

Research Article

Cite this article: Astuti, I. A. D., Wibawa, B., & Japar, M. (2025). Case-Based Optical Physics Teaching with Mobile Microlearning Integration: Determining Student Readiness Levels. *Educational Process: International Journal*, 17, e2025408.

<https://doi.org/10.22521/edupij.2025.17.408>

Received June 13, 2025

Accepted August 15, 2025

Published Online August 24, 2025

Keywords: Optics physics, Mobile microlearning, Case-based learning, Student readiness to learn

Author for correspondence:

Irnin Agustina Dwi Astuti

✉ irnin_9902922005@mhs.unj.ac.id

✉ Universitas Negeri Jakarta, Indonesia

**OPEN ACCESS**

© The Author(s), 2025. This is an Open Access article, distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted re-use, distribution, and reproduction, provided the original article is properly cited.

Case-Based Optical Physics Teaching with Mobile Microlearning Integration: Determining Student Readiness Levels

Irnin Agustina Dwi Astuti , Basuki Wibawa , Muhammad Japar

Abstract

Background/purpose. The students have difficulty understanding abstract concepts that are sometimes difficult to visualize in optics and physics, so learning innovations are needed to overcome these problems. Case-Based Learning (CBL) optical physics learning integrated with mobile microlearning offers an innovative approach to improving the quality of learning. This study explores students' readiness to implement Case-Based Learning (CBL) optical physics learning integrated with mobile microlearning.

Methods. The research method used was quantitative analysis by collecting data through questionnaires that measured several indicators of student readiness, including skills in using computers/smartphones, understanding of CBL learning integrated with mobile microlearning, readiness to receive material through mobile microlearning, and a positive attitude towards information and communication technology (ICT).

Results. The results showed that the students were well prepared to carry out CBL-based optical physics learning integrated with mobile microlearning, as seen in the average scale score of 4.25. All readiness indicators are in the ready category, indicating that students understand and can use technology well and show a positive attitude toward applying ICT in learning.

Conclusion. These findings imply that students are ready to adopt this innovative learning approach in learning optical physics, which can increase the effectiveness and flexibility of the learning process.

1. Introduction

Physics learning requires students to master not only the basic concepts of physics but also the integrated mathematical concepts applied to these physical concepts. This integration is crucial as it helps students understand the relationship between theory and practical observation in real-world phenomena (Dewi & Primayana, 2019; Ince, 2018). Students who have a strong grasp of theoretical concepts in physics typically possess solid mathematical skills, enabling them to perform complex mathematical calculations to explain physical phenomena (Eichenlaub & Redish, 2019; Hazari et al., 2010). Additionally, students must be able to integrate various physics concepts and apply them in diverse situations, allowing them to see connections between different aspects of physics and use their knowledge holistically to solve real-world problems (Banda & Nzabahimana, 2021; Hu & Rebello, 2013; Ng & Van Nguyen, 2006).

Optics, as a branch of physics, presents its own set of challenges that are more complex than those found in other areas of physics. The concepts in optics are often abstract and difficult to visualize directly, leading many students to misunderstand the material (Hu & Rebello, 2013; Zhenhua & Xiaolong, 2020). Phenomena such as refraction, reflection, and interference require a deep understanding of complex physical principles that are not always directly observable in daily life. Furthermore, optics also integrates fairly complex mathematical concepts, which can be a barrier for students who have not yet mastered basic mathematics. While optical phenomena such as the use of eyeglasses, cameras, or rainbows are commonly encountered in everyday life, a deep and conceptual understanding is still necessary to explain these phenomena scientifically.

At Universitas Indraprasta PGRI, the teaching of optical physics still relies heavily on the monotonous lecture method, causing students to feel bored and less motivated. The learning media used are limited to PowerPoint presentations, which only feature static text and images, while the material in optical physics requires dynamic visualizations to explain complex and abstract concepts. Moreover, the lack of textbooks or learning modules developed by lecturers is a major issue, as students rely solely on PowerPoint materials that do not provide a comprehensive understanding of optical physics concepts. This limitation results in students' understanding of optical physics being suboptimal and often superficial.

To address these challenges, more innovative learning approaches are needed. One such approach is Case-Based Learning (CBL), which utilizes real-world case studies to help students understand theoretical concepts and principles in the context of real-life situations (Marno et al., 2023; Malau-Aduli et al., 2013). In CBL, students are presented with complex cases that require in-depth analysis, discussion, and problem-solving. The aim of CBL is to connect theory with practice, while also developing students' problem-solving, critical thinking, and collaboration skills (Ali et al., 2024; Astuti et al., 2024). This approach is especially suitable for teaching optics, as it allows students to relate theoretical concepts to real-world phenomena they encounter in everyday life (Alani, 2020; Lee & Park, 2016). Through case analysis, students are trained to think critically and hone problem-solving skills essential for learning optical physics.

Along with the advancement of digital technology, microlearning has become a highly relevant alternative for teaching optical physics. Microlearning is a teaching strategy that delivers content in short segments, focusing on a specific topic or concept (Pham et al., 2024; Salleh et al., 2022; Zulueta & Panoy, 2022). By leveraging mobile technology, microlearning provides students with the flexibility to access learning materials anytime and anywhere, making it more efficient and adaptable to students' schedules (Astuti et al., 2025; Ismoyo et al., 2024; Hug, 2007). By using microlearning, complex optical physics material can be presented concisely and effectively, enabling students to learn more flexibly and independently.

This study aims to evaluate students' readiness for participating in optical physics learning based on Case-Based Learning (CBL) integrated with mobile microlearning. The research will assess how well students can utilize mobile technology to explore optical physics materials through case-based approaches relevant to their everyday lives. Through the integration of CBL and microlearning, it is expected that the challenges in optical physics learning will be addressed, significantly enhancing students' conceptual understanding.

2. Methodology

This study uses a descriptive research design to assess the readiness of Physics Education students at Universitas Indraprasta PGRI for the implementation of Case-Based Learning (CBL) integrated with mobile microlearning in optical physics education. The research aims to understand students' preparedness to engage with this innovative learning approach, which combines case-based methods with mobile technology. This hybrid model seeks to enhance students' conceptual understanding, foster critical thinking, problem-solving skills, and promote self-directed learning through the flexibility of mobile technology, allowing students to learn anytime and anywhere.

The study examines students' technological competence, their understanding of CBL, and their readiness to adopt mobile microlearning tools. By exploring their attitudes toward Information and Communication Technology (ICT), the research assesses students' motivation, prior experience, and willingness to embrace new technology in learning optical physics. The findings aim to provide insights for improving student support, technology infrastructure, and curriculum design, and contribute to the growing field of technology-enhanced science education.

2.1. Participant

This study employed a descriptive research design with the primary aim of obtaining a comprehensive overview of the readiness of Physics Education students at Universitas Indraprasta PGRI for the implementation of Case-Based Learning (CBL) in optical physics integrated with mobile microlearning. The data collection method was a survey conducted by distributing an online readiness questionnaire to participating students. The population of this study consisted of all active Physics Education students enrolled in the 2023/2024 academic year, totaling 78 individuals across different semester levels.

The sample of 32 students was selected using a purposive sampling method, targeting participants who had already completed or were currently taking the Optical Physics course, ensuring that they had sufficient exposure to the subject matter. The sample size was determined based on Slovin's formula with a 5% margin of error, which suggested a minimum of 28 participants. To strengthen data reliability, the final number was increased to 32. This sampling approach was intended to ensure that the respondents could represent the diversity of the population in terms of academic level, prior learning experience, and technology usage patterns. The online questionnaire was administered using Google Forms, with unique access links distributed individually to prevent multiple submissions by the same respondent and to maintain data validity.

2.2. Instrument

The primary data collection instrument in this study was a structured questionnaire specifically developed to assess students' readiness for the implementation of Case-Based Learning (CBL) in optical physics integrated with mobile microlearning. The questionnaire comprised 23 closed-ended statement items measured on a five-point Likert scale ranging from "strongly disagree" to "strongly agree." Item development was guided by an extensive review of literature on technology-enhanced science education, mobile microlearning adoption, and CBL pedagogical frameworks, ensuring theoretical alignment with the research objectives. The initial draft of the questionnaire was designed to cover both technical and pedagogical aspects of readiness comprehensively.

The instrument measured four core readiness indicators: (1) smartphone usage skills, which examined students' ability to operate smartphones efficiently for academic purposes; (2) understanding of CBL integrated with mobile microlearning, which evaluated their conceptual awareness, prior experiences, and ability to differentiate it from conventional learning approaches; (3) readiness to receive learning materials via mobile microlearning, which assessed their technological access, online learning preparedness, and proactive study habits; and (4) attitudes toward Information and Communication Technology (ICT), which captured their motivation, confidence, and perceived benefits of technology for learning. A detailed mapping of the 23 items to each indicator is provided in Table 1, offering clarity on how each construct was operationalized.

Table 1. Students' Readiness Questionnaire for Learning Optical Physics is Based on CBL Integrated with Mobile Microlearning

Indicator	Item statement
Smartphone usage skills	1. I possess the ability to operate my smartphone proficiently.
	2. I am capable of troubleshooting smartphone-related issues, including both hardware and software aspects.
	3. I routinely employ my smartphone as a tool to support academic activities.
	4. I consistently integrate smartphone usage into my daily routines.
Understanding of CBL learning integrated with mobile microlearning	5. I know the concept of Case-Based Learning (CBL) is applied in mobile microlearning.
	6. I am used to encountering optical physics cases and can solve them well.
	7. I comprehend the advantages of utilizing mobile learning in the context of optical physics education.
	8. I can differentiate between conventional learning methods and CBL-based mobile microlearning.
	9. I am proficient in accessing and utilizing internet-based services.
	10. I regularly engage in online communication or discussions with classmates via platforms such as WhatsApp, Line, and others.
Readiness receiving material learning via Mobile microlearning	11. I am adept at utilizing online learning features, including downloading materials, participating in online discussions, submitting assignments, completing quizzes, taking online exams, and posing questions digitally.
	12. I own a personal smartphone suitable for academic use.
	13. I have reliable internet access that enables me to participate in online learning activities.
	14. I have an active account for accessing online learning platforms.

	15. I take the initiative to study in advance before attending optical physics classes.
	16. I download and review all instructional materials provided by the lecturer.
	17. I believe that CBL-based mobile microlearning will help my understanding of optical physics.
	18. I have high motivation to learn using CBL-integrated mobile microlearning
Attitude Toward Information and Communication Technology (ICT)	19. I find technology very helpful in the teaching and learning process.
	20. I am interested in continuing to utilize technology in learning.
	21. I feel confident in using technology for learning optical physics.
	22. I believe that using ICT will improve my learning outcomes.
	23. I always keep up with technology to support learning.

To ensure content validity, the questionnaire underwent expert validation involving six specialists in physics education, educational technology, and instructional design. The experts reviewed the instrument based on three criteria: (1) alignment between items and the intended indicator, (2) structural clarity and grammatical accuracy, and (3) appropriateness of the language for the target population. Feedback from this process resulted in several refinements, including rewording of items for clarity, elimination of overlapping statements, and adjustment of terminology to better match students' context. Reliability analysis was conducted after piloting the instrument with a comparable sample, yielding Cronbach's alpha coefficients above the acceptable threshold of 0.70 for each subscale, indicating strong internal consistency. This rigorous development and validation process ensured that the instrument was both theoretically sound and empirically reliable.

2.3. Data Collection

Data were collected through an online questionnaire administered via Google Forms to ensure broad accessibility and efficiency in distribution. Each participant was required to log in using a unique institutional email to prevent duplicate submissions and maintain data integrity. Before filling out the questionnaire, students received an informed consent form outlining the study objectives, voluntary participation, and data confidentiality measures. The questionnaire was available for one week, during which reminder notifications were sent to encourage a high response rate, aligning with the technology-mediated nature of mobile microlearning.

The responses were exported to Microsoft Excel for preprocessing, where each Likert-scale score (1–5) was converted into interval data. Descriptive statistical analyses, including mean, standard deviation, and frequency distribution, were performed for each readiness indicator. Readiness levels were then interpreted based on the assessment scale by Wahyuningsih et al. (2022), which categorizes scores above 4.2 as "ready" where the application of CBL-based optical physics learning integrated with mobile microlearning can be fully implemented; scores between 3.4 and 4.1 as "ready" but requiring a little improvement; scores between 2.6 and 3.3 as "not ready" but needing a little improvement; and scores below 2.6 as "not ready" with a need for substantial improvement. This analytical procedure ensured a systematic, transparent, and replicable evaluation of students'

preparedness for the integration of CBL and mobile microlearning in optical physics learning. The level of student readiness for the implementation of Case-Based Learning (CBL) integrated with mobile microlearning in the context of optical physics was then interpreted using the assessment criteria presented in Table 2.

Table 2. Student Readiness Rating Scale in CBL-Based Optical Physics Learning Integrated with Mobile Microlearning (Wahyuningsih et al, 2022)

Scale	Category	Captions
>4,2	Ready	The application of CBL-based optical physics learning integrated with mobile microlearning can be applied
3,4 - 4,1	Ready	Needs a little improvement
2,6 - 3,3	Not ready	Needs a little improvement
<2,6	Not ready	Needs a lot of improvement

3. Results

After the students completed the learning readiness questionnaire regarding the implementation of Case-Based Learning (CBL) integrated with mobile microlearning, the data were analyzed to assess their preparedness. The raw responses were first converted into interval data, allowing for a more detailed and quantitative evaluation of each student's readiness. The results, as summarized in Table 3, provide an overview of the students' readiness levels across four key indicators: smartphone usage skills, understanding of CBL integrated with mobile microlearning, readiness to receive learning materials via mobile microlearning, and attitudes toward Information and Communication Technology (ICT). Each indicator's results were categorized according to the assessment scale developed by Wahyuningsih et al. (2022), which classifies students into levels of readiness ranging from "ready" to "not ready." This comprehensive analysis presents an in-depth view of how well students are prepared for engaging with the proposed learning approach and highlights areas where further support or improvement may be needed.

Table 3. Questionnaire Analysis Results

Indicator	Scale	Category
1	4,8	Ready
2	3,6	Ready
3	4,1	Ready
4	4,5	Ready

The four indicators presented in the table demonstrate high average scores, ranging from 3.6 to 4.8 on a 1–5 scale, with all indicators categorized as "Ready." This overall result suggests that the participants are generally well-prepared to engage in Case-Based Learning (CBL) integrated with mobile microlearning. Specifically, Indicator 1, with the highest score of 4.8, indicates a very strong readiness in the aspect it measures. This suggests that the students are highly confident and skilled in the area assessed by this indicator, reflecting their strong alignment with the requirements of mobile microlearning and CBL. On the other hand, Indicator 2, with the lowest score of 3.6, still falls within the "Ready" category but indicates a relatively weaker area. While the score is above the

threshold, it suggests that this particular aspect, likely related to the students' understanding or familiarity with CBL integrated with mobile microlearning, requires attention. This gap implies that, although the participants are generally prepared, this area could benefit from additional support, interventions, or preparatory activities before the full-scale implementation of the learning approach. Addressing this vulnerability may enhance students' overall readiness and ensure the success of the program.

The following section presents the results for each of the four indicators, displayed visually in the form of graphs and accompanied by detailed explanations. These visualizations provide a clearer understanding of the students' readiness levels across various aspects of Case-Based Learning (CBL) integrated with a mobile microlearning approach.

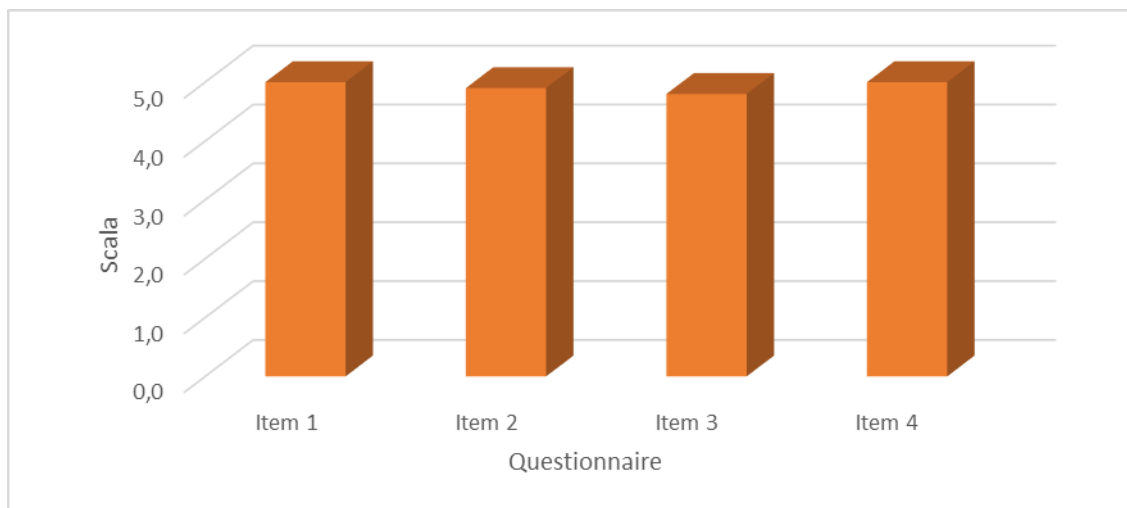


Figure 1. Results of Student Readiness on Indicator Smartphone Usage Skills

Overall, the findings for Indicator 1 demonstrate that Physics Education students are highly prepared to utilize digital devices such as computers, laptops, and smartphones. The questionnaire results for Indicator 1, which include Item 1 (mean score = 5.0), Item 2 (4.9), Item 3 (4.8), and Item 4 (5.0), reflect consistently high levels of readiness, with all item scores well above the threshold value of 3.3. These results indicate that students possess a strong ability to operate digital devices, particularly smartphones, and are proficient in integrating them into both daily routines and academic tasks. They exhibit the skills of efficiently typing, accessing information, and leveraging smartphones for various learning activities, skills that are typically associated with the millennial generation, known for its technological fluency and adaptability.

Despite all items under Indicator 1 falling within the "ready" category, there are still areas where further improvement can be made. Although students are well-equipped to use digital devices for basic academic tasks, enhancing certain aspects of their digital literacy and device usage will be crucial for the effective implementation of optical physics instruction through mobile microlearning platforms. Identifying these competencies enables educators and institutions to design targeted interventions aimed at further developing students' digital skills before the course begins. Strategic initiatives such as workshops, hands-on training, or additional resources on advanced smartphone features and troubleshooting could help students maximize their potential and ensure smoother integration of technology into the learning process.

As illustrated in Figure 2, the results for Indicator 2, which evaluates students' readiness to learn optical physics using Case-Based Learning (CBL) integrated with mobile microlearning, place the overall readiness level within the "ready" category. The questionnaire results for this indicator include the following mean scores: Item 5 (3.2), Item 6 (3.2), Item 7 (3.5), Item 8 (3.4), Item 9 (3.7), Item 10

(3.7), and Item 11 (4.3). These findings show that while students demonstrate overall readiness, the data also reveal variations in their understanding across different components of the learning model. Items 5 and 6, both scoring 3.2, fall into the "unprepared" category, indicating that a substantial number of students lack a solid conceptual understanding of Case-Based Learning (CBL) and are not yet familiar with solving case-based optical physics problems. Specifically, Item 5 addresses students' knowledge of the CBL concept applied within mobile microlearning. The low score suggests that many students do not yet fully comprehend how optical physics can be effectively taught using this pedagogical model. This lack of understanding highlights the need for a foundational introduction to CBL and its application in the context of optical physics. Prior to the full implementation of this approach, explicit explanations and adaptation processes will be crucial to help students engage with CBL more effectively.

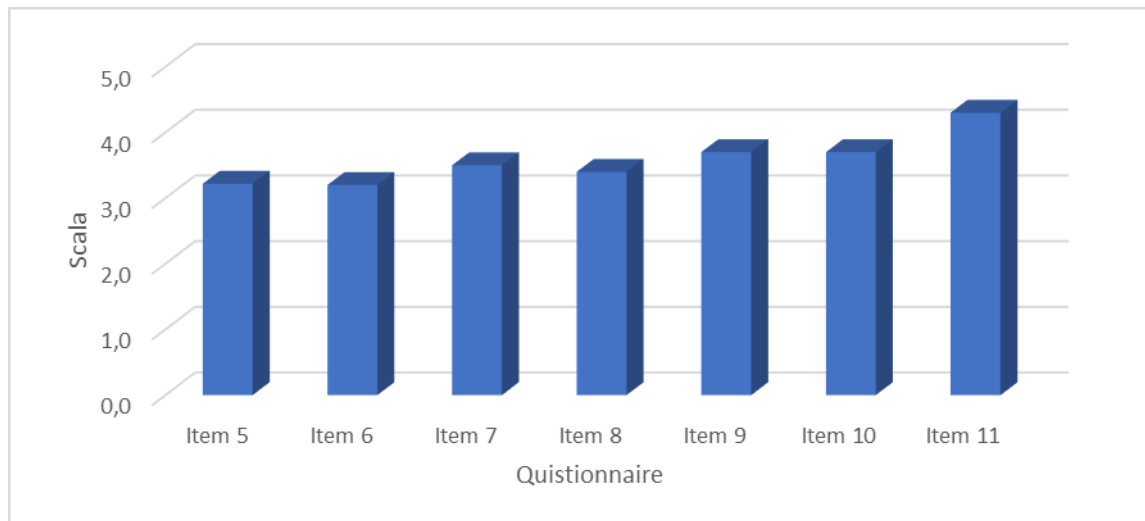


Figure 2. Results of Student Readiness on Indicator 2

In addition to Item 5, Item 6, which asks about students' familiarity with solving optical physics cases, also scores low (3.2), suggesting that students have limited exposure to case-based problem-solving, a key feature of CBL. This may be due to their prior learning experiences, where problems were typically presented in a more traditional, lecture-based format. As CBL requires critical and analytical thinking, it is essential to guide students in developing the skills to approach optical physics problems through case analysis. These results imply that students may need additional practice in case-based learning environments to build their confidence and competence. However, the other items in Indicator 2 indicate stronger readiness. Item 7 (mean = 3.5) reflects students' recognition of the benefits of mobile learning in optical physics, but their understanding is not yet fully developed. This suggests that while students are aware of the potential advantages of mobile microlearning, they may not yet be able to fully leverage mobile tools and resources for optical physics learning. A more thorough exploration of how mobile learning tools can enhance optical physics education would be beneficial to deepen their understanding.

Items 8 (3.4), 9 (3.7), 10 (3.7), and Item 11 (4.3) indicate clearer readiness and familiarity with mobile learning features. Items 9 and 10 suggest that students are comfortable with using smartphones to access materials and engage with mobile microlearning, which is a positive sign for the integration of mobile technology into their learning processes. Furthermore, Item 11, with a high score of 4.3, reflects students' strong confidence in using mobile learning tools and their motivation to engage with CBL-integrated mobile microlearning. This indicates that while some areas require further development, such as understanding the core principles of CBL and solving case-based problems, students are generally equipped with the skills necessary to use mobile learning tools effectively. To ensure a smooth implementation of CBL in optical physics education, it is

recommended to provide students with a brief orientation to CBL, along with examples of how to analyze and solve cases. Additionally, integrating mobile microlearning features, such as quick micro-lessons, simulations, and interactive quizzes, can further strengthen students' readiness and enhance their learning experience.

In conclusion, the results indicate that while the cohort demonstrates overall readiness, certain areas, particularly related to conceptual understanding and case-based problem-solving, require focused attention. By providing targeted interventions, such as introducing the CBL concept clearly, offering practice with case-based analysis, and utilizing mobile learning tools strategically, it will be possible to maximize students' readiness and ensure a successful implementation of CBL integrated with mobile microlearning for optical physics education. This approach will not only improve students' theoretical understanding but also foster their critical thinking and problem-solving skills, making them more effective learners in this innovative learning environment.

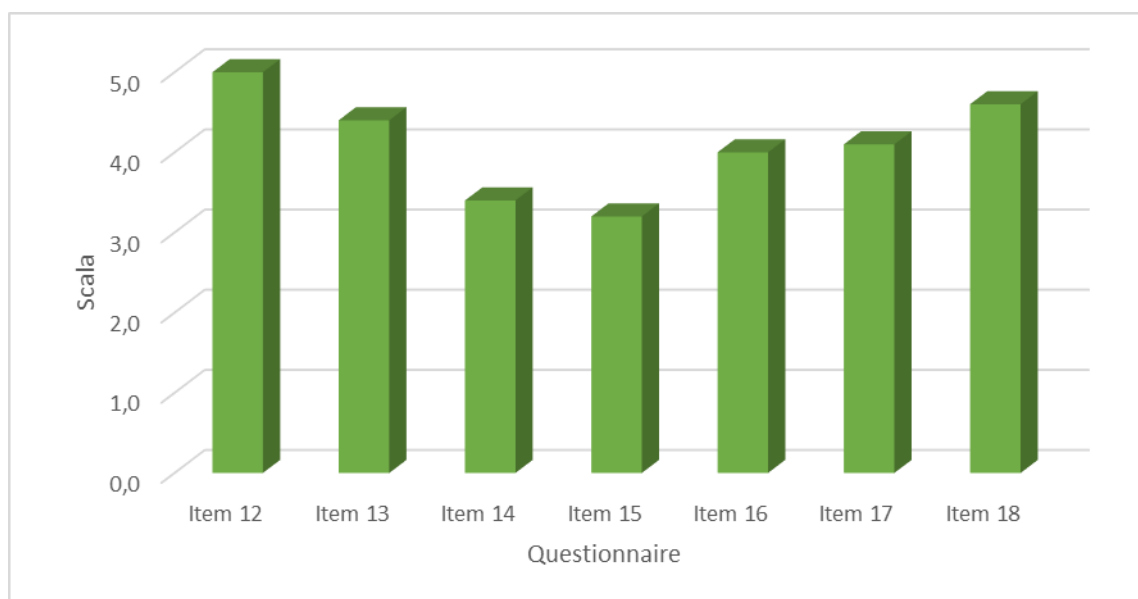


Figure 3. Results of Student Readiness on Indicator 3

Students generally demonstrate strong readiness for mobile microlearning (Indicator 3, overall mean = 4.1), with particularly high levels of device and internet access, as well as motivation (Items 12, 13, 16–18). As illustrated in Figure 3, the results show that most students are well-equipped for engaging with mobile microlearning, with Items 12 (5.0) and 18 (4.6) reflecting near-perfect readiness. However, areas such as pre-class preparation and access to learning management systems (LMS) are weaker (Item 14 = 3.4 and Item 15 = 3.2). While most students possess the necessary technical access and are motivated to engage with mobile microlearning, the findings indicate that targeted support is required to address issues related to LMS access and ensuring students come prepared to class.

The mean score for Indicator 3 of 4.1 places it within the "ready" category, indicating that students are well-positioned for mobile microlearning. In particular, Items 12 (5.0) and 18 (4.6) demonstrate strong readiness, showing that nearly all students own a smartphone and have reliable connectivity. Items 13 (4.4), 16 (4.0), and 17 (4.1) also suggest readiness, as students express positive attitudes toward mobile learning and its ability to improve conceptual understanding in optical physics. However, Item 14 (3.4) and Item 15 (3.2) reveal that some students struggle with accessing institutional learning accounts and preparing before class, which could impede their readiness for mobile microlearning.

The implications of these findings suggest that while the technical access and motivation for mobile microlearning are strong, practical interventions are necessary to support students in overcoming barriers related to LMS access and pre-class preparation. To address these gaps, it is recommended to provide a short onboarding module that helps students create or log into their LMS accounts, as well as a pre-class microtask or quiz that students must complete before attending class. Additionally, push reminders via SMS or WhatsApp can encourage students to complete these pre-class tasks. These steps will enhance students' preparedness and ensure a smoother implementation of mobile microlearning integrated with Case-Based Learning (CBL). The overall high readiness for this approach, combined with the need for targeted support in specific areas, indicates that mobile microlearning could be effectively implemented with these adjustments to optimize student engagement and learning outcomes.

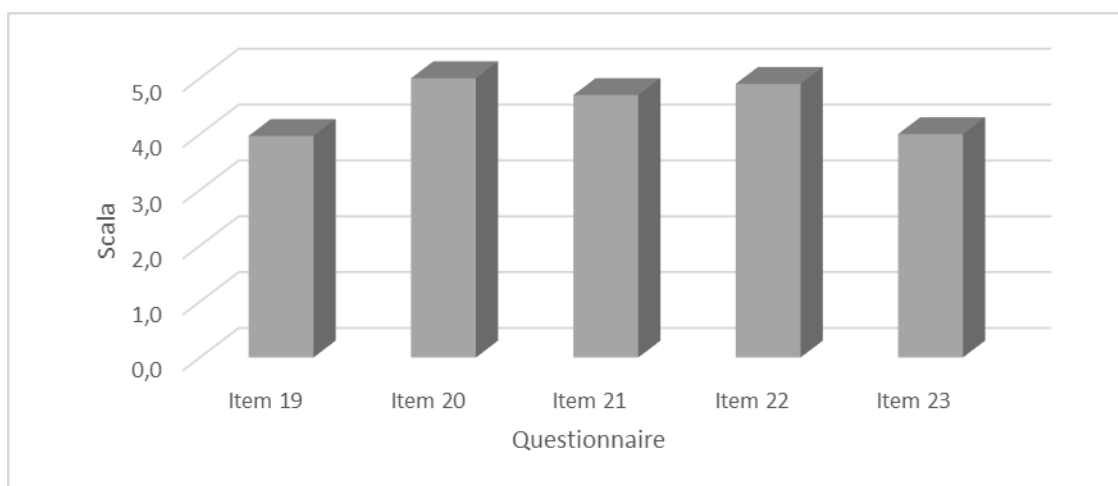


Figure 4. Results of Student Readiness on Indicator 4

Indicator 4 evaluates students' attitudes toward the integration of Information and Communication Technology (ICT) in optical physics learning through the Case-Based Learning (CBL) model, combined with mobile microlearning. The results show a strong and positive response across all items, with an overall mean of approximately 4.52, placing students in the "very ready" category. As presented in Figure 4, the data from Items 19 to 23 indicate that students possess high levels of enthusiasm, confidence, and belief in the value of ICT in their learning process. In particular, Item 20 (mean = 5.0), Item 21 (mean = 4.7), and Item 22 (mean = 4.9) stand out with very high scores, reflecting strong readiness for continued use of technology, confidence in using digital tools for optical physics, and a deep belief in the potential of ICT to enhance academic performance. These results demonstrate that students are not only open to the integration of ICT but also highly motivated to engage with it, suggesting an ideal foundation for the successful implementation of CBL and mobile microlearning.

However, as illustrated in Figure 4, Items 19 (mean = 4.0) and 23 (mean = 4.0) show somewhat lower, but still positive, responses. These items suggest that while students generally recognize the benefits of ICT, there is room for improvement in terms of demonstrating the practical applications of technology in optical physics learning. Specifically, while students acknowledge the potential value of technology (Item 19) and express a willingness to keep updating their skills (Item 23), these areas present an opportunity to enhance their understanding and engagement. A clearer demonstration of how ICT directly contributes to their learning, especially in relation to case-based learning scenarios, could strengthen their perceptions and increase their willingness to continuously update their technical skills.

Based on these findings, there are several practical implications for implementing CBL integrated with mobile microlearning. Given students' positive attitudes toward ICT, the potential for a

successful pilot is high. However, targeted support is necessary in certain areas to ensure smooth adoption. It is recommended to begin by providing a short orientation module (e.g., a 3–5 minute video with frequently asked questions) that explains the practical benefits of using the platform for CBL activities, highlighting how it can directly improve students' understanding and engagement in optical physics. Additionally, optional workshops on advanced features such as quiz creation, discussion tools, and assignment submissions can help students build confidence in using the platform. To encourage ongoing skill development, it is essential to establish a system for continuous professional development (CPD), such as offering micro-credentials or badges for students who actively participate in technology workshops. This approach will not only boost students' technical competence but also further integrate technology into their academic routines.

Furthermore, to ensure that students stay engaged and prepared, incorporating reminders via SMS or WhatsApp can be useful for encouraging pre-class preparation. Monitoring objective metrics, such as LMS login logs, task completion rates, and pre- and post-test performance, will provide more accurate data on student engagement and progress. This data can be used to validate the self-reported attitudes of students and ensure that the practical benefits of ICT are truly translating into improved learning outcomes.

4. Discussion

The research findings on students' readiness for the implementation of case-based learning (CBL) integrated with mobile microlearning in the context of optical physics indicate that, overall, students are categorized as “ready” to engage in this innovative learning approach. All four main indicators—smartphone usage skills, understanding of CBL integrated with mobile microlearning, readiness to receive learning materials through mobile microlearning, and attitudes toward Information and Communication Technology (ICT)—recorded average scores above the threshold value of the “ready” category (3.3), with a score range between 3.6 and 4.8 on a 1–5 scale. As shown in Figure 5, the average scores on these four main indicators reflect that students are well-prepared for this approach, with each indicator demonstrating strong readiness. These findings suggest that the students are generally well-prepared for the integration of digital technologies in their learning processes, demonstrating readiness that spans both technical capabilities and psychological factors, such as motivation and attitudes.

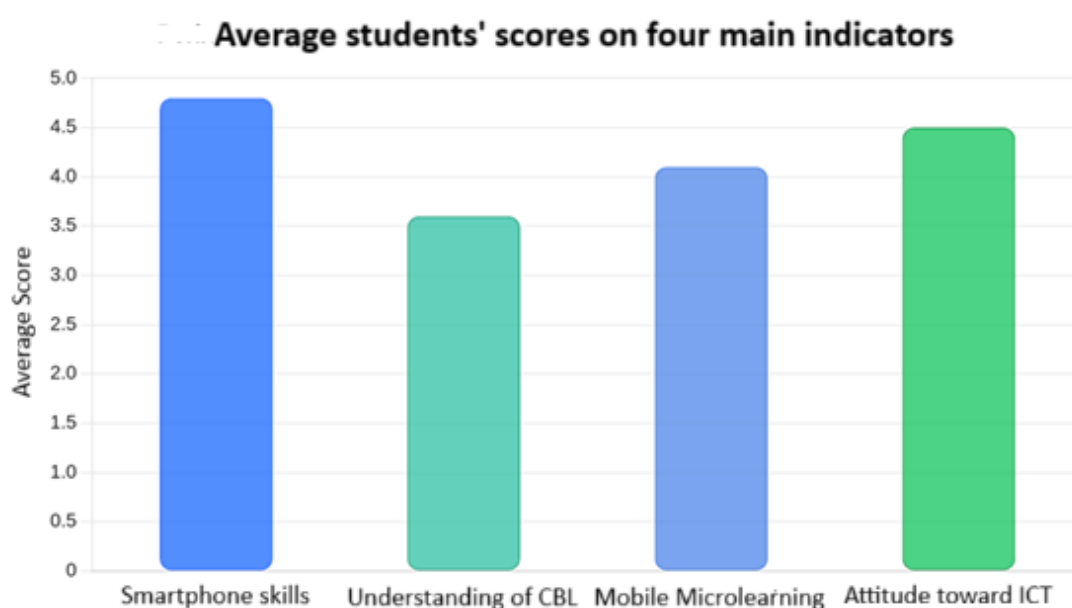


Figure 5. Average Students' Scores on Four Main Indicators

The research findings demonstrate that students are generally well-prepared to engage with Case-Based Learning (CBL) integrated with mobile microlearning in optical physics, as reflected by their strong scores in four primary indicators: smartphone usage skills, understanding of CBL, readiness to receive learning materials through mobile microlearning, and attitudes toward ICT. These indicators suggest that students possess a solid foundation for adapting to a digital, case-based learning environment. Their proficiency with mobile devices, coupled with a positive attitude toward ICT integration, supports the idea that students are technically equipped for technology-enhanced learning approaches, and are motivated to use these tools in their academic journey. The significance of these findings lies in the fact that readiness to engage with digital tools is a well-documented predictor of academic success in technology-mediated environments (Davis, 1989; Venkatesh et al., 2003). Specifically, students' enthusiasm for mobile microlearning, paired with their positive beliefs about ICT's role in education, suggests that the integration of CBL and mobile learning in optical physics could significantly enhance both student engagement and learning outcomes. The high confidence students exhibit in utilizing these tools further emphasizes the potential for technology-driven approaches to be successfully adopted in academic settings.

Despite these promising indicators, the findings also reveal areas that require further attention, particularly in students' conceptual understanding of CBL and their preparedness for pre-class activities. While students exhibit high technical proficiency and strong attitudes toward ICT, their lower scores in understanding CBL, especially in solving optical physics problems through case-based formats, indicate that their readiness is not consistent across all areas. A score of 3.6 for understanding CBL suggests that while students are comfortable with digital tools, they still struggle to adapt to the cognitive shifts required by CBL. This difficulty likely stems from their previous experiences, where physics education largely focused on memorization and solving formula-based problems, rather than engaging in the more complex cognitive processes required for case-based problem-solving (Astuti et al., 2024). The limited exposure to case-based approaches in prior education suggests that many students may not fully understand the pedagogical benefits of CBL, which emphasizes critical thinking, problem-solving, and the application of theory to real-world scenarios. This gap in students' understanding aligns with earlier studies, which highlight the critical importance of bridging the gap between theoretical knowledge and practical application through well-designed case studies (Kolodner et al., 2003; Macho-Stadler & Elejalde-García, 2013).

To address these conceptual gaps, the implementation of a dedicated CBL orientation module is recommended. This module would provide students with a comprehensive understanding of the case-based learning process, including how to analyze and solve complex, real-world problems within the context of optical physics. It would also explain the connection between CBL and the practical applications of physics concepts, such as the behavior of light in various scenarios. By providing students with this foundational knowledge before they engage with the full curriculum, the CBL orientation module would help bridge the gap between students' technical readiness and their cognitive preparedness, fostering a deeper understanding of CBL and enhancing their ability to engage with the material effectively.

Furthermore, the analysis of students' readiness to engage with learning materials through mobile microlearning (score: 4.1) uncovers practical challenges related to access and preparation. While students generally have strong access to mobile devices and the internet, issues related to Learning Management System (LMS) access and pre-class preparation hinder their ability to fully engage with mobile microlearning. The scores for LMS access (3.4) and pre-class preparation (3.2) suggest that operational barriers, such as difficulties logging into LMS accounts or inadequate preparation before class, impede the learning experience. These operational barriers are consistent with the findings of Silva et al. (2025), who emphasize that microlearning integrated with digital technologies can enhance student motivation and performance, but only if practical barriers, such as

LMS accessibility, are addressed. To mitigate these barriers, institutions need to provide dedicated technical support to resolve access issues, as well as to ensure that students are adequately prepared before each class. This could involve integrating mandatory pre-class tasks, such as watching instructional videos, completing quizzes, or engaging in online discussions. These tasks would ensure that students are familiar with the content prior to engaging in more complex learning activities, thus allowing them to be better prepared for the case-based challenges that mobile microlearning presents.

Regarding students' attitudes toward ICT integration, the research reveals a strong belief in the value of ICT for enhancing the learning experience, with an average score of 4.5. This positive attitude toward ICT is a key factor in the successful adoption of technology-based pedagogical models. Previous research has consistently shown that students' attitudes toward ICT play a significant role in determining the success of technology integration in education (Teo, 2011; Yildirim, 2000). Positive student attitudes not only foster greater engagement and motivation in technology-rich learning environments but also reduce resistance to adopting innovative teaching methods. The willingness of students to embrace ICT as a tool for learning contributes significantly to the success of pedagogical models that rely on digital tools, such as mobile microlearning and CBL.

This positive attitude is also aligned with Self-Determination Theory (SDT) (Ryan & Deci, 2000), which emphasizes that intrinsic motivation is driven by the fulfillment of three basic psychological needs: autonomy, competence, and relatedness. In the context of mobile microlearning integrated with CBL, students are provided with opportunities to satisfy these needs through learning experiences that offer flexibility (autonomy), interactive feedback (competence), and opportunities for collaboration (relatedness). According to SDT, the fulfillment of these needs enhances motivation and academic performance (Pintrich, 2003; Deci & Ryan, 2000). Mobile learning, for example, enables students to learn at their own pace and access content whenever it suits them, thereby increasing their sense of control over their learning process. Moreover, the opportunity to engage in problem-solving tasks and receive immediate feedback further enhances students' sense of competence and motivates them to continue learning.

Despite the strong positive attitudes students demonstrate toward ICT, challenges remain in ensuring that these attitudes translate into effective application within specialized academic contexts like optical physics. Research indicates that students, despite their enthusiasm for technology, often struggle to apply digital tools in ways that enhance their understanding of complex, domain-specific concepts (Breslow et al., 2013; Clark, 2007). In the case of optical physics, students may find it difficult to relate abstract concepts like light refraction and reflection to real-world applications, such as how lenses work in cameras or eyeglasses. This gap between general enthusiasm for ICT and its effective use in a specific academic discipline underscores the need for context-specific instructional strategies. To bridge this gap, it is essential to design learning activities that directly relate theoretical concepts to practical scenarios. For example, incorporating real-life case studies that focus on optical phenomena, such as how light behaves in different media or the role of lenses in everyday devices, can help students connect abstract concepts to tangible experiences. These case studies can make the content more relatable, thus improving students' understanding and engagement with optical physics.

Moreover, the integration of interactive ICT tools like simulations, augmented reality (AR), and virtual reality (VR) can further enhance students' ability to visualize and engage with optical phenomena. These tools provide immersive learning experiences that make complex physics concepts more accessible and easier to understand (Bailenson et al., 2008; Milgram & Kishino, 1994). By incorporating these technologies into CBL, educators can foster a more dynamic, interactive learning environment that not only enhances students' conceptual understanding but also provides opportunities for hands-on, real-world problem-solving. Studies have shown that immersive

technologies like AR and VR significantly improve engagement and retention in science education by offering visual and interactive representations of abstract concepts (Zhao et al., 2023).

To conclude, the integration of mobile microlearning and CBL in optical physics education offers significant potential for enhancing student engagement, problem-solving abilities, and conceptual understanding. However, addressing the identified gaps in students' conceptual understanding of CBL, preparedness for pre-class activities, and the effective application of ICT tools in optical physics learning is crucial for maximizing the success of this approach. By implementing strategic interventions, such as CBL orientation modules, technical support for LMS access, and integrating ICT tools that demonstrate real-world applications of optical physics, educators can create a learning environment that not only motivates students but also ensures they are cognitively and technically equipped to succeed. This integrated approach will foster a deeper understanding of the material, enhance problem-solving skills, and ultimately improve students' academic performance in optical physics.

5. Conclusion

The analysis and discussion reveal that students of Physics Education at Universitas Indraprasta PGRI are well-prepared for the implementation of CBL-integrated optical physics learning with mobile microlearning. The results from the questionnaire analysis show that all key readiness indicators fall within the "ready" category, which includes proficiency in computer/smartphone usage, understanding of CBL integrated with mobile microlearning, preparedness to engage with learning materials via mobile microlearning, and positive attitudes toward ICT. These findings suggest that students possess the technical, cognitive, and motivational qualities necessary for the successful adoption of this innovative learning method, providing confidence that they will be able to utilize it effectively to enhance optical physics education.

Furthermore, students' proficiency in using technology and smartphones supports the learning process, allowing them to access materials more flexibly and efficiently through mobile microlearning platforms, which can be accessed anytime and anywhere. This capability not only enables students to optimize the use of technology but also boosts their involvement and motivation in mastering optical physics concepts. While students are ready to engage with CBL-integrated mobile microlearning, attention must be given to further developing their conceptual understanding of CBL, particularly in applying it to optical physics. To maximize the effectiveness of this approach, interventions such as CBL orientation modules and improved pre-class preparations are recommended. In sum, students are well-equipped to embrace CBL-integrated mobile microlearning, with additional support needed to ensure they fully harness its potential for deeper engagement with optical physics.

Declarations

Author Contributions. Conceptualization, I.A.D.A., B.W., and M.J.; methodology: I.A.D.A., B.W., and M.J.; formal analysis, I.A.D.A.; resources I.A.D.A., B.W., and M.J.; data curation, I.A.D.A.; writing—original draft preparation, I.A.D.A.; writing—review and editing, I.A.D.A., B.W., and M.J.; visualization, I.A.D.A.; funding acquisition, I.A.D.A., B.W., and M.J.; All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest. the authors declare no conflict of interest.

Funding. The Directorate General of Higher Education, Ministry of Education and Culture of Indonesia for fully funding the Postgraduate Doctoral Dissertation Research Scheme Research Grant Program (PPS-PDD) in 2025 based on Decree Number 083/C3/DT.05.00/PL/2025 and Agreement/Contract Number 6/UN39.14/C3/DT.05.00/PPS-PDD/PL/2025.

Acknowledgments. The researcher would like to thank the Directorate General of Higher Education, Research and Technology-Ministry of Research, Technology and Higher Education of the Republic of Indonesia for supporting funding for this research through the Postgraduate Doctoral Dissertation Research Scheme Research Grant Program (PPS-PDD) in 2025 based on Decree Number 083/C3/DT.05.00/PL/2025 and Agreement/Contract Number 6/UN39.14/C3/DT.05.00/PPS-PDD/PL/2025. The authors also expressed their gratitude to Jakarta State University and Indraprastha PGRI University for providing full support for the completion of this study.

References

- Alani, F. (2020). Development of case-based learning (CBL) in engineering technology education. *International Journal of Engineering Education*, 36(3), 896–900.
- Ali, G., Qurnia, A., & Hasibuan, R. (2024). Development of a Case Based Learning (CBL) Model Based on a Knowledge Management System to Improve Students' Critical Thinking Skills. 16, 3029–3040. <https://doi.org/10.35445/alishlah.v16i3.4904>
- Astuti, I. A. D., Wibawa, B., & Japar, M. (2024). The Implementation of Case Based Learning in Physics Learning at the Collage: A Systematic Literature Review. *Journal of Physics: Conference Series*, 2866(1). <https://doi.org/10.1088/1742-6596/2866/1/012106>
- Astuti, I. A. D., Japar, M., & Wibawa, B. (2025). Physics Students' Perceptions of Microlearning: A New Approach in Education. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, 10(1), 166-174. <https://doi.org/10.26737/jipf.v10i1.6053>
- Bailenson, J., Patel, K., Nielsen, A., Bajscy, R., Jung, S. H., & Kurillo, G. (2008). The effect of interactivity on learning physical actions in virtual reality. *Media Psychology*, 11(3), 354-376. <https://doi.org/10.1080/15213260802285214>
- 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), 23108. <https://doi.org/10.1103/PhysRevPhysEducRes.17.023108>
- Breslow, L., Pritchard, D. E., DeBoer, J., Stump, G. S., Ho, A. D., & Seaton, D. T. (2013). Studying learning in the worldwide classroom research into edX's first MOOC. *Research & Practice in Assessment*, 8, 13-25.
- Clark, J. E. (2007). On the problem of motor skill development. *Journal of Physical Education, Recreation & Dance*, 78(5), 39-44. <https://doi.org/10.1080/07303084.2007.10598023>
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340. <https://doi.org/10.2307/249008>
- Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological inquiry*, 11(4), 227-268. https://doi.org/10.1207/S15327965PLI1104_01
- Dewi, P. Y. A., & Primayana, K. H. (2019). Effect of Learning Module with Setting Contextual Teaching and Learning to Increase the Understanding of Concepts. *International Journal of Education and Learning*, 1(1), 19–26. <https://doi.org/10.31763/ijelev.v1i1.26>
- Eichenlaub, M., & Redish, E. F. (2019). Blending Physical Knowledge with Mathematical Form in Physics Problem Solving. *Mathematics in Physics Education*, 127–151. https://doi.org/10.1007/978-3-030-04627-9_6

- Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching*, 47(8), 978–1003. <https://doi.org/10.1002/tea.20363>
- Hu, D., & Rebello, N. S. (2013). Understanding student use of differentials in physics integration problems. *Physical Review Special Topics - Physics Education Research*, 9(2), 1–14. <https://doi.org/10.1103/PhysRevSTPER.9.020108>
- Hug, T. (2007). Microlearning: an emerging field in science. *Microlearning Conference, 2006, June*, 1–324. https://www.uibk.ac.at/iup/buch_pdfs/microlearning2006-druck.pdf
- Ince, E. (2018). An Overview of Problem Solving Studies in Physics Education. *Journal of Education and Learning*, 7(4), 191–200. <https://doi.org/10.5539/jel.v7n4p191>
- Ismoyo, T., Wibawa, B., & Solihatin, E. (2024). Microlearning: New Learning Model for Buddhist Religious Education. *Proceedings of the 7th International Conference on Learning Innovation and Quality Education (ICLIQE 2023)*, Icliqe 2023. <https://doi.org/10.2991/978-2-38476-301-6>
- Kolodner, J. L., Camp, P. J., Crismond, D., Fasse, B., Gray, J., Holbrook, J., Puntambekar, S., & Ryan, M. (2003). Problem-Based Learning Meets Case-Based Reasoning in the Middle-School Science Classroom. *Journal of the Learning Sciences*, 12(4), 495–547. https://doi.org/10.1207/S15327809JLS1204_2
- Lee, M. H., & Park, M. S. (2016). The Effect of Case-based Learning (CBL) on Critical Thinking Disposition, Communication Ability, Problem Solving Ability and Self-directed Learning Ability of Nursing Students in Pathophysiology Course. *Journal of Korean Biological Nursing Science*, 18(3), 176–184. <https://doi.org/10.7586/jkbns.2016.18.3.176>
- Macho-Stadler, E., & Jesús Elejalde-García, M. (2013). Case study of a problem-based learning course of physics in a telecommunications engineering degree. *European Journal of Engineering Education*, 38(4), 408–416. <https://doi.org/10.1080/03043797.2013.780012>
- Malau-Aduli, B. S., Lee, A. Y. S., Cooling, N., Catchpole, M., Jose, M., & Turner, R. (2013). Retention of knowledge and perceived relevance of basic sciences in an integrated case-based learning (CBL) curriculum. *BMC Medical Education*, 13(1). <https://doi.org/10.1186/1472-6920-13-139>
- Marno, M., Wibawa, B., & Puadah, P. (2023). Case Based Learning in Religious Education Subjects for The Field of Inheritance Law. *Proceedings of the 7th International Conference on Learning Innovation and Quality Education (ICLIQE 2023)*, Icliqe. <https://doi.org/10.2991/978-2-38476-301-6>
- Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE TRANSACTIONS on Information and Systems*, 77(12), 1321–1329.
- Ng, W., & Van Nguyen, T. (2006). Investigating the integration of everyday phenomena and practical work in physics teaching in Vietnamese high schools. *International Education Journal*, 7(1), 36–50.
- Pham, H. H., Nguyen, N. T. N., Dinh Hai, L., Nguyen, T. T., & Nguyen, V. A. L. (2024). Science mapping the knowledge base on microlearning: using Scopus database between 2002 and 2021. *Journal of Research in Innovative Teaching and Learning*, 503. <https://doi.org/10.1108/JRIT-09-2023-0132>
- Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of educational Psychology*, 95(4), 667. <https://doi.org/10.1037/0022-0663.95.4.667>

- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology*, 25(1), 54-67. <https://doi.org/10.1006/ceps.1999.1020>
- Salleh, D., Khairudin, N., & Ibrahim, M. (2022). Micro Learning: Motivating Students' Learning Interests. *Jurnal Psikologi Malaysia*, 36(1), 153-162.
- Silva, E. S., Costa, W. P. D., Lima, J. C. D., & Ferreira, J. C. (2025). Contribution of microlearning in basic education: A systematic review. *Education Sciences*, 15(3), 302. <https://doi.org/10.3390/educsci15030302>
- Teo, T. (2011). Factors influencing teachers' intention to use technology: Model development and test. *Computers & Education*, 57(4), 2432-2440. <https://doi.org/10.1016/j.compedu.2011.06.008>
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478. <https://doi.org/10.2307/30036540>
- Wahyuningsih, R., Maryani, I., & Pujiastuti, P. (2022). The Effect of University Students Readiness in Online Science Learning toward Learning Motivation. *AL-ISHLAH: Jurnal Pendidikan*, 14(4), 4919-4928. <https://doi.org/10.35445/alishlah.v14i4.821>
- Yildirim, S. (2000). Effects of an educational computing course on preservice and inservice teachers: A discussion and analysis of attitudes and use. *Journal of Research on computing in Education*, 32(4), 479-495. <https://doi.org/10.1080/08886504.2000.10782293>
- Zhao, X., Ren, Y., & Cheah, K. S. (2023). Leading virtual reality (VR) and augmented reality (AR) in education: bibliometric and content analysis from the web of science (2018-2022). *Sage Open*, 13(3). <https://doi.org/10.1177/21582440231190821>
- Zhenhua, H., & Xiaolong, Y. (2020). Discussion on the Flipped Classroom Teaching Mode of College Physics Based on Micro Class Resources. *Acaelt*, 828-832. <https://doi.org/10.25236/acaelt.2020.174>
- Zulueta, L. F., & Panoy, J. F. D. (2022). Scenario-Based Microlearning Strategy for Improved Basic Science Process Skills in Self-Directed Learning. *International Journal of Science, Technology, Engineering and Mathematics*, 2(4), 54-73. <https://doi.org/10.53378/352932>

About the Contributor(s)

Irnin Agustina Dwi Astuti is a doctoral student in the Doctoral Program of Educational Technology Postgraduate at Universitas Negeri Jakarta, Indonesia, and a lecturer in the Department of Physics Education at Universitas Indraprasta PGRI, Indonesia. She focuses on teaching educational technology, ICT for learning, and physics education.

Email: irnin_9902922005@mhs.unj.ac.id / irnin.agustina@gmail.com

ORCID: <http://orcid.org/0000-0003-1974-6550>

Basuki Wibawa, is a professor at the Doctoral Program of Educational Technology Postgraduate, Universitas Negeri Jakarta, Indonesia. Basuki Wibawa received his PhD program from the Department of Educational Technology, Universitas Negeri Jakarta. He researches educational technology. These studies have been published in the International Journal, indexed in Scopus and Web of Science. He also has actively published these studies in the books.

Email: bwibawa@unj.ac.id

ORCID: <http://orcid.org/0000-0002-0290-1617>

Muhammad Japar, is a professor at the Doctoral Program of Educational Technology Postgraduate, Universitas Negeri Jakarta, Indonesia. Muhammad Japar received his PhD program from the Department of Educational Technology, Universitas Negeri Jakarta. He researches educational technology and civic education. These studies have been published in the International Journal, indexed in Scopus and Web of Science. He also has actively published these studies in the books.

Email: mjapar@unj.ac.id

ORCID: <http://orcid.org/0000-0002-9719-765X>

Publisher's Note: *The opinions, statements, and data presented in all publications are solely those of the individual author(s) and contributors and do not reflect the views of Universitepark, EDUPIJ, and/or the editor(s). Universitepark, the Journal, and/or the editor(s) accept no responsibility for any harm or damage to persons or property arising from the use of ideas, methods, instructions, or products mentioned in the content.*
