

Assessing the influence of multimedia instruction on knowledge transfer in higher education: Multimodal learning experiences

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Abstract

This study investigates the impact of multimedia instruction on knowledge transfer in higher education. Focused on the evolution from traditional lecture-based methods to interactive approaches, the research conducted at the Indonesian International Islamic University with postgraduate students highlights live demonstrations as the preferred multimedia tool, perfectly aligning with the practical nature of postgraduate education. The key findings underscore the integral role of technological infrastructure and teacher training in ensuring successful multimedia integration. Notwithstanding challenges such as curriculum misalignment and resistance to change, the study emphasizes the overwhelmingly positive impact of multimedia on learning outcomes. This insight offers crucial considerations for refining postgraduate curricula, strategically investing in technology, and promoting faculty development initiatives. The intricate interplay among technological infrastructure, teacher expertise, and curriculum alignment stresses the imperative of a holistic strategy. Implications extend to aligning multimedia content with student preferences, investing in robust institutional support, and recognizing the potential for personalized learning through multimedia tools. The study advocates for the strategic integration of visual and interactive elements in education, urging universities to embrace multimedia for optimal instructional outcomes and preparing students for modern world complexities, offering valuable insights for educators, instructional designers, and policymakers.

Keywords: multimedia instruction; knowledge transfer; higher education; teaching methodology; learning outcome; pedagogical approach

INTRODUCTION

The acknowledgment of diverse learning modalities and preferences among students has significantly influenced the trajectory of educational approaches in higher education (Abdulrahman et al., 2020). There has been a deliberate departure from conventional lecture-based instruction, with a gradual shift towards more inclusive and interactive techniques facilitated by the integration of multimedia elements, enabled by Information and Communication Technology (Lu, 2024). This shift plays a pivotal role in reshaping educational practices.



Multimodal learning emphasizes the integration of diverse media formats, including text, images, audio, and video, into educational resources. Grounded in cognitive theories, such as Mayer's Cognitive Theory of Multimedia Learning (Mayer, 1999; AlShaikh et al., 2024). This approach posits that exposure to a variety of stimuli enhances individuals' learning and retention capacities, as highlighted by (Qiao et al., 2024). Engaging multiple sensory modalities not only accommodates different learning preferences but also reinforces information delivery through multiple channels, potentially fostering deeper comprehension and retention (Ramgadwala, 2024).

The integration of diverse media formats represents a paradigm shift in educational methodologies, highlighting that optimal learning outcomes are achieved when educators address multiple learning styles simultaneously through multimodal instruction (Chen et al., 2021). There is a growing emphasis on utilizing multimedia tools to construct learning environments that are not only inclusive but also conducive to the diverse requirements of students. An analysis of best practices to enhance higher education teaching staff digital and multimedia skills (de Juana-Espinosa et al., 2023).

In higher education settings, the integration of multimedia elements, such as videos, animations, and interactive simulations, plays a crucial role in facilitating knowledge transfer and promoting active student engagement (Barbetta, 2023; Harun & Singh, 2024) which is also supported by Limperos et al. (2015) who explain about online teaching technologies. The advantages of multimodal learning strategies underscore the importance of creating inclusive and engaging learning environments tailored to diverse learning styles and preferences (Querol-Julián & Crawford Camiciottoli, 2019). Technological integration, especially through digital platforms and interactive tools, further amplifies the potential of multimodal learning experiences, with virtual and augmented reality, simulations, and interactive multimedia platforms offering immersive and engaging environments (Ektefaie et al., 2023). In their research "I learned about children, things that I had never learned before Enhancing Knowledge, Fostering Belonging, and Advancing", Mayer et al. (2024)'s findings highlight that the strategic inclusion of visuals significantly increases students' ability to apply acquired knowledge in problem-solving scenarios. Moreover, Mayer emphasizes the importance of careful design, particularly the spatial relationship between text and visuals, in optimizing learning outcomes within multimedia instruction as also supported by (Özcan, 2022).

Integrating multimedia technology in education transforms learning experiences by combining text, graphics, audio, video, and animation (Mutlu-Bayraktar et al., 2019). The Promise and Challenges of Multimodal Learning Analytics suggest that Learning outcomes result from interactions between intra-individual factors, such as prior knowledge, emotions, and motivation; as well as the contextual factors in which the learning takes place (Cukurova et al., 2020; Rieger et al., 2021). As discussed by Ouhaichi et al., (2023), multimodal learning marks a shift from traditional lectures, particularly benefiting online education by fostering inclusivity and flexibility. The importance of multimedia technologies and applications in education as a learning tool is further emphasized by Xu et al. (2023), who demonstrated its significance in enhancing students' academic achievement at King Saud University. Additionally, Ryoo and Winkelmann (2021) discuss the impact of multimedia structure and format on DVD for Social Studies teaching, noting that the nature of the theme and assessed outcomes influence multimedia design. However, visual sources and documentary excerpts didn't significantly affect knowledge and application outcomes. These studies demonstrate the effectiveness of incorporating images, animations, and interactive elements alongside textual content to facilitate a more effective comprehension

of concepts (Pimmer et al., 2016; Rahmanu & Molnár, 2024). Understanding the dynamic interplay between technological tools, pedagogical approaches, and content knowledge is crucial for educators to harness the full potential of multimedia in enhancing the teaching and learning journey (Wu, 2024).

Cukurova et al. (2020) make a significant contribution to elucidating the impact of multimedia on the enhancement of learning experiences. Their research substantiates the notion that incorporating images and animations alongside textual content facilitates a more effective comprehension of concepts, thereby actively involving learners' social, emotional, and intellectual faculties. Understanding the dynamic interplay between technological tools, pedagogical approaches, and content knowledge is crucial for educators to harness the full potential of multimedia to enhance the teaching and learning journey.

As the educational landscape embraces digital transformation, comprehending the implications of multimedia instruction becomes crucial for educators, curriculum designers, and policymakers. Despite the growing adoption of multimedia instruction, there exists a gap in understanding the nuanced impact of such approaches on knowledge transfer. While acknowledging the positive impact on learning outcomes, this study aims to explore preferences, challenges, and factors influencing the integration of multimedia in educational contexts. Using descriptive statistics and cross-tabular analysis, the research aligns instructional methods with student preferences and addresses institutional challenges for optimal learning experiences (Liu, 2023). Therefore, this study aims to investigate currently available multimedia tools, identify suitable components tailored to specific audiences, assess the effectiveness of multimedia tools in facilitating successful teaching and learning outcomes, and explore key factors contributing to potential shortcomings in their utilization. The research aims to address the following questions: What multimedia tools are currently employed in instructional settings? Which multimedia components are most suitable for specific target audiences? What factors significantly enhance the effectiveness of multimedia tools in facilitating successful teaching and learning outcomes? What factors are responsible for impeding the efficacy of multimedia tools in the context of teaching and learning?

METHODS

The general approach or blueprint used by a researcher to carry out a study is referred to as the research design. This involves choices between data-gathering methods, sample methodologies, experimental or observational approaches, and data-processing procedures (Rainforth et al., 2024). Quantitative research, specifically a cross-sectional design, was chosen for its ability to provide a structured, numerical analysis of multimedia instruction's influence on knowledge transfer in higher education. This approach enables a systematic examination, utilizing descriptive statistics to summarize the characteristics and frequencies of multimedia tools, namely video lectures, interactive presentations, podcasts, and live demonstrations. The quantitative design also facilitates the application of cross-tabulation techniques to identify relationships between these multimedia components and the target audience, which comprises postgraduate students from diverse academic disciplines at Indonesia International Islamic University. Subjects were not manipulated or placed into conditions; instead, they were observed within their natural instructional settings. There was no random assignment of participants to conditions. Thus, the research design is characterized as non-experimental and conducted within the natural context of higher education settings.

The participants in this study are postgraduate students from Indonesia International Islamic University, representing diverse academic disciplines. The initial target included all enrolled postgraduate students, resulting in a sample size of 90 respondents. However, due to incomplete questionnaire responses, 10 participants were excluded. Consequently, the final participant cohort comprises 80 university master's students, ensuring the integrity and completeness of the collected data for rigorous examination and interpretation. Data were collected through a structured questionnaire designed to gather information on students' experiences with multimedia instruction and its impact on knowledge transfer. The questionnaire consisted of both closed-ended and Likert-scale questions, allowing for quantitative analysis. Prior to distribution, a pilot test was conducted to refine the questionnaire and ensure its reliability and validity.

RESULT AND DISCUSSION

The research investigates various aspects of multimedia tools in pedagogy, focusing on their prevalence, effectiveness, and challenges in educational settings; and addresses the following : first, to scrutinize the prevailing multimedia tools employed in instructional contexts, 2nd, to ascertain the suitability of specific multimedia components for the intended audience, 3rd, to identify the most effective mode facilitating the success of multimedia tools in educational settings, and to delve into the primary factor contributing to the shortcomings in the utilization of multimedia tools for teaching and learning.

The mode, representing the multimedia tool with the highest frequency, is Live Demonstrations with 47 occurrences as shown in figure 1 below, constituting 59% of the total responses as seen in table 1 below. This substantial percentage underscores the prevalence and preference for live demonstrations as the dominant multimedia tool among the identified options. The frequency distribution table provides a clear overview of the distribution of preferences among students for different multimedia tools. Live demonstrations stand out as the most favored mode, suggesting a strong inclination towards real-time, practical presentations. This information is crucial for educators and instructional designers seeking to align their teaching methods with the preferences of the students. The absence of preferences for podcasts indicates a lower interest in audio-only content delivery methods among the participants.

Table 1. Frequency distribution table of multimedia tools

Multimedia Tools	Frequency	Percentage
Video Lectures	19	24%
Interactive Presentations	14	18%
Podcasts	0	0%
Live Demonstrations	47	59%

Frequency and Percentage

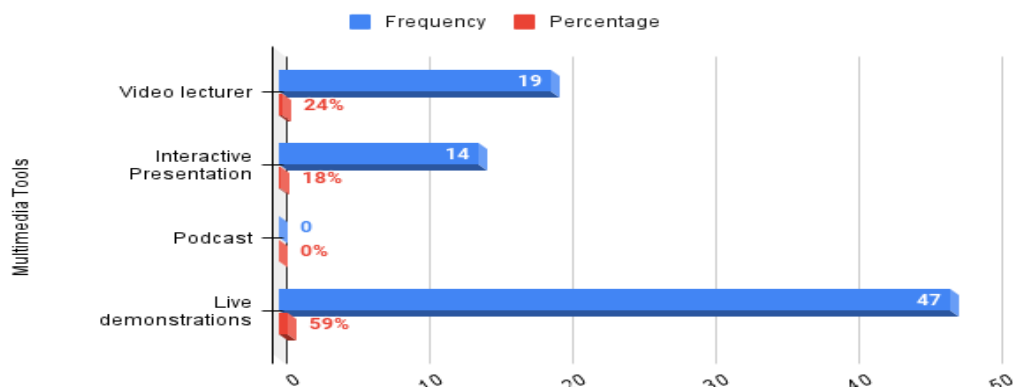


Figure 1. preferences of students regarding different modes of multimedia content delivery

Multimedia component preferences for the audience

The mode, representing the multimedia component with the highest frequency, is Interactive Quizzes with 44 occurrences as seen in the frequency table 2 below constituting 55% of the total responses as seen in the pie chart below. This substantial percentage underscores the prevalence and strong preference for interactive quizzes and polls as the dominant multimedia component among the identified options. The frequency distribution table reveals distinct preferences among participants for various multimedia components. Interactive quizzes and polls emerge as the most favored, indicating a substantial interest in engaging and participatory instructional elements. Online mode also registers a notable preference, aligning with the contemporary trend towards digital and remote learning. While projectors and audio-visual elements receive fewer preferences, they still signify a subset of participants favoring traditional audio-visual aids. These insights provide valuable guidance for educators and instructional designers, emphasizing the importance of interactive and online elements in crafting effective instructional content.

Table 2. Frequency distribution table: Multimedia component preferences

Multimedia Tools	Frequency	Percentage
Online mode	27	34%
Projector	5	6%
Audio-visual	4	5%
Interactive quizzes	44	55%

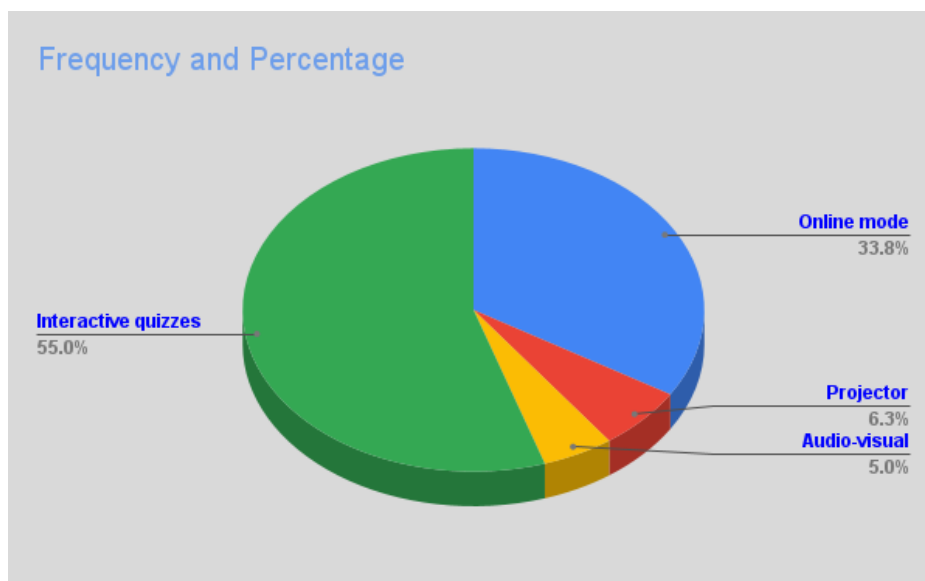


Figure 2. Preferences of students regarding different modes of multimedia content delivery

Factors Aiding Success in the Use of Multimedia Tools

The mode, representing the factor with the highest frequency as demonstrated in the table below, is technological Infrastructure with 31 occurrences, constituting 39% of the total responses. This significant percentage underscores the perceived importance of technological infrastructure in aiding the success of multimedia tools usage. The frequency distribution table illuminates the distribution of preferences among participants regarding factors that aid the success of multimedia tools. Technological infrastructure emerges as the predominant factor, suggesting its pivotal role in facilitating effective integration and utilization of multimedia tools. This finding implies that participants attribute a substantial impact on success to the presence of robust technological support. These insights provide educators and administrators valuable guidance for resource allocation and strategic planning in the effective implementation of multimedia tools in university settings.

Table 3. Frequency distribution table for the factors aiding success in the use of multimedia tools

Factors Aiding success	Frequency	percentage
Availability of funds	5	6%
Nature of the student	9	11%
Technological infrastructure	31	39%
Teacher training and expertise	25	31%
Curriculum alignment	10	13%

Factors contributing to failure in the use of multimedia tools

The mode, representing the challenge with the highest frequency, is Inadequate Integration with the Curriculum with 24 occurrences, constituting 30% of the total responses as shown in the table below. This substantial percentage indicates that the majority of participants perceive curriculum integration as a significant challenge in incorporating multimedia tools.

The frequency distribution table offers a comprehensive overview of the challenges encountered in integrating multimedia tools, shedding light on the varying concerns expressed by participants. The prevalence of challenges such as Lack of Technical Support, Resistance to Change, and Inadequate Integration with the Curriculum underscores the multifaceted nature of obstacles faced by educators and institutions. This information is valuable for educators, administrators, and policymakers seeking to address these challenges strategically and enhance the seamless integration of multimedia tools into educational practices.

Table 4. Frequency distribution table for the identified challenges in integrating multimedia tools

Challenges in Integrating Multimedia Tools	Frequency	percentage
Availability of funds	5	6%
Nature of the student	4	5%
Environment	6	8%
Lack of technical support	21	26%
Resistance to change	20	25%
Inadequate integration with the curriculum	24	30%

Frequency and percentage

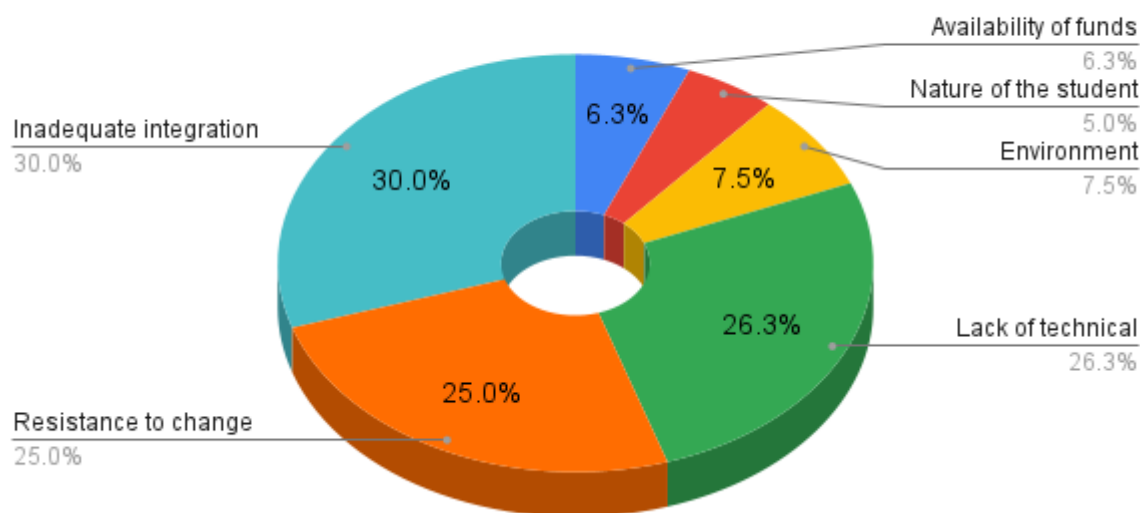


Figure 3. Challenges in Integrating Multimedia Tools

Cross-tabulation Analysis

Factors influencing multimedia use vs. impact on knowledge

The cross-tabulation analysis of factors influencing multimedia use versus their impact on knowledge yields insightful patterns and trends in respondents' perceptions. Notably, the availability of funds is associated with a "Greater Extent" impact on knowledge, suggesting that financial resources play a positive role in facilitating knowledge transfer through

multimedia tools demonstrated in the table below. The nature of the student is identified as another influential factor, with respondents perceiving a higher impact on knowledge when considering student characteristics. Technological infrastructure emerges as a significant contributor, with a considerable number of respondents associating a "Greater Extent" impact on knowledge with robust technological support. Moreover, teacher training and expertise exhibit a positive correlation with perceived impact, emphasizing the pivotal role educators play in optimizing multimedia tools for enhanced learning outcomes. Curriculum alignment is also underscored as a crucial factor, with respondents linking a "Greater Extent" impact on knowledge to multimedia tools that align seamlessly with the academic syllabus. These findings collectively provide nuanced insights into the factors perceived to have a stronger impact on knowledge transfer, offering valuable guidance for educators and policymakers in strategically leveraging multimedia tools for optimal learning outcomes.

Table 5. Cross-tabulation table: Factors influencing multimedia use vs. impact on knowledge

	Greater Extent	Medium Extent	Lower Extent	No Impact
Availability of funds	2	2	0	0
Nature of the student	5	1	2	1
Technological infrastructure	16	2	8	2
Teacher training and expertise	13	7	3	3

Challenges in integrating multimedia tools vs. Impact on Knowledge

The cross-tabulation table below reveals patterns regarding challenges affecting the perceived impact on knowledge. Among the highlighted challenges, the most striking observation is resistance to Change, 13 in total, with a greater extent of impact on knowledge. This resistance may arise from various factors such as unfamiliarity with technology or a preference for traditional teaching methods by educators. Resistance can slow down the adoption of multimedia, limiting the exposure of learners to innovative and have interactive learning experience. 9 respondents who identified the lack of technical support as a challenge predominantly reported experiencing a greater extent of impact on knowledge. This limitation can result in difficulties accessing the tools and troubleshooting technical issues, ultimately affecting the seamless integration of multimedia into the learning environment.

Conversely, insufficient alignment of multimedia tools with the curriculum can lead to a bad learning experience. This may result in a lack of coherence in content delivery, diminishing its effectiveness in enhancing understanding and retention of key concepts. These patterns indicate a noteworthy link between these challenges and an amplified perceived impact on knowledge. These findings are instrumental for educators and administrators in strategizing interventions to mitigate challenges and enhance the seamless integration of multimedia tools, ultimately fostering a more effective learning environment.

Table 6. Cross-tabulation table: Challenges in integrating multimedia tools vs. impact on knowledge

	Greater Extent	Medium Extent	Lower Extent	No Impact
Availability of funds	1	1	3	0
Nature of the student	2	0	0	2
Environment	3	2	1	0
Lack of technical support	9	7	2	3
Resistance to change	13	3	3	1
Inadequate integration with the curriculum	12	4	5	3

Preferred modes of content delivery vs. perception of multimedia tools

The cross-tabulation table (Table 7) examining the relationship between preferred modes of content delivery and the overall perception of multimedia. The table presents a breakdown of student's attitudes categorized as positive, neutral, or negative towards four different modes of content delivery: video lectures, interactive presentations, podcasts, and live demonstrations. Upon reviewing the counts in each cell of the table, it becomes evident that a higher number of respondents who preferred live demonstrations expressed a positive perception (25 counts) compared to those who chose video lectures (11 counts) and interactive presentations (9 counts). Additionally, live demonstrations garnered a relatively higher count (11) in the negative perception category compared to video lectures (1 count) and interactive presentations (4 counts).

The cross-tabulation suggests a correlation between the preference for live demonstrations and a more diverse range of perceptions, both positive and negative. This could indicate that respondents perceive live demonstrations as a mode of content delivery that elicits stronger reactions, possibly due to its interactive and dynamic nature. Conversely, video lectures and interactive presentations show a higher count in the positive perception category, suggesting that these modes are more consistently associated with positive attitudes. The absence of responses in the negative category for video lectures and podcasts indicates a relatively more favorable perception of these modes. These findings offer valuable considerations for educators and instructional designers looking to align content delivery methods with students' preferences and perceptions for an enhanced learning experience.

Table 7. Cross-tabulation table: Preferred modes of content delivery vs. perception of multimedia tools

	Positive	Neutral	Negative
Video lectures	11	7	1
Interactive presentations	9	1	4
Podcasts	0	0	0
Live demonstrations	25	11	11

Positive, Neutral and Negative

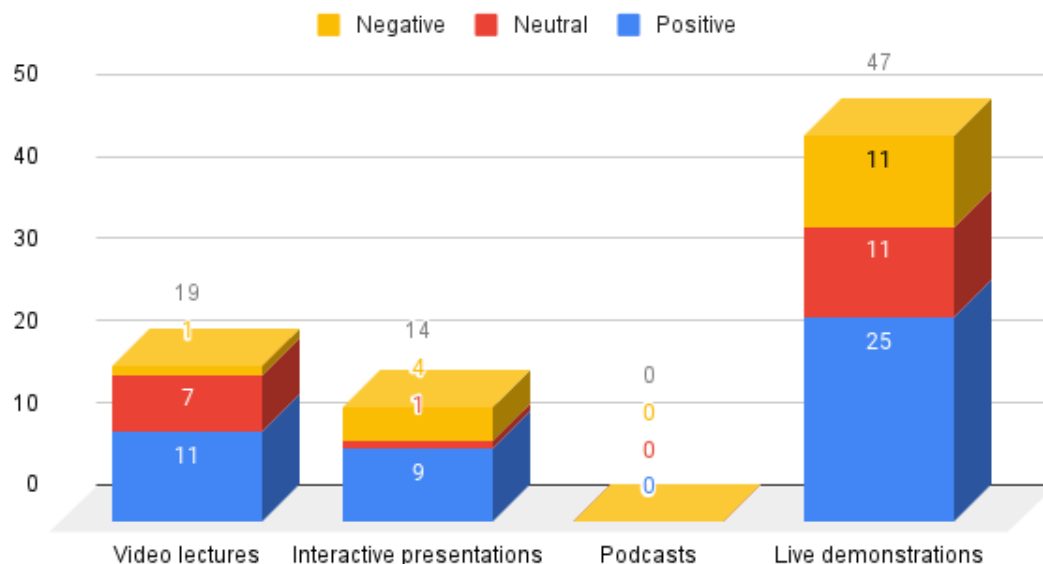


Figure 4. Preferred modes of content delivery vs. perception of multimedia tools

In comparison to previous research results, [Ouhaichi et al. \(2023\)](#) found that adding pictures to words in instructional messages significantly increased students' ability in problem-solving transfer, emphasizing the importance of multimedia in enhancing learning outcomes. [Xu et al. \(2023\)](#); [Giannakos & Cukurova, 2023](#)) also highlighted the positive impact of multimedia on academic achievement and learning experiences, corroborating the findings on multimedia's effectiveness in education. However, [Spikol and Cukurova \(2020\)](#) noted that the structure and format of multimedia may not significantly affect knowledge and application outcomes, suggesting a nuanced relationship between multimedia design and learning outcomes, which contrasts with the emphasis on technological infrastructure in the current study.

Overall, while previous research emphasizes the positive impact of multimedia on learning outcomes, the current study provides insights into the preferences, challenges, and factors influencing the successful integration of multimedia tools in educational contexts, highlighting the importance of aligning instructional methods with student preferences and addressing institutional challenges for optimal learning experiences.

Discussion

Analyzing multimedia tool preferences and success factors among postgraduate level students

Analyzing the multimedia tool preferences and success factors among postgraduate students reveals valuable insights for universities seeking to optimize their educational strategies. The preference for live demonstrations among postgraduate students reflects a desire for real-world applications, aligning seamlessly with the practical and experiential learning emphasis in higher education. To leverage this preference, universities can integrate more real-world examples and applications, incorporating live demonstrations into their curriculum to make educational content more relevant. Moreover, the inclination

toward interactive quizzes among postgraduate students underscores their appreciation for engaging learning methods that stimulate advanced intellect, a crucial aspect in research-oriented master's programs. Recognizing this, universities can enhance the learning experience by incorporating more quizzes, discussions, and collaborative activities, fostering a dynamic and intellectually stimulating environment that aligns with the preferences of postgraduate students.

The identified success factors shed light on dimensions significantly contributing to the academic achievements of postgraduate students. The emphasis on the significance of technological infrastructure highlights its pivotal role in facilitating advanced research and collaborative projects. To benefit from this insight, universities can strategically invest in and upgrade their technological infrastructure, providing access to cutting-edge software and high-performance computing resources, thereby meeting the advanced research needs of postgraduate students. Furthermore, the recognition of teacher training and expertise as a crucial success factor emphasizes the influential role educators play in shaping the trajectory of advanced research pursuits. Universities can gain from this information by prioritizing ongoing teacher training programs, ensuring faculty members are updated with the latest advancements in their fields. Recognizing and rewarding teaching excellence can motivate educators to enhance their expertise, ultimately benefiting the academic achievements of postgraduate students.

The success factors identified, including technological infrastructure and teacher training, emphasize the need for alignment with curriculum goals and pedagogical strategies. The symbiotic relationship between these elements contributes to the seamless integration of multimedia tools into the educational landscape. Aligning multimedia tools with curriculum goals is crucial for effective incorporation, yet challenges in achieving this alignment, such as inadequate integration with the curriculum, highlight the need for a strategic and collaborative approach. For example, introducing interactive simulations in courses focused primarily on theoretical concepts without linking these tools to assessment outcomes can lead to student confusion about their relevance. Such misalignments suggest the need for a more intentional integration process. A collaborative approach, involving curriculum designers, faculty, and technology experts, can help tailor multimedia tools to meet specific learning objectives. Additionally, pilot testing and gathering feedback from both students and instructors can help fine-tune these tools for effective use. Educator training on aligning multimedia tools with course outcomes is also essential, ensuring that multimedia supports the curriculum's educational objectives (Sailer et al., 2024). This approach highlights that successful multimedia integration depends on intentional alignment with both pedagogical and institutional goals.

Universities can use these insights to tailor their postgraduate curriculum, strategically invest in technological advancements, prioritize faculty development initiatives, and enhance student engagement. By doing so, institutions can optimize their educational strategies, improve the overall learning experience, and foster success in advanced research-oriented programs.

Analyzing success-enabling factors and obstacles in integrating multimedia tools within the university setting

The exploration of success-enabling factors and obstacles in integrating multimedia tools within the university setting reveals a multifaceted scenario. One critical aspect is the symbiotic relationship between technological infrastructure and technical support. While a robust technological foundation is crucial, the absence of effective technical support can impede success. This underscores the necessity for universities to adopt a comprehensive

approach, ensuring not only the availability of advanced multimedia tools but also the provision of adequate technical assistance. Furthermore, the acknowledgment of teacher training and expertise as pivotal success factors introduces another layer of complexity. The proficiency and adaptability of educators are essential components for successful integration. However, the challenge of resistance to change, whether from educators or institutional structures, emerges as a substantial barrier. Universities must recognize the significance of investing in continuous professional development for educators to enhance their skills and adaptability. Simultaneously, addressing institutional resistance through strategic planning becomes imperative for a seamless integration process.

The alignment of curriculum with multimedia tools is identified as a success-promoting factor, emphasizing the importance of incorporating innovative tools seamlessly into educational frameworks. However, challenges arise in achieving this alignment, such as inadequate integration with the curriculum. Here, universities need to focus on a strategic and collaborative approach, fostering communication between technology experts and curriculum designers to ensure a harmonious incorporation of multimedia tools.

In summary, the intricate web of synergies and tensions in the integration of multimedia tools within the university setting underscores the need for a holistic strategy. Universities can benefit from this information by recognizing the interdependence of technological infrastructure, teacher expertise, and curriculum alignment. By addressing challenges head-on, institutions can formulate targeted strategies that optimize the integration of multimedia tools. This, in turn, can lead to enhanced academic outcomes, providing a dynamic and technologically enriched learning environment for students. Embracing change, investing in professional development, and fostering collaboration are key pillars for universities to navigate this complex landscape successfully.

Implications for educators and policymakers

The implications of our findings for educators, instructional designers, and policymakers are multifaceted. Designing and delivering multimedia content should align with the preferences identified, emphasizing live demonstrations, interactive quizzes, and online modes to foster engagement and effective learning among postgraduate students. This aligns with Mayer's Cognitive Theory of Multimedia Learning, which asserts that people learn more effectively when information is presented through both visual and auditory channels, as it reduces cognitive overload and allows for better retention of knowledge. Institutional support, particularly in technological infrastructure and professional development for educators, emerges as a critical component for the success of multimedia tools. Adequate investment in these areas can significantly enhance the integration of multimedia tools into teaching practices at the postgraduate level.

One significant implication for educators is the potential for multimedia technologies to support individualized learning. The flexibility afforded by these tools allows students and teachers to tailor their learning experiences, working at their own pace and rhythm. This flexibility aligns with Mayer's theory, which emphasizes that learners benefit when they can process information at a pace that matches their cognitive capacities. Multimedia technologies, by facilitating repetitive practice and skill development, contribute to the intensification of the educational process, nurturing individual competencies crucial for future specialists. Furthermore, the emphasis on clarity in education through the use of visual and interactive elements reveals the potential for multimedia technologies to improve comprehension and retention. According to Mayer's principles, integrating visual elements with corresponding spoken or written text reduces cognitive load and enhances understanding, which is critical for effective learning. This has implications for pedagogical

strategies, encouraging innovative approaches to content delivery. Universities can benefit by integrating multimedia technologies strategically into their curriculum, ensuring that pedagogical goals are met effectively. This may involve faculty development programs to enhance educators' proficiency in utilizing multimedia tools for optimal instructional outcomes.

It is crucial for universities to recognize that the transformative potential of multimedia technologies is not limited by technological capabilities alone. Instead, their effective integration hinges on alignment with pedagogical learning objectives. This insight emphasizes the need for universities to adopt a holistic approach when incorporating multimedia technologies into their educational framework. By viewing these technologies as means to achieve practical skills and abilities, universities can navigate the challenges and fully capitalize on the benefits offered by multimedia in reshaping the educational landscape.

Recommendations for curriculum development

Integration of live demonstrations in research-driven courses

The integration of live demonstrations into research-driven courses serves as a valuable solution to address challenges that postgraduate students often encounter in the methodology of research. Postgraduate students, particularly those engaged in advanced research, frequently face difficulties in translating theoretical concepts into practical applications. The abstract nature of research methodologies can pose a barrier to understanding, and students may struggle to grasp the intricacies of applying these methodologies in real-world scenarios.

In a university functioning as a research institute, the recommendation to integrate live demonstrations directly addresses this challenge. By incorporating real-world applications into theoretical discussions, educators create a bridge between academic concepts and practical research. For instance, in a postgraduate research methods course, live demonstrations can be strategically introduced to showcase the hands-on application of various research methodologies. This approach allows students to witness, firsthand, how theoretical concepts manifest in actual research practices.

The hands-on nature of live demonstrations provides students with tangible insights into the research process. It goes beyond theoretical discussions on methodology, offering a visual and experiential understanding of how research is conducted in real-world settings. This immersive learning experience not only caters to the preference for real-world relevance among postgraduate students but also addresses the specific challenges they face in grasping the practical nuances of research methodologies. Moreover, live demonstrations enable students to enhance their comprehension and applicative skills. By observing the application of research methodologies in a live setting, students gain a deeper understanding of the sequential steps, decision-making processes, and potential challenges involved in conducting research. This practical exposure contributes to a more robust skill set, empowering students to navigate the complexities of research methodology with confidence.

In summary, the integration of live demonstrations serves as a targeted solution to the challenges faced by postgraduate students in understanding and applying research methodologies. It transforms the learning experience by providing a real-world context, fostering a deeper comprehension of theoretical concepts, and equipping students with the practical skills necessary for advanced research pursuits.

Facilitation of collaborative research platforms

In recognizing the critical role of technological infrastructure and collaborative learning in advanced research, the university can take concrete steps to establish online platforms dedicated to fostering collaborative research projects. These platforms serve as virtual spaces that encourage interdisciplinary collaboration among postgraduate students and researchers. For instance, the university could develop an online research hub equipped with collaborative document-sharing features. This hub becomes a centralized digital space where researchers can upload, share, and collectively edit documents related to their projects. This not only streamlines communication but also ensures that all team members have real-time access to the latest project developments, contributing to a more efficient and collaborative research process.

Additionally, the platform can integrate project management tools, allowing students to set milestones, assign tasks, and track progress collaboratively. For example, a shared project calendar could help students schedule research milestones and deadlines, promoting effective time management and coordination within research teams. This feature enhances overall project organization and ensures that each team member contributes actively to the research endeavor. Furthermore, to inspire greater involvement in research activities, the collaborative platform can incorporate features that showcase ongoing projects, achievements, and opportunities for collaboration. This could include a virtual bulletin board highlighting successful research outcomes, profiles of researchers, and announcements about upcoming research-related events. By creating a visually engaging and informative space, the platform not only enhances awareness but also instills a sense of pride and motivation among postgraduate students, inspiring them to actively participate in collaborative research initiatives.

In essence, the establishment of these collaborative research platforms goes beyond providing a technological solution. It cultivates a vibrant research ecosystem within the institution by fostering active engagement, efficient communication, and a shared sense of accomplishment among postgraduate students and researchers. Through this initiative, the university not only aligns with the identified success factors but also lays the groundwork for a dynamic and collaborative research culture that enhances the overall academic experience for postgraduate learners.

Strategic investment in technological infrastructure

To bolster the research capabilities of the university and enhance the postgraduate learning experience, a strategic investment in technological infrastructure is imperative. Allocating resources to upgrade technological facilities can significantly contribute to the success of postgraduate students engaged in advanced research. One tangible recommendation is the establishment of a state-of-the-art Research Computing Center. The university can allocate funds to create a dedicated Research Computing Center, equipped with cutting-edge computing resources and advanced software tools. This center becomes a hub for postgraduate students conducting research, offering a technologically enriched space conducive to advanced academic pursuits. High-performance computing resources, including clusters and servers, facilitate computationally intensive tasks, empowering students to engage in sophisticated data analysis, simulations, and modeling.

In addition, the Research Computing Center can provide access to specialized software tools relevant to various disciplines. For instance, in scientific research, students may need access to specialized simulation software, while those in social sciences may require advanced statistical analysis tools. The availability of such resources ensures that postgraduate students have the technological support needed for their individual research

endeavors. Moreover, the center serves as a collaborative space where interdisciplinary projects can thrive. Researchers from different departments can leverage the shared infrastructure to collaborate on projects that transcend traditional academic boundaries. This fosters a dynamic research environment, encouraging the exchange of ideas and the cultivation of cross-disciplinary approaches.

By strategically investing in technological infrastructure, the university not only addresses the preference for advanced technological tools among postgraduate students but also creates a foundation for collaborative research initiatives. This, in turn, contributes to the overall academic achievements of the postgraduate community and elevates the institution's standing as a research-driven university.

Limitation of the research

The findings of this study, while offering valuable insights, are subject to certain limitations that warrant acknowledgment. Firstly, the research scope was confined to postgraduate students enrolled in master and PhD programs. As a result, the generalizability of the study's findings to other academic contexts, such as undergraduate programs or professional degrees, is constrained. The unique characteristics and learning preferences of undergraduate students may differ significantly, underscoring the need for caution in applying the results beyond the specific demographic studied.

Another notable limitation pertains to the exclusive focus on student perspectives. While understanding student preferences is essential, the absence of insights from faculty members and administrators represents a significant gap in the research. These key stakeholders play crucial roles in shaping and implementing educational strategies, and their perspectives are vital for a comprehensive understanding of the dynamics surrounding multimedia instruction.

Additionally, external factors such as disparities in technology access and cultural influences on multimedia integration could impact the effectiveness of multimedia tools across diverse contexts. For instance, students from underprivileged backgrounds may face challenges related to reliable internet access, quality devices, or even familiarity with digital platforms, which can hinder their ability to fully engage with multimedia content. Moreover, cultural factors might shape how multimedia tools are received and utilized in different regions. In certain cultures, traditional methods of teaching may be more dominant, creating resistance to adopting innovative multimedia-based approaches. These factors highlight the need for future research to explore how external variables may influence the successful integration of multimedia in diverse educational settings.

Recommendations for future research

Future research endeavors are advised to take a more inclusive approach to address these limitations and enrich the depth of knowledge in this area. Firstly, studies should consider diversifying the academic levels included in the investigation. This expansion would involve incorporating undergraduate programs and professional degrees to capture a more comprehensive understanding of how multimedia preferences and success factors vary across different educational levels. For example, research could compare the multimedia preferences of undergraduate students, who may have different cognitive processing capacities compared to postgraduate students, or examine how professional degrees, which often have more applied learning contexts, influence multimedia engagement.

Additionally, future research should actively seek the perspectives of faculty members and administrators. Their insights into the challenges, benefits, and strategies related to implementing multimedia instruction are integral to grasping the broader

dynamics at play. Future studies could explore faculty members' readiness and willingness to integrate multimedia into their teaching practices, as well as their perceptions of the effectiveness and challenges of using multimedia tools. For administrators, research could investigate how institutional policies, resources, and support structures impact the adoption of multimedia in curricula, and how these elements align with the needs and preferences of both faculty and students. Exploring these perspectives could also highlight potential gaps in training, institutional support, and technological infrastructure, providing a more comprehensive understanding of the barriers and facilitators to multimedia integration.

Addressing these recommendations in future studies will contribute to a more nuanced and comprehensive understanding of the impact of multimedia instruction across various academic levels and perspectives within higher education. Moreover, such research could also examine the role of institutional leadership in fostering a culture of multimedia use, and explore how faculty professional development programs can be enhanced to support the effective implementation of multimedia teaching strategies.

CONCLUSION

This study significantly advances the field by delving into the impact of multimedia instruction on knowledge transfer in higher education, particularly focusing on postgraduate students at the Indonesian International Islamic University. The identification of live demonstrations as the preferred multimedia tool for postgraduate students, which aligns with the practical and applied nature of their academic pursuits, provides a unique insight into student preferences. Furthermore, the research highlights critical success factors—such as technological infrastructure and teacher training while also addressing the challenges of curriculum misalignment and resistance to change. These insights enhance our understanding of the dynamic interplay between technological tools, pedagogical strategies, and content knowledge, offering valuable guidance for educators and policymakers seeking to optimize multimedia integration in higher education. The scientific justification for this work lies in the transformative potential of multimedia technologies, which can significantly enhance learning outcomes when aligned with pedagogical objectives. The study emphasizes the need for clarity in content delivery, particularly through visual and interactive elements, and urges universities to strategically incorporate multimedia into their curricula to foster engaging and effective learning environments.

Implications for educators and policymakers include the need to align multimedia content with student preferences and harness its potential to support personalized learning. Moving forward, future research should explore the perspectives of faculty and administrators to provide a more comprehensive understanding of the challenges and strategies related to multimedia integration. Such research will help inform institutional policies and professional development initiatives, ensuring that multimedia tools are deployed effectively across diverse academic contexts and sets the stage for future investigations into the strategies and best practices for seamlessly integrating multimedia into higher education, aiming to cultivate dynamic learning environments that equip students with the skills and competencies needed to navigate the complexities of the modern educational landscape.

AUTHOR CONTRIBUTION

Author 1 prepared research instruments, a literature review, collected and analyzed quantitative data, and a discussion of findings. Author 2 proofread, organized, and interpreted the findings. Author 3 reviewed documents for amendments.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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