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RESEARCH ARTICLE

Mobile Learning Media and Physics Education: Exploring Student Preferences, Competence, and Motivation in the Digital Era

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Abstract: In this digital era, mobile technology has transformed the education system and made mobile learning media increasingly important, especially in physics education as a complex discipline. Mobile-based learning media, such as physics simulation applications accessed via mobile phones, interactive learning videos via tablets, and mobile learning platforms, have been shown to help students understand abstract and complex physics concepts. However, there is still a gap in the literature regarding how students' preferences for mobile-based learning media affect their physics learning competence and motivation in the context of physics education. This study aims to investigate the relationship between students' preferences for mobile-based learning media, physics competence, and learning motivation in physics learning. This study used a quantitative design with a survey method to collect data from 54 high school students in West Sumatra Province regarding their preferences for various types of mobile-based learning media in physics learning. Data were analyzed using multiple regression to determine the relationship between the variables studied. The results showed that students' preferences for mobile-based learning media had a significant positive impact on physics learning competence and motivation. The findings of the study also showed that students' preferences for PhET simulations accessible via smartphones, mobile-based educational social media applications, and physics learning videos had a significant influence on various aspects of students' physics competence and learning motivation. However, the impact varies depending on the type of learning media preferred and the pattern of students' mobile device usage in physics learning. This study provides valuable insights for physics education practitioners to improve students' learning experiences by considering students' preferences for mobile-based learning media. The implications of this study suggest that understanding and accommodating students' preferences for mobile-based learning media can significantly improve physics competence and learning motivation, thereby improving students' overall learning outcomes.

Keywords: mobile learning media, learning strategy, student preference, physics competence, learning motivation

1 Introduction

The rapid development of technology and information has brought significant changes in various aspects of life, including education (Burbules et al., 2020; Coccoli et al., 2014; Timotheou et al., 2023). In this digital era, the application of technology in learning is becoming increasingly important, especially in complex disciplines such as physics (Asrizal et al., 2022; Ramírez-Leal et al., 2022). Educational technology offers many tools and media to improve teacher-student interactions, streamline material delivery, and increase student understanding and engagement (Bakri et al., 2020; Banda & Nzabahimana, 2021; Bergdahl et al., 2020; Semkow-Nedza, 2022). The use of learning media, whether visual, interactive, or simulation, has been shown to help students understand abstract and complex concepts (Mayer, 2014; McStay, 2023; Prahani et al., 2024). The use of mobile device in learning contexts has changed the way students interact with different types of media (Papadakis, 2023). Interactive simulations accessible through mobile technology have shown higher levels of engagement compared to laptop use, due to the intuitive nature of the touch interface and the portability of the device (Chen & Wang, 2021). Similarly, social media usage patterns for study groups indicate that students tend to be more active in discussions when using mobile technology, which allows for real-time participation and more spontaneous communication. Physics, which is often considered challenging by students (Ekici, 2016; Fadillah & Sahyar, 2023), requires the implementation of effective pedagogical strategies to explain complex concepts such as mechanics, thermodynamics, and electromagnetism. Traditional teaching strategies that rely on lectures and textbooks are often insufficient to explain these concepts clearly (Festiyed et al., 2022; Novitra et al., 2021; Usmeldi, 2015). Learning media such as educational videos (Ndihokubwayo et al., 2020), interactive simulations (Banda & Nzabahimana, 2023; Sari et al., 2023), and game-based applications (Pratama & Setyaningrum, 2018; Wang et al., 2022; Zourmpakis et al., 2023) can provide clear and engaging visualizations, helping students understand physics concepts better (Clark et al., 2023). Integrating technology into physics education not only addresses the various learning styles of students but also bridges the gap between theoretical concepts and practical understanding (Kalogiannakis & Papadakis, 2020). Therefore, it is imperative for educators to continuously update their teaching strategies and incorporate these technological advancements to create more inclusive and effective learning experiences in physics education (Papadakis et al., 2020).

Interactive video-based learning media has become a very effective tool in delivering material in educational environments, offering various significant advantages in the teaching and learning process (Bakri et al., 2020; Kusuma et al., 2021; Ndihokubwayo et al., 2020). Learning videos can improve the quality of student learning by presenting information in an interesting and dynamic way and helping to increase student interest and motivation through concrete visualizations and animations that make it easier to explain abstract concepts (Bakri et al., 2020; Bravo et al., 2011). Learning videos optimized for mobile devices show higher retention rates when designed with short durations (5-7 minutes), clear subtitles, and easy-to-use navigation controls on touchscreens. In addition, the use of learning videos can save class time, provide more active learning opportunities for students, and allow students to explain the material clearly, which meets various individual learning styles (Pappas et al., 2017). Video instruction reduces the burden on teachers in the traditional lecture model, allowing them to record an explanation once and play it back to students, allowing teachers to focus on other aspects of teaching, such as providing individual tutoring or developing innovative learning materials (Hockicko et al., 2015; Zhang et al., 2006). Therefore, it is imperative for educators to continually update their teaching strategies and incorporate these technological advancements while considering mobile accessibility and student usage patterns to create more inclusive and effective learning experiences in physics education (Kalogiannakis & Papadakis, 2020).

Furthermore, educators can use PhET Colorado, an interactive media developed in Colorado through simulation, for virtual practicums (Wieman et al., 2008). PhET was developed with interactive multimedia-based computer technology and can be used as a virtual laboratory (Perkins, 2020; Perkins et al., 2006). Interactive multimedia includes video, animation, graphics, images, audio, text, and hypertext (Mayer, 2014; Perkins et al., 2012). PhET can be accessed for free and is flexibly developed for classroom learning. The use of PhET via mobile devices shows an interesting usage pattern, where students tend to spend more time exploring when using mobile technology compared to laptops. Simulations in PhET are interactive and packaged in a game-like form, making it easier for students to explore (Maulani et al., 2020). PhET's responsive design that prioritizes mobile devices allows students to access simulations anytime and anywhere, creating a learning transmission that encourages independent exploration outside of formal class hours. Research shows that aligning students' learning preferences with their teaching strategies improves their learning motivation and academic competence (Ceberio et al., 2016; Gikas & Grant, 2013). By aligning educational content with students' preferences and considering their mobile device usage patterns, educators can foster more personalized and effective learning experiences, ultimately improving students' motivation and learning outcomes (Papadakis, 2020).

In physics education, students' preferences for particular learning media can have a significant impact on their conceptual understanding and problem-solving skills. According to constructivist learning theory, students construct knowledge through active engagement and interaction with learning materials (Alt & Itzkovich, 2019; Calalb, 2023). Simulations, such as PhET, align with this theory by providing interactive and immersive experiences that allow students to directly manipulate and observe physical phenomena, thereby deepening their conceptual understanding (Banda & Nzabahimana, 2023; Olugbade et al., 2024). Cognitive load theory also supports the use of multiple learning media. This theory states that well-designed multimedia can reduce extraneous cognitive load and increase learning efficiency by presenting information through both visual and auditory channels (Chen et al., 2023; Hanham et al., 2023; Sweller, 2011). Instructional videos, for example, can break down complex concepts into more manageable chunks, making learning more engaging and understandable (Wu et al., 2021; Zhang et al., 2006). However, while theoretical frameworks suggest the potential benefits of various learning media, empirical studies reveal a gap in understanding how individual preferences for these media affect learning outcomes in physics, particularly in the context of mobile learning. Desnita and Susanti (2017) noted that individual preferences are often overlooked, with most studies focusing on the effectiveness of media in general rather than personalized learning experiences (Amelia et al., 2021; Sastradika et al., 2021; Simanjuntak et al., 2018; Utari et al., 2021). Therefore, this study aims to bridge this gap by exploring the relationships between the use of media-based teaching strategies, students' learning media preferences, physics competencies, and learning motivation in the context of physics education integrated with mobile learning.

There are several research questions that this study aims to answer: How do media-based teaching strategies affect students' competence in physics? How do media-based teaching strategies affect students' motivation to learn physics? How do students' preferences for different types of learning media affect their physics competence and learning motivation? This study aims to offer insights into more effective teaching strategies and assist in designing learning experiences that are more tailored to students' learning preferences by utilizing mobile devices. Thus, the results of this study can contribute to improving the quality of physics education and fostering students' interest and motivation in learning physics. This study discusses the existing literature by investigating the relationship between students' learning media preferences and their physics competence and learning motivation. In addition, this study examines how teachers' use of learning media can be optimized to support students' learning outcomes effectively. Combining the analysis of teachers' teaching strategies and students' learning media preferences is expected to contribute to the literature on physics education and classroom teaching practices.

2 Materials and Methods

This study employed a quantitative research design using a survey method to collect data from four high schools in the West Sumatra Province of Indonesia. The sample selection used a convenience sampling method, and student demographic data has been summarised in Table 1. 54 completed questionnaires were collected, consisting of 33% males and 66% females. As there were no incomplete or duplicated data, all responses were used for data analysis. It should be noted that all students completed the data without any coercion and indicated a willingness to volunteer.

Table 1 Participant Demographics

Criteria	Items	Frequency	Percentage(%)
Gender	Male	18	0.33
	Female	36	0.66
Grade	X	12	0.22
	XI	23	0.43
	XII	19	0.35

Data were collected through an online survey that assessed students' perceptions of instructional media in Physics classes across four constructs: teacher teaching strategies, Physics competencies, instructional media preferences, and learning motivation. Table 2 shows the confirmatory factor analysis of each construct used in this study. All items had good factor loadings, with values above 0.50 (Hair et al., 2019; Peterson, 2000). Composite reliability (CR) and Cronbach's alpha (α) for all constructs were greater than 0.80, and average variance extracted (AVE) was greater than 0.50 (Dash & Paul, 2021; Hair et al., 2021). Thus, we have verified the reliability and validity of the data, ensuring credibility for further analysis.

The data were analyzed using SmartPLS (V.4) and SPSS (V.22) software. SmartPLS (V.4) software was used to test the validity of the research instrument, while SPSS (V.22) was used to determine the relationship between teaching strategies and preferences with student competence and motivation through multiple regression analysis (univariate; ENTER model).

3 Results

3.1 The Relationship between Media-Based Learning Strategies and Physics Learning Competence and Motivation

Table 3 shows the results of multiple regression tests showing the relationship between media-based teaching strategies (TTM1-TTM3) and students' physics competencies (PHC1-PHC5),

Table 2 Properties of Research Instruments

Construct	Code	Items	Factor Loading	CR	α	AVE
Teacher's Teaching Strategy	TTM1	My teacher always uses learning media in explaining physics material	0.765	0.847	0.844	0.646
	TTM2	My teacher often uses physics learning media to illustrate physics concepts that are difficult to understand.	0.791			
	TTM3	My teacher often uses physics learning media as part of their teaching strategy	0.852			
Physics Competence	PHC1	I am able to write down physics problems clearly and precisely.	0.804	0.855	0.855	0.546
	PHC2	I am able to formulate a temporary answer to the physics problem clearly and accurately.	0.719			
	PHC3	I am able to write down the steps to solve the physics problem	0.659			
	PHC4	I am able to write the answer to the problem clearly and precisely	0.740			
	PHC5	I am able to write down the physics-physics relationship that I measure and calculate.	0.763			
Learning Media Preferences	LMP1	I prefer to use educational videos to learn physics (YouTube, video tutorials, etc.)	0.630	0.833	0.829	0.501
	LMP2	I prefer to use simulation to learn physics (PhET simulations, interactive apps, etc.)	0.738			
	LMP3	I prefer to use educational games to learn physics (physics-based games, gamification apps, etc.)	0.715			
	LMP4	I prefer to use educational websites to learn physics (Khan Academy, Coursera, online learning sites, etc.)	0.625			
	LMP5	I prefer to use social media to learn physics (study groups on Facebook, discussion forums on WhatsApp, learning videos on TikTok, etc.)	0.814			
Learning Motivation	LMT1	I understand the teacher's explanation well	0.904	0.936	0.936	0.710
	LMT2	I feel happy when the teacher gives physics lessons	0.881			
	LMT3	I actively ask questions when learning physics	0.832			
	LMT4	I feel comfortable in learning physics in class	0.754			
	LMT5	I become more actively involved in physics learning	0.834			
	LMT6	I am interested and feel happy to solve various daily problems with physics	0.843			

with each question item displaying standardized coefficients (Beta), t-values, and p-values. In the statement that teachers always use learning media in explaining physics material (TTM1) there is a significant influence on students' ability to write physics question answers clearly and accurately (PHC4), but it is not significant in other aspects. If teachers often use physics learning media to illustrate difficult-to-understand concepts (TTM2) there is a significant influence on the ability to write steps to solve physics questions (PHC3). However, this is not significant in other aspects of writing ability. Meanwhile, the use of physics learning media as part of the teacher's teaching strategy (TTM3) does not show a significant influence on the ability to write and understand physics questions in all aspects measured. These results indicate that the use of physics learning media by teachers has a different influence on students' physics abilities.

Table 3 The Relationship Between Media-Based Teaching Strategy and Students' Physics Competencies

Codes	PHC1		PHC2		PHC3		PHC4		PHC5	
	Beta	t	Beta	t	Beta	t	Beta	t	Beta	t
TTM1	0.23	1.30	0.18	1.04	0.11	0.63	0.41	2.34*	0.31	1.93
TTM2	0.13	0.75	0.18	1.02	0.39	2.23*	0.19	1.04	0.29	1.76
TTM3	0.16	0.88	0.21	1.14	0.04	0.24	-0.14	-0.72	0.05	0.27

Note: $^{*}p < 0.05$.

Table 4 presents the results of the analysis of the relationship between media-based learning strategies (TTM1-TTM3) and student learning motivation (LMT1-LMT6). When teachers always use learning media to explain physics material (TTM1), there is no significant effect on all aspects measured. However, the use of learning media to illustrate difficult-to-understand physics concepts (TTM2) has a significant effect on student understanding (LMT1), active student involvement in asking questions (LMT3), and comfort in learning physics (LMT4), although not significant on feelings of pleasure (LMT2) and several other aspects of motivation (LMT5 and LMT6). The use of physics learning media as part of a teaching strategy (TTM3) has a significant effect on all aspects measured, with a very significant effect on feelings of pleasure (LMT2) and active involvement in solving everyday physics problems (LMT6). These results indicate that the use of learning media by teachers, especially as part of a teaching strategy, has a significant positive impact on various aspects of student motivation in learning physics.

Table 4 The Relationship Between Media-Based Teaching Strategy and Learning Motivation

Codes	LMT1		LMT2		LMT3		LMT4		LMT5		LMT6	
	Beta	t	Beta	t	Beta	t	Beta	t	Beta	t	Beta	t
TTM1	0.21	1.59	0.06	0.54	0.16	1.18	0.14	1.08	0.14	1.00	-0.04	-0.39
TTM2	0.33	2.50*	0.03	0.22	0.30	2.26*	0.33	2.51*	0.28	1.90	0.21	1.80
TTM3	0.32	2.27*	0.76	6.22***	0.38	2.69*	0.40	2.93**	0.36	2.34*	0.69	5.74***

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

3.2 The Relationship between Learning Media Preferences and Physics Learning Competence and Motivation

The results of the previous analysis (see Table 3 and 4) show that the use of physics learning media by teachers has a positive effect on students' physics competence and learning motivation. Therefore, it is important to know students' learning media preferences to further optimize the use of learning media in physics classes. Table 5 shows that students' preferences for the use of learning media (LMP1-LMP5) have varying effects on students' physics competence (PHC1-PHC5). Educational videos (LMP1) do not have a significant effect on all aspects of physics competence measured. The preference for using simulations (LMP2) has a significant effect on the ability to write steps to solve physics problems (PHC3) but is not significant for other aspects of competence. The preference for using educational games (LMP3) does not have a significant effect on all aspects of physics competence. The preference for using educational websites (LMP4) also does not show a significant effect on physics competence. However, the preference for using social media (LMP5) has a significant effect on the ability to formulate temporary answers (PHC2). These results indicate that the preference for using simulations and social media can improve several aspects of students' physics competence, while the preference for other learning media does not have a significant effect.

Table 5 The Relationship Between Learning Media Preferences and Students' Physics Competencies

Codes	PHC1		PHC2		PHC3		PHC4		PHC5	
	Beta	t	Beta	t	Beta	t	Beta	t	Beta	t
LMP1	0.14	0.79	0.12	0.72	0.06	0.34	0.05	0.27	0.10	0.59
LMP2	0.23	1.23	0.24	1.45	0.46	2.50*	0.15	0.86	0.24	1.35
LMP3	0.03	0.14	0.01	0.04	-0.03	-0.14	-0.04	-0.24	0.17	0.95
LMP4	-0.13	-0.78	-0.09	-0.57	-0.02	-0.14	0.14	0.89	-0.02	-0.15
LMP5	0.28	1.41	0.42	2.33*	0.02	0.08	0.35	1.82	0.17	0.88

Note: $^{*}p < 0.05$.

As presented in Table 6, this study revealed that students' preferences for different learning media also affect students' motivation in learning physics. The use of educational videos (LMP1) showed a significant effect on interest and happiness in solving everyday physics problems (LMT6). The use of simulations (LMP2) had a significant effect on the comfort of learning physics in class (LMT4). However, these preferences did not have a significant effect on other aspects of motivation. Educational games (LMP3) only had a significant effect on physics learning motivation in all aspects measured. Preferences for educational websites (LMP4) also did not show a significant effect on physics learning motivation in all aspects measured. The use of social media (LMP5) had a significant effect on understanding teacher explanations (LMT1). These results indicate that students' preferences for certain learning media, especially educational videos, simulations, and social media, can improve several aspects of students' physics learning motivation.

4 Discussion

4.1 Relationship of Media-Based Learning Strategy with Students' Physics Competence

This study revealed that the use of media-based teaching strategies in physics impacts students' physics competence in various ways. The finding that consistent use of learning media

Table 6 The Relationship Between Learning Media Preferences and Learning Motivation

Codes	LMT1		LMT2		LMT3		LMT4		LMT5		LMT6	
	Beta	t	Beta	t	Beta	t	Beta	t	Beta	t	Beta	t
LMP1	0.13	0.83	0.31	1.92	0.16	0.94	0.08	0.44	0.22	1.24	0.46	2.75**
LMP2	0.29	1.75	0.20	1.24	0.24	1.37	0.37	2.08*	0.07	0.41	0.06	0.34
LMP3	0.10	0.58	0.03	0.16	0.29	1.67	0.13	0.70	0.05	0.27	-0.04	-0.23
LMP4	-0.19	-1.29	-0.09	-0.57	-0.05	-0.34	-0.07	-0.41	-0.07	-0.45	-0.17	-1.12
LMP5	0.37	2.12*	0.30	1.70	0.04	0.20	0.10	0.53	0.34	1.73	0.30	1.66

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

to explain physics concepts (TTM1) significantly improves students' ability to write clear and precise answers to physics questions (PHC4) is in line with Mayer's (2014) and Issa et al.'s (2011) cognitive theory of multimedia learning, which emphasizes that visual media can clarify abstract concepts and facilitate understanding. This finding provides empirical validation of previous studies (Lee et al., 2023; Mayer & Pilegard, 2005; Peterson, 2016), which highlight the importance of visual aids and multimedia in aiding students' understanding by breaking down complex ideas into more digestible visual formats. However, the lack of significant effects on other competency aspects, such as problem formulation (PHC1), provisional answer formulation (PHC2), solution procedure writing (PHC3), and physics-physics relationship writing (PHC5), suggests that media may be more effective in assisting certain competency aspects. This observation is consistent with previous research (Banda & Nzabahimana, 2021, 2023), which argues that while media can present information clearly, it may not always promote deep and comprehensive understanding of complex physics concepts. This highlights an important area for further research: understanding the limitations of media-based instruction and exploring ways to improve its effectiveness across all aspects of physics competency.

In contrast, the use of instructional media to illustrate complex concepts (TTM2) significantly affected students' ability to write procedural steps for solving physics problems (PHC3). This finding is consistent with research showing that visualization and simulation help students understand complex problem-solving procedures (Banda & Nzabahimana, 2023; Rutten et al., 2012). Understanding problem-solving steps is essential in physics education because it allows students to break down complex problems into more manageable parts (Usmeldi, 2015). This supports the idea that procedural knowledge (Jonassen & Carr, 2020), which is essential in problem solving, benefits greatly from media that offer interactive and visual representations of problems (Daryanes et al., 2023). However, the limited significant effects on other competency aspects suggest that this instructional media may be more beneficial for procedural understanding than conceptual understanding. The dichotomy between procedural and conceptual learning through media needs to be addressed in future pedagogical design, ensuring that media resources can provide a holistic learning experience. In contrast, the use of instructional media as part of a teaching strategy (TTM3) did not significantly affect students' writing ability and understanding of physics problems in all aspects measured. This may reflect the importance of good instructional design and integration of instructional media with other teaching strategies (Clark & Mayer, 2023). De Jong et al (2008) and Sari et al (2023) argue that instructional media must be carefully designed and integrated with broader teaching strategies to effectively enhance student competency. This underscores the importance of not only using media but doing so in a way that is carefully integrated with other teaching methods to maximize learning outcomes.

4.2 Impact of Mobile Learning Environments on Data Interpretation

In the context of modern learning, it is important to consider how mobile learning environments can influence the interpretation of data obtained. For example, do students who prefer tools accessible via mobile devices such as video or social media have different motivational profiles or learning outcomes compared to those who use desktop-based media? The findings of this study indicate that there are indeed significant differences. Preference for social media (LMP5) significantly influenced the ability to formulate tentative answers (PHC2) and understand teacher explanations (LMT1). This indicates that students who actively use mobile-based platforms for learning tend to develop better critical thinking and social interaction skills (Papadakis, 2020). Social media, which is generally accessed via mobile devices, facilitates collaborative learning that takes place anytime and anywhere, creating a more flexible and responsive learning environment (Ansari & Khan, 2020; Gikas & Grant, 2013).

In contrast, preference for simulations (LMP2), which generally require a more complex desktop interface, showed a significant effect on the ability to write physics problem-solving steps (PHC3) and comfort in learning physics (LMT4). This suggests that desktop-based media still has advantages for learning that requires complex visual manipulation and deep procedural understanding. Educational videos (LMP1) that can be accessed via mobile technology showed a significant effect only on interest in solving everyday physics problems (LMT6). This suggests that media that can be accessed across platforms tends to increase the practical application of physics learning in everyday life, because students can access learning content in a variety of situations and contexts. These profile differences suggest that instructional design should consider the unique characteristics of mobile learning environments that have many advantages. Mobile learning tends to support social interaction, flexibility of access, and practical application, while desktop learning is more supportive of complex manipulation and deep procedural understanding. However, students are more likely to find mobile technology easy to use than desktop technology.

4.3 Relationship Between Media-Based Learning Strategies and Student Learning Motivation

The results of the study also showed that media-based teaching strategies had a significant effect on student learning motivation. The consistency of the use of physics learning media by teachers (TTM1) did not have a significant effect on student learning motivation in all aspects measured. This shows that the frequency of media use alone is not enough to influence learning motivation and supports the view that the quality of media use is more important than quantity (Reeves, 1998). Research has shown that utilizing interesting and interactive learning media, such as audio-visual tools (Rahayu et al., 2023; Sanulita et al., 2024; Sarwinda et al., 2020) and YouTube for educational purposes (D'Aquila et al., 2019; Widiantari & Dewi, 2023) can have a positive impact on student motivation. This is important because it shifts the focus from simply incorporating technology to using it strategically to enhance the educational experience. However, the use of media to explain complex concepts (TTM2) significantly increased students' understanding (LMT1), engagement in asking questions (LMT3), and comfort level in learning physics (LMT4). This supports the view that strategic use of learning media can increase students' engagement and comfort in learning (Sung et al., 2016). When students feel more comfortable and engaged in learning, they tend to have higher motivation to learn and explore the material further (Puspitarini & Hanif, 2019). This finding is important for educators who strive to foster more engaging and supportive learning environments. The use of media as part of the learning method (TTM3) showed a significant effect on all aspects of motivation measured, especially on enjoyment (LMT2) and active engagement in solving everyday physics problems (LMT6). This finding underscores the importance of well-integrated learning media in teaching strategies to enhance the overall learning experience and increase student motivation (Sastradika et al., 2021; Yang & Baldwin, 2020). When students feel happy and engaged in learning, they are more motivated to actively participate and further develop their skills (Usmeldi et al., 2017). This is in line with self-determination theory, which states that motivation is enhanced when learning activities meet students' needs for competence, autonomy, and relatedness (Deci & Ryan, 2000; Ryan & Deci, 2020).

4.4 Relationship Between Learning Media Preferences and Students' Physics Competence

Students' preferences for certain learning media also affected their physics competence. Educational videos (LMP1) did not significantly affect all aspects of physics competence measured, indicating that although videos can capture students' attention (Solé-Llussà et al., 2020), they may be less effective in enhancing in-depth understanding of physics concepts. This is consistent with findings that passive consumption of content does not always result in higher-order thinking or deeper learning (Hobbins et al., 2020; Liu & Zhang, 2022). However, preference for using simulations (LMP2) significantly affected students' ability to write steps in physics problem-solving procedures (PHC3). Interactive simulations enhance understanding of complex concepts and make learning more enjoyable (Banda & Nzabahimana, 2023). This suggests that media that allow for active interaction and exploration may be more effective in enhancing students' problem-solving skills (Ceberio et al., 2016). The effectiveness of simulations is supported by constructivist theory, which advocates learning through practice and experience (Almulla, 2023; Alt & Itzkovich, 2019; Calalb, 2023). Preference for educational games (LMP3) only significantly affected some aspects of physics competency. While games can increase engagement (Alsawaier, 2018), they may only occasionally be effective in enhancing conceptual understanding or specific problem-solving skills. This highlights both the potential and limitations of gamified learning environments, suggesting the need for more sophisticated designs that target deeper learning outcomes. Similarly, preference for using educational websites (LMP4) did not show a significant effect on physics competency. While providing extensive information (Purnama et al., 2023), websites may be less effective in facilitating deep understanding without additional guidance. This highlights the importance of incremental learning experiences (Silva et al., 2023; Zuo et al., 2023) where resources are structured and supported by instructional design to facilitate understanding. However, preference for social media (LMP5) significantly affected students' ability to formulate tentative answers (PHC2). Social media can be an effective learning tool, allowing students to interact and learn collaboratively (Ansari & Khan, 2020; Gikas & Grant, 2013). Collaboration and discussion with peers through social media can help students better understand physics concepts and how to apply them in various contexts (Molinillo et al., 2018). This is in line with Baber (2022) and Chuang (2021), who emphasized the importance of social interaction in learning..

4.5 The Relationship Between Learning Media Preferences and Student Learning Motivation

Students' preferences for certain learning media also affect their learning motivation. The use of educational videos (LMP1) significantly affects interest and happiness in solving everyday physics problems (LMT6). This supports research showing that educational videos can increase student engagement and motivation (Wu et al., 2021; Zhang et al., 2006). When students enjoy and are interested in the material presented through videos, they are more motivated to learn further and apply their knowledge in real-life situations (De Leng et al., 2007; Liao & Wu, 2023). In addition, preference for simulations (LMP2) significantly affects the comfort of learning physics in class (LMT4). Interactive simulations can make learning more enjoyable and reduce students' anxiety when facing complex concepts (Banda & Nzabahimana, 2021, 2023; Perkins, 2020; Prabowo et al., 2018). When students feel comfortable and confident in learning, they tend to be more motivated and engaged in the learning process. This supports Schunk (2023) and Trautner & Schwinger (2020) who stated that students' beliefs in their ability to succeed in a particular task can improve their motivation and learning outcomes. Preference for social media (LMP5) showed a significant effect on understanding teacher explanations (LMT1) and interest in solving everyday physics problems (LMT6). This supports the view that social media can be an effective learning tool, allowing students to interact and learn collaboratively (Ansari & Khan, 2020; Gikas & Grant, 2013). Social media platforms allow interaction with teachers or peers about current issues (Ali et al., 2017; Molinillo et al., 2018) and can improve students' understanding of physics concepts and their ability to apply them in real-life situations (Oguguo et al., 2020; Zheng et al., 2010).

These findings suggest that instructional media, when used strategically and in alignment with students' preferences, can enhance their physics competency and motivation to learn. This study underscores the importance of selecting and using appropriate instructional media in physics education and the need to consider students' preferences to optimize learning outcomes. By understanding and leveraging students' preferences for instructional media, educators can design more effective and engaging learning experiences, which in turn, can enhance students' academic achievement and motivation to learn physics. Furthermore, these findings suggest that future research should continue to explore the nuanced ways in which different types of media can be integrated into instructional strategies to maximize their effectiveness. This could involve investigating how media can be combined with traditional teaching methods, how to best train educators to use these tools, and how to adapt media to meet the varying needs of students. Overall, technology integration in education should not be viewed as a one-size-fits-all solution but rather as a dynamic tool that can be adapted to enhance various aspects of the learning experience.

These findings have significant implications for physics education and the use of instructional media. First, understanding the relationship between students' instructional media preferences, physics competencies, and learning motivation provides a clearer view of how to improve students' learning experiences in physics. By knowing students' instructional media preferences, teachers can adjust the use of instructional media to improve students' understanding of physics concepts and their motivation. Second, the implications of this study are relevant to curriculum development and learning design. The results show that the use of instructional media, especially simulations and social media, can improve several aspects of students' physics competencies and learning motivation. Therefore, integrating appropriate instructional media into the physics curriculum can help improve the effectiveness of learning and students' interest in the subject.

In addition, this study highlights the importance of teacher training in using instructional media. Teachers who are skilled in integrating instructional media into their teaching can create a more engaging and interactive learning environment, encourage student participation and improve their understanding of physics concepts. Another implication is the importance of research and development of innovative instructional media. By understanding students' instructional media preferences and their impact on physics learning, developers can design more effective and engaging learning applications and tools for students. Thus, the findings of this study provide a strong foundation for developing better physics learning strategies that utilize technology more effectively, as well as providing directions for future research and development of learning media.

Although this study offers valuable insights into the relationships between the use of media-based teaching strategies, learning media preferences, students' physics competency, and learning motivation, it is important to acknowledge several limitations. First, the generalizability of the results may be limited because the study was conducted with a limited sample of students in a secondary school setting, so the results may not be directly applicable to a wider student population. Furthermore, this study only considered media-based teaching strategies and learning media preferences as independent variables. In contrast, other factors such as individual learning styles and social support should have been considered in detail. In addition, this study is temporally limited, as it was conducted over a specific period and may not have considered changes in learning media and teaching strategies in the future. Therefore, future studies need to expand the scope of variables, use more diverse measurement methods, and conduct cross-cultural or cross-national studies to understand the relationships between teaching strategies, media preferences, physics competency, and students' learning motivation.

5 Conclusion

This study uncovers the complex relationships among media-based teaching strategies, students' learning media preferences, physics competencies, and learning motivation. The results indicate that teachers' use of learning media, especially as part of a teaching strategy, has a significant positive impact on various aspects of students' competence and motivation in learning physics. The findings also suggest that the use of learning media, especially simulations and social media, can have a positive impact on several aspects of students' physics competencies and learning motivation. However, these effects vary depending on the type of learning media and students' technology preferences, particularly between mobile and desktop users. Based on the findings that students' preferences for mobile-based media correlate with different motivational profiles and learning outcomes, this study provides specific practical implications for mobile learning environments. Teachers can strategically incorporate mobile-based simulations; for example, by utilizing mobile-optimized physics simulation applications, such as PhET Interactive Simulations Mobile, students can conduct virtual experiments anytime and anywhere, encouraging independent exploration and deeper conceptual understanding. Furthermore, physics curricula can be integrated with platforms that can be accessed via smartphones. These include the use of augmented reality (AR) applications to interactively visualize abstract physics concepts, or leveraging mobile-friendly learning management systems (LMS) to facilitate student discussions and collaboration outside of class. Given the positive influence of social media on learning motivation, teachers can also create physics study groups on social media platforms popular with students, facilitate informal discussions about physics phenomena in everyday life, and encourage students to share simple experiments or physics observations through short videos. These approaches directly provide a practical bridge for audiences involved in mobile learning system research or design, demonstrating how academic findings can be translated into innovative instructional designs. These findings provide valuable insights for educational practitioners who aim to improve students' learning experiences in physics by effectively utilizing learning media, especially in mobile environments. Teachers can adjust teaching strategies and choose learning media that suit students' preferences to enhance their understanding of physics concepts and learning interests. Thus, these findings offer a strong foundation for developing better and more innovative physics learning strategies and provide directions for future learning media research and development. Prospects for developing the results of this study include expanding the scope of variables considered, such as individual learning styles and social support, and using more diverse measurement methods. Future research can investigate the long-term impact of media-based teaching strategies on student learning outcomes and explore the integration of various learning media with traditional teaching methods to maximize their effectiveness.

Conflicts of interest

The authors declare that they have no conflict of interest.

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