaction effectively	1–4
7	Giving Feedback	Teacher provides feedback during learning activities	1–4
8	Giving Feedback	Teacher provides feedback on students' responses or task performance	1–4

Rating Scale:

1 = Poor

2 = Fair

3 = Good

4 = Very Good

Appendix C. Student Needs Analysis Questionnaire

Response Format:

Respondents selected one of two options for each statement:

✓ Yes

✓ No

Part A. Questionnaire on Existing Physics Teaching Materials

No	Statement	Response
1	The books used by students are the same as those used by the teacher.	Yes / No
2	The books used are relevant to students' learning needs.	Yes / No
3	The books used are suitable to students' characteristics.	Yes / No
4	The books are easy to read and understand.	Yes / No
5	The references provided in the books are sufficient.	Yes / No
6	The learning resources provided are up to date and relevant.	Yes / No
7	The information presented in the books is clear.	Yes / No
8	The language used in the books is appropriate and understandable.	Yes / No
9	The presentation of the content is clear.	Yes / No
10	The images in the books are clear and supportive.	Yes / No
11	The design and appearance of the books are attractive.	Yes / No
12	The books help improve students' critical thinking skills.	Yes / No

Part B. Questionnaire on Students' Needs for Google for Education–Based Digital Teaching Materials

No	Statement	Response
1	Physics learning has been enjoyable so far.	Yes / No
2	Physics is one of my favorite subjects.	Yes / No
3	The availability of textbooks is sufficient (one student, one book).	Yes / No
4	The textbooks currently used help improve my critical thinking skills.	Yes / No
5	I need digital teaching materials based on Google for Education.	Yes / No
6	I agree that Google for Education–based digital teaching materials should be applied in physics learning.	Yes / No