DEVELOPMENT OF AN AI-ASSISTED INSTRUCTIONAL VIDEO FOR THE SCHRODINGER EQUATION IN MODERN PHYSICS

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Abstrak

Pembelajaran Fisika Modern khususnya pada materi Persamaan Schrödinger, sering mengalami kendala akibat sifat konsep yang abstrak dan dominasi representasi matematis. Kondisi tersebut semakin diperkuat oleh keterbatasan pembelajaran tatap muka pada situasi pascabencana banjir di wilayah Sumatera, khususnya Aceh. Penelitian ini bertujuan untuk mengembangkan video pembelajaran Fisika Modern berbasis AI yang mampu memperkuat visualisasi dan narasi konsep Persamaan Schrödinger serta mendukung pembelajaran mandiri mahasiswa. Penelitian ini menggunakan pendekatan penelitian dan pengembangan dengan melibatkan 40 mahasiswa program sarjana (S1) pada mata kuliah Fisika Modern di Universitas Islam Negeri Ar-Raniry. Video pembelajaran dikembangkan dengan memanfaatkan AI untuk visualisasi konsep, cuplikan film populer sebagai konteks konseptual, penjelasan menggunakan coretan langsung melalui pen tablet, serta dilengkapi dengan akses asisten penjelasan konsep berbasis AI melalui QR Code. Data dikumpulkan melalui validasi ahli, uji kelayakan mahasiswa, dan angket respon mahasiswa. Hasil penelitian menunjukkan bahwa video pembelajaran yang dikembangkan berada pada kategori sangat layak dan dinilai mudah diakses, menarik, serta relevan untuk pembelajaran mandiri. Pemanfaatan platform TikTok sebagai media distribusi video dinilai efektif dalam mengatasi keterbatasan akses dan kendala jaringan. Penelitian ini menyimpulkan bahwa video pembelajaran berbasis AI berpotensi menjadi solusi pendukung pembelajaran Fisika Modern yang fleksibel dan adaptif pada kondisi pascabencana.

Kata kunci: *Video pembelajaran, Fisika Modern, Persamaan Schrödinger, pembelajaran mandiri*

Abstract

Learning Modern Physics, particularly the Schrödinger equation, often presents significant challenges due to the abstract nature of the concepts and the dominance of mathematical representations. These challenges were further intensified by the limitations of face-to-face instruction in post-disaster conditions in Sumatra, especially in Aceh. This study aimed to develop an AI-based Modern Physics instructional video designed to enhance conceptual visualization and narrative clarity of the Schrödinger equation while supporting students' independent learning. The study employed a research and development approach involving 40 undergraduate students enrolled in a Modern Physics course at Universitas Islam Negeri Ar-Raniry. The instructional video was developed using artificial intelligence to strengthen conceptual visualization, integrate excerpts from popular films as contextual representations, and provide explanations through real-time digital pen annotations. In addition, the video was complemented by an AI-based conceptual assistant accessed with a QR code to support students' self-directed learning. Data were collected through expert validation, student feasibility testing, and student response questionnaires. The results indicated that the developed instructional video was categorized as highly feasible and was perceived as accessible, engaging, and relevant for independent learning. The use of TikTok as a video distribution platform was found to be effective in addressing access limitations and network constraints. The findings suggest that AI-based instructional videos have strong potential as a flexible and adaptive learning support solution for Modern Physics education in post-disaster contexts.

Keywords: *Instructional video; Modern Physics; Schrödinger equation; independent learning.*

INTRODUCTION

Modern Physics is a fundamental course that plays a crucial role in developing students' understanding of key concepts in twentieth-century physics, particularly quantum mechanics. One of the most challenging topics within this course is the Schrödinger equation, as its concepts and theoretical foundations are highly abstract, cannot be directly observed, and often conflict with classical physical intuition[1]. As a result, many students experience difficulties in understanding the physical meaning of the equation and in relating its mathematical formulation to the microscopic phenomena it represents[2]. These difficulties frequently lead to low levels of conceptual understanding and the persistence of misconceptions in Modern Physics learning.

Instructional media play a strategic role in physics education by helping students connect abstract concepts with more concrete representations[3]. Appropriately designed learning media can facilitate conceptual understanding, reduce cognitive load, and minimize misconceptions that often arise when instruction overemphasizes symbolic and mathematical representations [4]. Accordingly, learning media should not merely transmit information but also enable dynamic and meaningful visualization of concepts. Instructional videos have emerged as a relevant solution because they allow the integration of visualization, animation, and structured narration, thereby supporting students in constructing more accurate mental representations.[5] Several studies over the past decade have demonstrated that the use of videos and animations in physics education effectively enhances students' conceptual understanding.[6] Nevertheless, most existing instructional videos remain largely one-directional and do not fully address students' needs for additional, self-directed explanations when conceptual difficulties occur.

Cognitive load theory emphasizes that abstract scientific topics require carefully sequenced multimedia to prevent working memory overload.[7] In quantum mechanics, translating mathematical formalism into intuitive mental models remains a persistent instructional challenge. Research-based interactive simulations, such as those from the QuVis project, demonstrate that visual scaffolding can help students connect symbolic

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[1] Luqman Hakim and M Nawir, "Analytical Radial Part Schrodinger Equation in D -Dimensions for Eckart plus Manning Rosen Potential as The Quantum Physics Learning," *Jurnal Pendidikan Teknologi Dan Kejuruan BALANGA* 4, no. 1 (2016): 30–39.

[2] Chandra Halim and M Farchani Rosyid, "Kajian Integral Lintasan Lévy Dalam Mekanika Kuantum Fraksional Untuk Membentuk Persamaan Schrödinger Fraksional," 2020.

[3] Renda Yuriananta and Prima Vidya Asteria, "Pelatihan Pembuatan Media Pembelajaran Berbantuan Artificial Intelligence (AI) Untuk Guru," *Jurnal Gramaswara*, no. 2019 (2024): 274–85, https://doi.org/10.21776/ub.gramaswara.2024.004.03.07.

[4] Ariama dan F Ci A Burhendi2, "Pengembangan Website Sebagai Media Pembelajaran Fisika Berbasis Augmented Reality Dengan Menggunakan Metode Marker Based Tracking Pada Materi Listrik Dinamis," *Jurnal Penelitian Pembelajaran Fisika* 13, no. 2 (2022): 181–90, https://doi.org/10.26877/jp2f.v13i2.12132.

[5] Syarifah Hafizah, "PENGGUNAAN DAN PENGEMBANGAN VIDEO DALAM PEMBELAJARAN FISIKA," *Jurnal Pendidikan Fisika* VIII, no. 2 (2020): 226–40, https://doi.org/http://dx.doi.org/10.24127/jpf.v8i2.2656.

[6] Yuriananta and Asteria, "Pelatihan Pembuatan Media Pembelajaran Berbantuan Artificial Intelligence (AI) Untuk Guru."

[7] Richard Mayer and Logan Fiorella, *The Cambridge Handbook of Multimedia Learning*, 3rd ed. (Cambridge: Cambridge University Press, 2021), https://doi.org/10.1017/9781108894333; John Sweller, "Cognitive Load Theory and Educational Technology," *Educational Technology Research and Development* 68, no. 1 (2020): 1–16, https://doi.org/10.1007/s11423-019-09701-3.

equations with physical interpretations.[8] Although AI-driven visualization tools demonstrate potential in reducing extraneous cognitive load, their integration into self-paced higher education materials remains fragmented.[9] Current implementations often lack pedagogical alignment with independent learning frameworks, limiting scalability in constrained environments. Embedding AI-enhanced visual scaffolding within structured instructional videos can bridge this gap, offering students consistent, self-directed conceptual support without requiring continuous instructor mediation.

Along with the rapid advancement of digital technology, artificial intelligence (AI) has increasingly been adopted in education, including physics learning[10]. Previous studies have reported that AI can support learning processes through enhanced visualization, more systematic instructional narration, and the provision of conceptual explanation assistants that can be accessed flexibly by students[11]. In physics education, AI has the potential to bridge the gap between mathematical representations and conceptual understanding, particularly for complex and abstract topics such as the Schrödinger equation. However, much of the existing literature has positioned AI primarily as an intelligent tutoring system or an automated assessment tool, which may be difficult to implement in practice and can raise concerns related to assessment validity and user acceptance. Empirical studies that integrate instructional videos for Modern Physics with AI in a simple, realistic, and contextual manner remain limited. In particular, the use of AI as a supportive tool to strengthen video visualization and narration, as well as to provide an easily accessible post-viewing conceptual assistant, has rarely been reported. Moreover, the integration of AI through QR code access to support independent learning has received little attention in higher education contexts.

The learning context becomes increasingly challenging when instruction must be conducted under emergency conditions, such as post-disaster situations that restrict face-to-face teaching. In such circumstances, students are required to engage in more independent learning with limited direct interaction with lecturers[12]. Several studies have indicated that post-disaster conditions disrupt learning continuity, limit access to educational resources, and reduce the intensity of lecturer–student interaction[13]. Consequently, students require flexible learning support that can be accessed anytime and anywhere. Prior research has also emphasized that independent learning in science courses demands learning media that present content clearly and systematically while

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[8] Antje Kohnle et al., "Interactive Simulations To Support Quantum Mechanics Instruction for Chemistry Students," *Journal of Chemical Education* 94 (February 2, 2017), https://doi.org/10.1021/acs.jchemed.6b00459.

[9] Thomas K F Chiu et al., "Systematic Literature Review on Opportunities, Challenges, and Future Research Recommendations of Artificial Intelligence in Education," *Computers and Education: Artificial Intelligence* 4 (2023): 100118, https://doi.org/https://doi.org/10.1016/j.caeai.2022.100118.

[10] Riordan Alfredo et al., "Computers and Education : Artificial Intelligence Human-Centred Learning Analytics and AI in Education : A Systematic Literature Review" 6, no. December 2023 (2024), https://doi.org/10.1016/j.caeai.2024.100215.

[11] Muhammad Arsyad and Universitas Halu Oleo, "Pemanfaatan AI Dan Deep Learning Dalam Pembelajaran STEAM Berbasis Outcome-Based Education," no. March (2025), https://doi.org/10.47827/jer.v6i1.638.

[12] Umut Lagap et al., "International Journal of Disaster Risk Reduction Towards Reliable Deep Learning for Post-Disaster Damage Assessment : An XAI-Based Evaluation," *International Journal of Disaster Risk Reduction* 130, no. September (2025): 105839, https://doi.org/10.1016/j.ijdrr.2025.105839.

[13] Huangbin Liang et al., "Resilience-Based Post Disaster Recovery Optimization for Infrastructure System via Deep Reinforcement Learning," *Reliability Engineering and System Safety* 265, no. PA (2026): 111478, https://doi.org/10.1016/j.ress.2025.111478.

providing conceptual reinforcement to prevent sustained misconceptionsherefore, the availability of instructional media that not only offer visual content but also provide independent conceptual clarification has become an urgent need[14]. In this context, the development of AI-assisted instructional videos is considered a relevant and innovative strategy to support Modern Physics learning under constrained conditions, as reflected in studies reporting the effectiveness of AI in enhancing visualization quality, instructional narration, and digital learning accessibility.[15]

Emergency educational disruptions consistently limit synchronous instruction, forcing students toward self-regulated learning models.[16] In advanced physics courses, this shift often exacerbates conceptual fragmentation due to insufficient guided scaffolding.[17] While mobile platforms improve content accessibility, they rarely embed domain-specific conceptual assistants for complex topics.[18] Consequently, students in post-disaster regions require instructional media that combine low-bandwidth distribution with structured cognitive support. Integrating AI-powered explanatory tools within distributed video formats directly addresses this need, enabling continuous, self-directed engagement with abstract quantum concepts despite infrastructural constraints.

Based on these considerations, the development of an instructional video for the Schrödinger equation was designed to support students' understanding of abstract concepts through structured visualization and narration. In this study, artificial intelligence was utilized as a supportive tool in the development and presentation of the instructional video, enabling the product to facilitate students' independent learning without replacing the role of the lecturer. Accordingly, this study aims to develop an AI-assisted instructional video for teaching the Schrödinger equation in Modern Physics and to examine its feasibility as a learning medium as well as students' responses to its use in independent learning, particularly within a post-disaster context. This study is grounded in the hypothesis that the developed AI-assisted instructional video meets the feasibility criteria for instructional media and receives positive responses from students.

METHOD

This study employed a research and development (R&D) approach aimed at producing an instructional video for Modern Physics on the topic of the Schrödinger equation. The R&D approach was selected because the study focused not only on theoretical analysis but also on the systematic development of an instructional medium and the evaluation of its feasibility as a learning support tool[19].

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[14] Purwanto and Cindi Nabila Utami Eko Risdianto Andik, "Development of Digital Module on Kinematics Material Assisted by Artificial Intelligence Video Through MOOCs for Eleventh-Grade HIGH School Students," *Kasuari: Physics Education Journal* 8, no. 1 (2025): 50–63.

[15] Purwanto and Cindi Nabila Utami Eko Risdianto Andik.

[16] Charles Hodges et al., "The Difference Between Emergency Remote Teaching and Online Learning," Educause Review, 2020, https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning.

[17] Melissa Bond et al., "Mapping Research in Student Engagement and Educational Technology in Higher Education : A Systematic Evidence Map," *International Journal of Educational Technology in Higher Education* 17, no. 2 (2020), https://doi.org/https://doi.org/10.1186/s41239-019-0176-8 REVIEW.

[18] Nguyen Duy et al., "AI-Assisted Learning: An Empirical Study on Student Application Behavior," *Multidisciplinary Science Journal* 7 (November 14, 2024): 2025275, https://doi.org/10.31893/multiscience.2025275.

[19] Dina Maryani, "Pengembangan Media Pembelajaran Video Animasi Berbantuan ' AI ' Pada Pembelajaran Mengidentifikasi Informasi Penting Dalam Teks LHO Kelas VIII Di SMP Negeri 2 Cihampelas," *Jurnal Karya Insan Pendidikan Terpilih* 3, no. 2 (2025): 3–6.

The research participants consisted of 40 undergraduate students enrolled in a Modern Physics course at Universitas Islam Negeri Ar-Raniry Banda Aceh. The study was conducted within an independent learning context due to the limited implementation of face-to-face instruction following post-disaster conditions in Sumatra, particularly in Aceh. The developed instructional video was designed to be used independently by students as a primary learning resource for the Schrödinger equation. The development process followed several stages, including needs analysis, video design, content development, and feasibility evaluation[20]. During the needs analysis stage, students' difficulties in understanding the Schrödinger equation were identified, along with the requirements for instructional media suitable for independent learning. The design stage involved organizing the instructional flow, determining appropriate conceptual visualizations, and developing a structured narrative for the video. In the content development stage, artificial intelligence was employed as a supportive tool to enhance conceptual visualization and instructional narration, enabling abstract concepts to be presented more clearly and systematically. In addition, the instructional video was complemented by an AI-based chatbot functioning as a conceptual explanation assistant, allowing students to obtain clarification independently after viewing the video.

The data collected in this study consisted of quantitative data obtained from expert feasibility evaluations and students' responses to the instructional video. Data collection instruments included expert validation sheets and student response questionnaires developed using a Likert scale. Data were collected after the instructional video had been fully developed. The video was first evaluated by experts to assess its feasibility in terms of content accuracy, visual design, and instructional presentation. Following revision based on expert feedback, the video was implemented in an independent learning setting. After viewing the video, students were asked to complete a response questionnaire to evaluate their learning experience. Data analysis was conducted descriptively by calculating mean scores and percentages to determine the feasibility level of the instructional video and the overall student responses.

RESULT AND DISCUSSION

Result

The results of this study comprise expert validation outcomes, product feasibility testing, and an analysis of students' responses to the AI-assisted instructional video on the Schrödinger equation. The instructional video was developed to support students' independent learning under post-disaster conditions in Sumatra, particularly in Aceh. Accordingly, clarity of content, quality of visualization, and ease of access were emphasized as the primary evaluation aspects.

Expert Validation Results

Expert validation was conducted to examine the feasibility of the instructional video from both content and media perspectives. The evaluation focused on the alignment of the instructional content with course learning outcomes, the accuracy of physics concepts, the quality of visual representations, and the clarity of instructional narration. A summary of the expert validation results is presented in Table 1.

Table 1. Expert validation results of the AI-assisted instructional video

Evaluation Aspect	Mean Score	Category
Alignment of content with CPL/CPMK	4,50	Highly Feasible

[20] Mutiara D Cahyani and Tania A Gusman2, "Desain Dan Uji Validitas E-Modul Perkuliahan Kimia Fisika Berbasis Problem Based Learning," *ORBITAL : JURNAL PENDIDIKAN KIMIA* 7 (2023): 117–25.

Conceptual accuracy of the Schrödinger equation	4,30	Highly Feasible
Quality of AI-assisted visualization	4,35	Highly Feasible
Clarity and coherence of video narration	4,30	Highly Feasible
Integration of visual and audio elements	4,20	Feasible
the average total score	4,33	Highly Feasible

Product Feasibility Testing Results

Product feasibility testing was conducted by involving 40 undergraduate students enrolled in the Modern Physics course. Students were asked to use the instructional video independently and to evaluate its feasibility as a learning resource. A summary of the product feasibility testing results is presented in Table 2.

Table 2. Student Feasibility Evaluation of The Instructional Video

Evaluation Aspect	Mean Score	Category
Ease of understanding the material	4,00	Feasible
Clarity of visualization	4,20	Feasible
Clarity of narration and explanation	4,35	Highly Feasible
Suitability for independent learning	4,30	Highly Feasible
Ease of video access	5,00	Highly Feasible
the average total score	4,37	Highly Feasible

Analysis of Student Response Questionnaire

The analysis of the student response questionnaire was conducted to examine students' perceptions of the AI-assisted instructional video and the accompanying chatbot. The results of the questionnaire analysis are summarized in Table 3.

Table 3. Student Responses To The AI-Assisted Instructional Video and Chatbot

Statement	Agreement (%)
The video helps me understand the concept of the Schrödinger equation	87,5
The visualization facilitates understanding of the physical meaning of the equation	85,0
The video narration is clear and easy to follow	82,5
The video is effective for independent learning	84,7
Accessing the video via TikTok facilitates learning under limited network conditions	90,0
The AI-based chatbot accessed via QR code helps explain basic terms and concepts	80,0
The chatbot is easy to access and use as a companion to the instructional video	82,5

Discussion

Expert Validation Results

Based on the expert validation results presented in Table 1, the instructional video met the feasibility criteria and was classified in the highly feasible category. The video was able to present the Schrödinger equation in a systematic manner that was easy for students to follow. AI-enhanced visualizations effectively clarified key quantum concepts, particularly the interpretation of the wave function and probability, enabling students to move beyond a purely mathematical focus. As a result, the video supported a more balanced understanding that integrated mathematical formulation with physical meaning. In addition, the instructional video incorporated illustrative excerpts from

Western films that explicitly or implicitly visualize concepts related to quantum mechanics as a contextual introduction.

These illustrative segments functioned as conceptual anchors, helping students relate the Schrödinger equation to familiar visual representations drawn from popular media. This approach enhanced students' engagement and conceptual accessibility without compromising the scientific accuracy of the content. Furthermore, with respect to conceptual accuracy, the video was complemented by real-time digital pen annotations that demonstrated equation derivations and symbol explanations step by step. This approach allowed students to follow the lecturer's reasoning process more authentically and transparently, thereby supporting deeper conceptual understanding.

The high validation scores can be explained by the inherent characteristics of quantum mechanics content, which strongly requires conceptual visualization support. The integration of visualization and structured narration, consistent with principles of multimedia learning, helped reduce students' cognitive load when engaging with abstract concepts. This finding aligns with prior studies in physics media development, which emphasize expert validation of content alignment, conceptual accuracy, visualization quality, and clarity of presentation as key indicators of instructional feasibility[21].

Through the use of clearly defined sub-sections, the expert validation results in this study were systematically analyzed and compared with commonly applied feasibility indicators reported in previous physics education research. Such analysis enabled an assessment of the extent to which the developed instructional video met relevant academic and pedagogical standards, while also situating the findings within the broader body of research on physics instructional media development.[22]

The integration of AI-generated visualizations specifically addresses documented challenges in quantum mechanics education, where students struggle to reconcile probabilistic interpretations with classical intuitions.[23] By dynamically mapping abstract wave functions to spatial probability distributions, the video operationalizes evidence-based representational strategies that promote conceptual coherence. Expert reviewers noted that this visual scaffolding aligns with established physics education research emphasizing multiple, coordinated representations to reduce misconception formation. Consequently, the high feasibility scores reflect pedagogical fidelity to domain-specific learning principles rather than mere technical quality.

Product Feasibility Testing Results

Based on perspective in the table 2, the feasibility testing results indicate that students perceived the instructional video as highly feasible for independent learning, with an overall mean score of 4.37. The highest score was obtained for ease of video access, suggesting that students experienced minimal difficulty in accessing the learning material. High ratings were also reported for the clarity of narration and explanation, as well as the suitability of the video for independent learning. These findings indicate that the instructional video effectively supported students in understanding the learning

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[21] Burhendi2, "Pengembangan Website Sebagai Media Pembelajaran Fisika Berbasis Augmented Reality Dengan Menggunakan Metode Marker Based Tracking Pada Materi Listrik Dinamis."

[22] Tosca Dalto et al., "How Is Preservice Teachers ' Gaze during Classroom Observation Connected to Their Assessments of Teaching Quality ? A Controlled Study in Screen-Based and Immersive Video Environments ☆" 101, no. September 2024 (2026).

[23] Guangtian Zhu and Chandralekha Singh, "Improving Students ' Understanding of Quantum Measurement . I . Investigation of Difficulties," *Physical Review Special Topics - Physics Education Research* 8 (2012): 1–8, https://doi.org/10.1103/PhysRevSTPER.8.010117.

sequence of the Schrödinger equation without relying entirely on direct lecturer explanations.

These results can be attributed to the choice of TikTok as the video distribution platform. The instructional video was accessed through a TikTok account, which was selected due to its relative stability and accessibility under limited network conditions. Students' familiarity with the platform further supported ease of access and efficient content distribution. This approach proved particularly relevant in post-disaster learning conditions in Sumatra, especially in Aceh, where infrastructure disruption and unstable internet connectivity posed significant challenges to conventional online learning platforms.

These findings are consistent with previous studies reporting that flexible and widely adopted social media platforms can effectively support learning continuity in emergency and post-disaster contexts. Compared to formal learning management systems, TikTok offers adaptive bandwidth usage and allows students to access learning content repeatedly with minimal technical barriers. The present study extends earlier research by demonstrating that short-form video platforms can be strategically repurposed as instructional media for complex physics topics when combined with structured narration and AI-supported visualization. This approach highlights the potential of leveraging familiar digital ecosystems to support independent learning in constrained educational environments.[24]

Leveraging familiar digital platforms for formal instruction aligns with frameworks emphasizing accessibility and contextual relevance in emergency education.[25] In resource-constrained settings, familiar platforms reduce technological friction and lower cognitive barriers to entry, enabling seamless content engagement. The strategic adaptation of TikTok for academic purposes demonstrates how pedagogical intent can transform entertainment ecosystems into viable learning infrastructures. This finding underscores the necessity of context-responsive media design in post-disaster educational recovery.

Analysis of Student Response Questionnaire

The questionnaire results indicate that the majority of students expressed positive perceptions of the AI-assisted instructional video. High agreement percentages were reported for statements related to conceptual understanding, particularly in connecting the mathematical formulation of the Schrödinger equation with its physical interpretation. Students also perceived the video as effective for independent learning, suggesting that the instructional design successfully supported self-directed engagement with complex quantum concepts.

These positive responses can be attributed to the integration of AI to enhance visualization and instructional narration, as well as the availability of an AI-based conceptual assistant accessed via a QR code. The chatbot functioned as a supplementary learning tool that allowed students to clarify terminology and foundational concepts after watching the video, thereby enriching the learning experience without replacing the instructional role of the lecturer[26]. This supportive role of AI aligns with principles of

[24] Yogi Pratama Yendra et al., "PEMANFAATAN MEDIA SOSIAL APLIKASI TIKTOK SEBAGAI MEDIA," *Jurnal Rekayasa Sistem Informasi Dan Teknologi* 1, no. 4 (2024): 300–307.
[25] Hodges et al., "The Difference Between Emergency Remote Teaching and Online Learning."
[26] Benjamin Agyare et al., "Computers and Education : Artificial Intelligence A Cross-National Assessment of Artificial Intelligence (AI) Chatbot User Perceptions in Collegiate Physics Education," *Computers*

technology-enhanced learning that emphasize augmentation rather than substitution of pedagogical practices.

the findings are consistent with previous studies highlighting the effectiveness of instructional videos and animations in physics education at the higher education level. However, this study offers a distinct contribution by positioning AI as a practical tool for improving video quality and supporting independent learning in post-disaster contexts, rather than employing AI as an automated feedback system or intelligent tutoring platform. This contextualized and realistic use of AI addresses both pedagogical and infrastructural constraints commonly faced in emergency learning situations.

The QR-linked AI assistant effectively supported self-regulated learning by providing just-in-time conceptual clarification without demanding synchronous connectivity.[27] Students utilized the chatbot to resolve terminology ambiguities and reinforce procedural knowledge, fostering metacognitive monitoring during independent study. This on-demand support structure aligns with scaffolding theories that emphasize learner control and adaptive assistance. Ultimately, positioning AI as an auxiliary resource preserves pedagogical agency while extending instructional reach beyond temporal classroom limits.

As supporting evidence of the developed product, a visual representation of the instructional video is provided in Figure 1, which presents screenshots illustrating the AI-assisted visualization design and narrative structure of the Modern Physics instructional video.

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[27]Ido Roll and Ruth Wylie, "Evolution and Revolution in Artificial Intelligence in Education," *International Artificial Intelligence in Education Society 2016* 26 (2016): 582–99, https://doi.org/10.1007/s40593-016-0110-3.

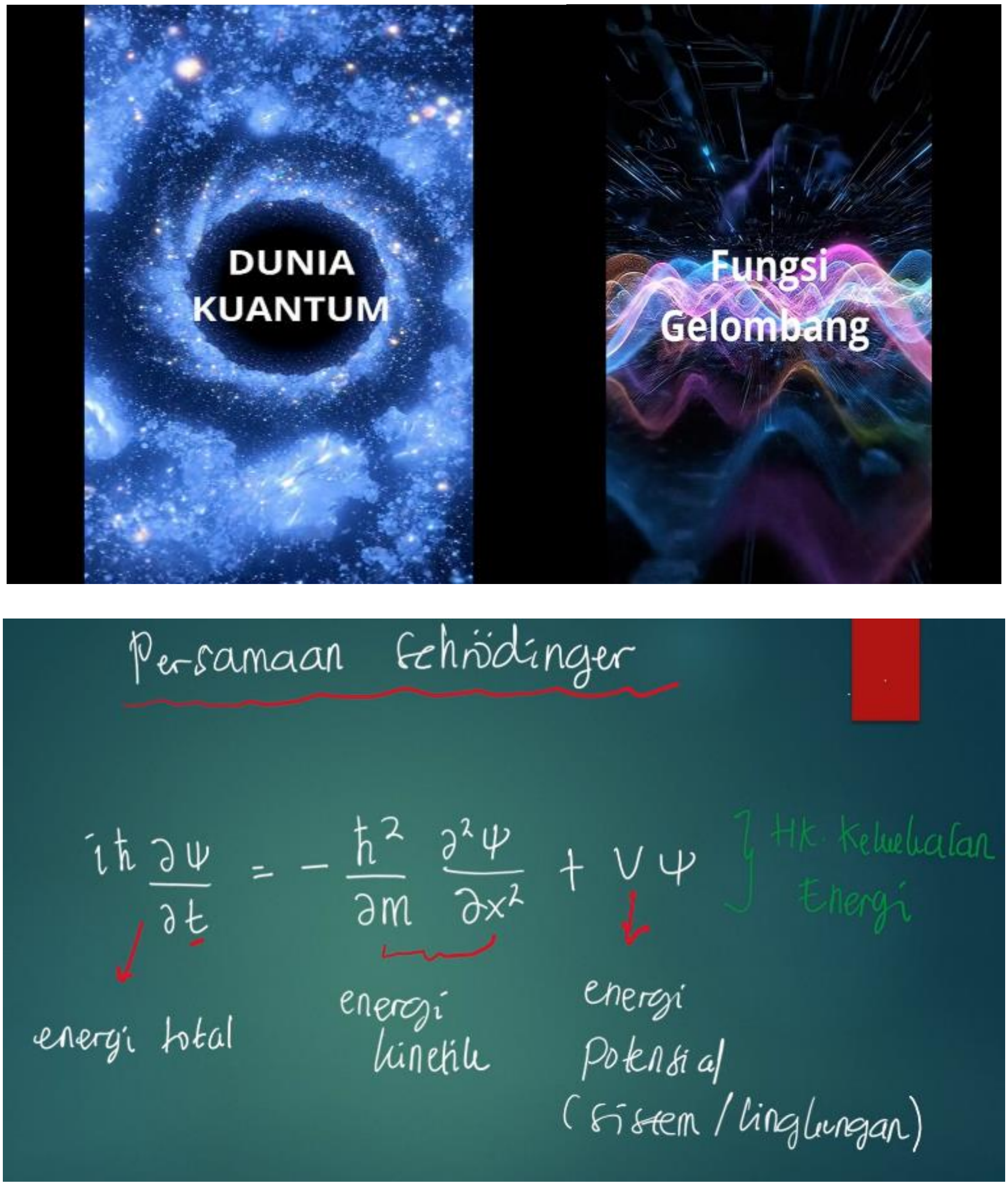

Figure 1. Visual design of the AI-assisted instructional video

Figure 1 presents screenshots of an instructional video on Modern Physics focusing on the Schrödinger equation, integrating AI-enhanced visualizations with structured narration. The video opens with a clear title screen, followed by AI-generated visuals that clarify abstract concepts such as wave functions and quantum probability distributions. Popular film excerpts serve as conceptual anchors, helping students connect course material to familiar visual representations. Mathematical explanations are delivered through real-time digital pen annotations that demonstrate equation derivations and symbol meanings step by step. This combination of AI-powered visualization, pop-culture context, and systematic instruction is designed to reduce cognitive load, enhance engagement, and support balanced conceptual understanding that integrates mathematical formulation with physical meaning for effective independent learning.

CONCLUSION

This study resulted in the development of an AI-assisted instructional video for Modern Physics on the topic of the Schrödinger equation, which was classified as highly feasible based on expert validation and student feasibility testing. The instructional video was developed by integrating AI-enhanced visualization, excerpts from popular films representing quantum mechanical concepts, and real-time digital pen annotations, enabling the content to be presented in a more contextualized and accessible manner for students. The feasibility testing and student response analysis indicated that the instructional video was easy to access, engaging, and relevant for supporting students' independent learning.

The use of TikTok as the video distribution platform was found to be particularly effective under post-disaster conditions in Sumatra, especially in Aceh, where limitations in face-to-face instruction and network accessibility posed significant challenges. In addition, the integration of an AI-based chatbot accessed via a QR code provided supplementary support for students to clarify concepts after watching the video, without replacing the instructional role of the lecturer.

This approach positioned AI as a supportive learning tool rather than an autonomous teaching system. Overall, the findings demonstrate that the development of AI-assisted instructional videos has strong potential as a flexible and adaptive solution for independent learning in emergency or post-disaster contexts.

The results also suggest that technology- and AI-based instructional media can serve as an effective complementary strategy in Modern Physics education, particularly for abstract and conceptually demanding topics. Future research is recommended to examine the effectiveness of the developed instructional video in improving students' conceptual understanding and learning outcomes through quantitative measures, as well as to explore its application across other physics topics.

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