JPP (Jurnal Pendidikan dan Pembelajaran)
Vol. 31, No. 2, Oktober 2024, hal. 71~78
ISSN: 2580-2313, DOI: 10.17977/um047v31i22024p71-78

Developing animated video-based learning with powtoon to foster critical thinking in data presentation

Tomi Listiawan[1], Jane Eka Sari Radiyah[2]
[1,2]Mathematics Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang, Malang, Indonesia

Article Info

Article history:

Received 08 12, 2024
Revised 09 29, 2024
Accepted 10 30, 2024

Keywords:

Animated video learning
Critical thinking
Data presentation
Multimedia-assisted pedagogy

ABSTRACT

Critical thinking is a vital skill for students to interpret data and make informed decisions, especially in data presentation. This study focuses on developing and evaluating animated video-based learning content using Powtoon software to enhance critical thinking skills in data presentation, following the ADDIE (Analyze, Design, Develop, Implement, and Evaluate) instructional design model. In the Analyze phase, a needs assessment was conducted to identify gaps in students' critical thinking skills regarding data interpretation. During the Design and Develop phases, instructional videos were created to target key critical thinking components, including analysis, interpretation, and evaluation. In the Implement phase, the content was introduced to an experimental group, with a control group using traditional instructional methods. A quasi-experimental approach with pre- and post-tests measured critical thinking improvements in both groups. Results demonstrated a significant increase in critical thinking abilities within the experimental group, with mean scores improving from 55.2 to 82.4, compared to the control group's increase from 54.8 to 65.3. The study concludes that Powtoon-animated videos are an effective tool for fostering critical thinking in data presentation, offering practical implications for multimedia-assisted learning in mathematics education. Recommendations for further research on technology integration in education are discussed.

Corresponding Author:

Tomi Listiawan
Mathematics Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang
Jalan Semarang No.5, Malang, Indonesia
Email: tomi.listiawan.fmipa@um.ac.id

1. INTRODUCTION

Critical thinking skills are recognized as essential competencies in 21st-century education, equipping students with the ability to analyze information, make informed decisions, and solve problems effectively. Recent studies highlight the importance of fostering critical thinking as students face increasingly complex data and information across various disciplines (Dekker, 2020). Within educational settings, the need for critical thinking has grown due to its role in preparing students for both academic success and informed citizenship.

In the specific context of data presentation, critical thinking is particularly vital. Effective data presentation requires students not only to interpret and visualize data accurately but also to draw meaningful conclusions. Despite its importance, research indicates that many students struggle to engage critically with data, especially when taught through traditional lecture-based methods (Aston, 2023; Huber & Kuncel, 2016; Rivas et al., 2022). These challenges underscore the need for innovative instructional approaches that encourage students to analyze, evaluate, and synthesize data effectively.

Interactive and engaging learning media have shown considerable potential to enhance students' critical thinking skills. Animated videos, in particular, provide a visually compelling means of conveying information, supporting both engagement and understanding. Studies suggest that animated videos in instructional settings improve student attention and foster analytical thinking by creating a more immersive learning experience. As a result, animated video-based learning has gained attention as an effective tool for promoting higher-order thinking skills. The advantages of animated videos are especially notable in facilitating complex cognitive processes, which can be challenging to achieve through traditional instruction alone. By incorporating visual aids and narrations, animated videos simplify abstract or complex concepts, making them easier for students to understand and apply critically (Barta et al., 2022; Ennis, 2018; Fikriyati et al., 2022; Raj et al., 2022). This is particularly beneficial in subjects like data presentation, where the ability to visualize and interpret data is crucial.

Powtoon, a user-friendly animation software, has become increasingly popular for creating engaging educational videos without requiring advanced technical skills. Educators are leveraging Powtoon to create customized video content that can support diverse learning objectives and styles . Research indicates that Powtoon-based learning materials enhance student participation and motivation, thereby promoting a more active and reflective learning process (Khofifah & Kamalia, 2022; Sania et al., 2022).

Empirical studies reveal that students learn more effectively when engaged with interactive multimedia content, which enables them to visualize concepts and build connections between ideas. By fostering engagement, Powtoon-based animated videos encourage students to delve deeper into the content, promoting a more thorough understanding and stimulating critical thinking. These tools also allow educators to present information in a narrative format, which has been shown to improve retention and comprehension.

However, while interactive media like Powtoon has gained prominence in classrooms, its specific impact on critical thinking skills remains an area warranting further research. Several studies have shown promising results, with animated video-based learning improving students' analytical and evaluative skills, particularly in subjects requiring data interpretation . Nevertheless, comprehensive research focused on critical thinking in data presentation is limited (Corti, 2005; Reding, 2017).

Traditional methods of instruction, though valuable, have certain limitations in fostering critical thinking, particularly for topics requiring visual interpretation, like data presentation. Conventional approaches often rely on lectures and textbooks, which can be less effective in promoting active engagement and higher-order thinking skills. Some studies argue that these methods fail to sufficiently challenge students to critically analyze and interpret information.

Moreover, educational technology research emphasizes the benefits of interactive content in motivating students. Animated videos have been found to enhance both engagement and motivation, two essential factors for successful learning. Research shows that students who learn through animated videos are more inclined to actively participate in classroom discussions and demonstrate a deeper enthusiasm for understanding complex topics.

The relevance of multimedia-based learning continues to grow in the digital era. As digital natives, today's students are accustomed to engaging with multimedia and often prefer content that incorporates interactive and visual elements. Studies suggest that multimedia learning aligns well with students' learning preferences, which can lead to improved academic outcomes and higher motivation to learn (Alsaffar et al., 2022; Hsu et al., 2022). The shift toward digital and interactive learning tools reflects broader trends in education aimed at preparing students for a technology-rich world. With the rise of data-driven industries, the ability to interpret and present data is becoming an essential skill, further highlighting the need for instructional tools that develop critical thinking in this area . Animated videos offer a means to meet this demand, supporting the development of skills essential for academic and professional success .

This study aims to develop and evaluate animated video-based learning materials created with Powtoon to enhance critical thinking in the context of data presentation. By focusing on both engagement and cognitive development, this research addresses the gap in instructional methods that foster critical thinking skills in data-driven subjects. Furthermore, this study seeks to build on existing research by providing empirical evidence on the effectiveness of Powtoon as a tool for improving critical thinking skills. Through quasi-experimental testing, this study assesses the impact of Powtoon-based videos on students' abilities to analyze and interpret data critically, thereby offering insights into the practical applications of animation software in educational settings.

The significance of this research lies in its potential contributions to both educational practice and theory. Animated videos represent a promising instructional medium for developing critical thinking, especially in complex areas like data interpretation. By examining the effectiveness of Powtoon-based animated content, this study aims to inform educators and curriculum designers about the potential benefits of integrating animation into their teaching strategies to support critical thinking development.

In summary, this research focuses on the design, implementation, and evaluation of animated video-based learning materials as a means to enhance critical thinking in data presentation. It aims to fill a critical gap in educational technology research by providing insights into how animated video content can promote higher-order thinking skills in an era increasingly dependent on data literacy.

2. METHOD

This study applied the ADDIE (Analyze, Design, Develop, Implement, Evaluate) model as a structured instructional design framework to develop and assess animated video-based learning materials aimed at fostering critical thinking skills in data presentation. Each phase of the ADDIE model was tailored to support the study's objectives and ensure a rigorous development and evaluation process (Safitri & Aziz, 2022; Spatioti et al., 2022).

Analyze

The Analyze phase involved identifying students' baseline abilities and specific learning needs related to critical thinking in data presentation. Preliminary assessments, including surveys and diagnostic tests, were conducted with 60 high school students enrolled in a mathematics course, divided equally into experimental and control groups. These assessments indicated gaps in students' abilities to critically engage with data, particularly in pattern recognition, source evaluation, and drawing informed conclusions.

Additionally, interviews with experienced mathematics educators were conducted to understand challenges associated with teaching data presentation. Insights from these analyses highlighted the need for engaging, visually stimulating content to facilitate students' understanding of data-related concepts and improve their analytical skills. Consequently, the objectives of the video-based instructional material were established: to support critical thinking through data interpretation, evaluation, and synthesis.

Design

During the Design phase, specific learning objectives and content requirements were established to guide the instructional development. The main learning objectives were:

1. To improve students' abilities to critically analyze data presentations.
2. To enhance understanding of data visualization techniques.
3. To develop students' skills in identifying and interpreting significant data trends.

Powtoon was selected as the animation tool due to its versatility and ease of use, allowing for the creation of engaging, interactive video content without advanced technical skills. A storyboard was designed to align with the learning goals and systematically structure the content development process. This storyboard incorporated visual and narrative elements focused on explaining complex data concepts, illustrating data trend examples, and prompting critical thinking through reflection questions.

Develop

In the Develop phase, the animated videos were produced based on the storyboard. The videos featured visually engaging graphics, clear narration, and interactive elements designed to encourage student reflection. Each segment focused on a specific aspect of data presentation, such as chart interpretation, identifying misleading visualizations, and understanding data trends. Interactive questions were embedded within the videos to promote immediate application of newly acquired knowledge.

The videos were reviewed by subject matter experts, including two mathematics educators and an educational technology specialist, to ensure accuracy and pedagogical soundness. Feedback from these experts was utilized to refine the content and ensure that the videos were accessible and engaging for high school students. Adjustments were made to simplify complex data concepts and improve visual clarity.

Implement

During the Implement phase, the Powtoon-based videos were deployed in a classroom setting with the experimental group, while the control group received traditional instruction on data presentation. Both groups comprised 30 students and were taught by the same instructor to maintain instructional consistency. The experimental group engaged with the animated videos over three class sessions, each lasting 45 minutes and covering topics related to data presentation aligned with the course curriculum. Each session included pre- and post-video discussions, allowing students to ask questions and clarify any misunderstandings. These discussions aimed to promote deeper cognitive engagement and encourage students to reflect on their learning experiences.

Student engagement was monitored through observations, and feedback was collected via student questionnaires. Additionally, critical thinking pre- and post-tests were administered to both groups to assess any improvement in critical thinking skills. These test scores provided quantitative data on changes in critical thinking abilities, allowing for a comparative analysis of the effectiveness of Powtoon-based learning versus traditional instruction.

Evaluate

The final phase, Evaluate, involved analyzing data collected from the pre- and post-tests, questionnaires, and classroom observations to assess the instructional effectiveness of the animated video content. A t-test was employed to compare critical thinking scores before and after the intervention for both the experimental and control groups.

The paired sample t-test formula used was as follows:

$$t = \frac{\overline{D}}{s_D/\sqrt{n}}$$

where:

- $\overline{D}$ Represents the mean difference between the pre-test and post-test scores in the experimental group,
- s_D is the standard deviation of the difference between the pre-test and post-test scores, and
- n is the sample size or the number of paired data points (i.e., students in the experimental or control group).

The results of this evaluation indicated a statistically significant improvement in critical thinking skills in the experimental group compared to the control group, suggesting that the Powtoon-based animated videos were effective in enhancing critical thinking within the context of data presentation.

3. RESULTS AND DISCUSSION

Analyze

The initial analysis phase revealed a clear need for instructional improvements in developing students' critical thinking skills, particularly in the area of data presentation. Through preliminary assessments and educator feedback, it became evident that students struggled with several key aspects of critical thinking in data interpretation: recognizing patterns, evaluating the integrity of data visualizations, and discerning misleading information. These deficiencies were particularly noticeable in students who had not been exposed to interactive learning tools or media-rich content, underscoring the potential value of engaging instructional strategies. A thorough review of the literature supported the need for novel teaching methods in critical thinking development (Barta et al., 2022; Dong et al., 2023; Shen & Yodkhumlue, 2012).

The analysis also identified a gap in the traditional pedagogical approach to teaching data presentation. In the conventional method, students were primarily exposed to static textbooks and traditional lectures, which were insufficient in developing the necessary analytical skills. This observation is consistent with findings from earlier studies, which indicated that traditional methods often fail to engage students in deep learning processes(Ananda et al., 2023; O'Reilly et al., 2022). The objective, therefore, was to integrate interactive and visually engaging learning tools that could address these challenges and enhance students' critical thinking.

Design

The design phase focused on developing instructional materials that were specifically tailored to improve critical thinking skills in data presentation. The decision to use Powtoon, a platform that supports the creation of animated and interactive videos, was based on its ability to present content in a visually appealing and cognitively accessible manner. The design aimed to facilitate active learning, where students would not only passively consume information but also engage with it interactively.

Each Powtoon video was carefully structured to include several key components: introduction to data presentation concepts, examples of data visualizations, critical thinking prompts, and interactive questions. These elements were integrated into the storyboard to ensure that students could immediately apply the knowledge they gained from the video in meaningful ways. The use of interactive elements was designed to stimulate reflective thinking and provide real-time feedback, which has been shown to improve student engagement and learning outcomes (Anjarsari et al., 2023; Eka et al., 2022).

The design of the videos was also influenced by cognitive load theory, which suggests that learning materials should be optimized to prevent cognitive overload and enhance retention (Sweller, 2019). The visual nature of the Powtoon videos aimed to simplify complex data concepts and present them in a way that would facilitate better comprehension and critical analysis. This aligns with the recommendations of research on multimedia learning, which has consistently shown the effectiveness of visual aids in improving understanding (Mayer, 2019a).

Develop

During the development phase, a series of Powtoon-based animated videos were created, each focused on specific aspects of data presentation and critical thinking. These videos included a variety of data visualization examples, such as bar charts, pie charts, and line graphs, with interactive elements such as quizzes and decision-making scenarios embedded within the videos. Students were prompted to answer questions that required them to analyze the data, identify patterns, and reflect on the reliability of the information presented.

Each video was developed with a focus on clarity, engagement, and interactivity. Expert reviews from both mathematics educators and instructional designers ensured that the content was accurate and aligned with the learning objectives. Additionally, the design team tested the videos with a small group of students prior to full implementation, using feedback to make necessary adjustments to the pacing, visual clarity, and interactive elements.

Figure 1. Opening Video

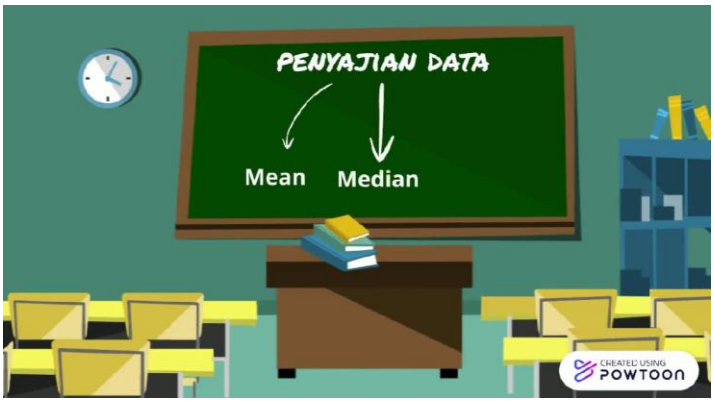

Figure 2. Content animated video

The development process also involved selecting appropriate data examples that would challenge students' critical thinking abilities. For instance, datasets containing misleading graphs or biased representations were used to prompt students to apply critical evaluation skills. These examples aimed to help students recognize the importance of data integrity and the potential pitfalls in presenting data misleadingly, thus fostering a more sophisticated approach to data analysis.

Implement

The implementation phase involved introducing the Powtoon-based videos to the experimental group, while the control group continued with traditional instructional methods. The Powtoon videos were implemented over a period of three weeks, with each student in the experimental group engaging with one video per week. The videos were made available online, allowing students to watch them at their convenience, and they were followed by online quizzes and discussion sessions to reinforce learning.

The engagement level among students in the experimental group was high, with many students voluntarily participating in post-video discussions and expressing interest in the content. Classroom observations revealed that students were highly motivated by the interactive elements of the videos, which seemed to capture their attention more effectively than traditional methods. This is consistent with previous research suggesting that interactive and multimedia-rich content is more engaging and effective in fostering active learning(Housner & Griffey, 1985; Jang, 2010; Zacharia, 2005).

In contrast, the control group, which received traditional lecture-based instruction, showed less enthusiasm. Students were often passive recipients of the material, with limited opportunities for active engagement. This difference in engagement likely contributed to the disparity in critical thinking improvements between the two groups, highlighting the need for more dynamic and interactive instructional approaches.

Evaluate

The evaluation phase involved assessing the effectiveness of the Powtoon-based videos using pre- and post-test measures of critical thinking skills. Both groups completed a pre-test before the intervention, which assessed their baseline abilities in data interpretation and critical thinking. The experimental group showed a mean pre-test score of $M = 65.3$ (SD = 5.6), while the control group had a similar mean score of $M = 64.9$ (SD = 5.9), indicating that both groups started with comparable levels of knowledge and critical thinking ability.

Following the intervention, both groups took the same post-test. The experimental group showed a significant improvement in their scores, with the mean post-test score rising to $M = 82.7$ (SD = 6.2). A paired sample t-test confirmed that the improvement was statistically significant, $t(29) = 7.82$, $p<0.001$. In contrast, the

control group's post-test mean score increased only slightly to $M = 68.1$ (SD = 6.1), and a paired sample t-test revealed no significant difference, $t(29) = 1.56$, $p = 0.13$.

To further assess the effectiveness of the Powtoon-based videos, an independent samples t-test was conducted to compare the post-test scores between the experimental and control groups. The results showed a significant difference in favor of the experimental group, $t(58) = 5.63$, $p < 0.001$. These findings suggest that the Powtoon-based videos were more effective in fostering critical thinking skills than traditional instruction.

The results of this study provide strong evidence for the effectiveness of Powtoon-based animated videos in enhancing students' critical thinking skills in data presentation. The significant improvement in the experimental group's post-test scores indicates that the use of multimedia and interactive elements in the learning process can have a substantial impact on students' ability to analyze and interpret data critically.

This study aligns with prior research that has shown the benefits of visual and interactive learning materials in promoting critical thinking and engagement (Anggita, 2021; Apriliani et al., 2021; Massofia & Yolanda, 2023). The Powtoon videos, which integrated both visual storytelling and interactive components, allowed students to engage with the material in a way that traditional lecture-based methods could not. By prompting students to actively participate in their learning, the videos fostered deeper cognitive processing, which is essential for developing critical thinking skills.

The results also highlight the importance of cognitive load theory in instructional design. The Powtoon videos, by presenting complex data concepts in a visually appealing and structured manner, helped students manage their cognitive load and focus on higher-order thinking processes. This is in line with research that supports the use of multimedia learning tools to reduce cognitive overload and enhance understanding (Mayer, 2019b).

Moreover, the success of the Powtoon-based intervention suggests that educators should consider integrating interactive multimedia tools into their teaching practices to improve critical thinking skills, especially in subjects like data analysis, which require high levels of cognitive engagement. Traditional methods may no longer be sufficient to meet the demands of 21st-century education, where critical thinking and data literacy are crucial skills.

Despite the promising findings, there are limitations to this study. The sample size was relatively small, and the study was conducted within a single institution, which may limit the generalizability of the results. Future research should explore the impact of Powtoon-based videos in more diverse educational settings and with larger sample sizes. Additionally, future studies could investigate the long-term effects of video-based learning on critical thinking skills and explore the use of other multimedia tools in similar contexts.

In conclusion, the results of this study suggest that Powtoon-based animated videos can significantly improve students' critical thinking abilities in data presentation. The use of interactive, visually engaging learning materials provides a promising alternative to traditional instruction, encouraging deeper cognitive engagement and enhancing the development of essential analytical skills. Educators and instructional designers are encouraged to consider integrating multimedia learning tools like Powtoon to foster critical thinking and data literacy in their classrooms.

4. CONCLUSION

This study demonstrates the effectiveness of Powtoon-based animated videos in enhancing critical thinking skills in data presentation. The integration of interactive, multimedia learning tools provided students with a unique opportunity to engage deeply with the content, fostering a more active learning environment compared to traditional, lecture-based methods. The significant improvement in the experimental group's critical thinking scores, as evidenced by pre- and post-test comparisons, highlights the potential of visual storytelling and interactive components in developing essential analytical skills.

The use of Powtoon as a tool for creating animated videos proved to be a successful strategy for simplifying complex data concepts while encouraging higher-order cognitive processes, such as evaluation, interpretation, and analysis. By promoting active engagement with the material, the videos allowed students to critically assess data visualizations, identify patterns, and understand the integrity of data representation, all of which are crucial skills in today's data-driven world.

Furthermore, this study supports the notion that traditional teaching methods, while valuable, may not be sufficient on their own in fostering critical thinking skills. The findings suggest that incorporating modern, interactive tools like Powtoon into instructional design can enhance the learning experience and better equip students with the skills they need to navigate complex data sets. While the results are promising, it is important to recognize the study's limitations, including the small sample size and the focus on a single institution. Future research should explore the long-term effects of animated video-based learning on critical thinking, as well as its applicability in diverse educational settings and across various subjects. Additionally, further studies could compare the effectiveness of different multimedia platforms to determine the most effective tools for promoting critical thinking.

Powtoon-based animated videos offer a promising, engaging, and effective approach to enhancing critical thinking skills in data presentation. Educators are encouraged to explore the integration of multimedia learning tools in their curriculum, as they have the potential to not only improve critical thinking but also to make the learning process more engaging and enjoyable for students. The findings of this study contribute to the growing body of literature advocating for the use of interactive, technology-driven teaching methods to support the development of critical thinking and other higher-order cognitive skills in the classroom.

ACKNOWLEDGEMENTS

This research is funded by the Universitas Negeri Malang funding for scal year 2024 with the contract number 4.4.203/UN32.14.1/LT/2024

REFERENCES

Alsaffar, R. D., Alfayly, A., & Ali, N. (2022). Extended Technology Acceptance Model for Multimedia-Based Learning in Higher Education. *International Journal of Information and Education Technology*, *12*(12). https://doi.org/10.18178/ijiet.2022.12.12.1754

Ananda, L. R., Rahmawati, Y., & Khairi, F. (2023). Critical Thinking Skills of Chemistry Students by Integrating Design Thinking With STEAM-PjBL. *Journal of Technology and Science Education*, *13*(1). https://doi.org/10.3926/jotse.1938

Anggita, Z. (2021). Penggunaan Powtoon Sebagai Solusi Media Pembelajaran Di Masa Pandemi Covid-19. *Konfiks Jurnal Bahasa Dan Sastra Indonesia*, *7*(2). https://doi.org/10.26618/konfiks.v7i2.4538

Anjarsari, E., Juniati, D., & Khabibah, S. (2023). The Effectiveness of PowToon Audiovisual Media on Mathematics Learning Three-Dimensional Geometry Object Elementary School. *VYGOTSKY*, *5*(1). https://doi.org/10.30736/voj.v5i1.694

Apriliani, M. A., Maksum, A., Wardhani, P. A., Yuniar, S., & Setyowati, S. (2021). Pengembangan media pembelajaran PPKn SD berbasis Powtoon untuk mengembangkan karakter tanggung jawab. *Jurnal Ilmiah Pendidikan Dasar*, *8*(2). https://doi.org/10.30659/pendas.8.2.129-145

Aston, K. J. (2023). 'Why is this hard, to have critical thinking?' Exploring the factors affecting critical thinking with international higher education students. *Active Learning in Higher Education*. https://doi.org/10.1177/14697874231168341

Barta, A., Fodor, L. A., Tamas, B., & Szamoskozi, I. (2022). The development of students critical thinking abilities and dispositions through the concept mapping learning method – A meta-analysis. In *Educational Research Review* (Vol. 37). https://doi.org/10.1016/j.edurev.2022.100481

Corti, L. (2005). Survey Data in Teaching Project (SDiT): Enhancing Critical Thinking and Data Literacy. *IASSIST Quarterly*, *28*(2). https://doi.org/10.29173/iq796

Dekker, T. J. (2020). Teaching critical thinking through engagement with multiplicity. *Thinking Skills and Creativity*, *37*. https://doi.org/10.1016/j.tsc.2020.100701

Dong, M., Li, F., & Chang, H. (2023). Trends and hotspots in critical thinking research over the past two decades: Insights from a bibliometric analysis. *Heliyon*, *9*(6). https://doi.org/10.1016/j.heliyon.2023.e16934

Eka, H. F., Oktaviana, D., & Haryadi, R. (2022). Pengembangan Media Pembelajaran Video Animasi Menggunakan Software Powtoon terhadap Kemampuan Berpikir Kritis pada Materi Sistem Persamaan Linier Dua Variabel. *JagoMIPA: Jurnal Pendidikan Matematika Dan IPA*, *2*(1). https://doi.org/10.53299/jagomipa.v2i1.136

Ennis, R. H. (2018). Critical Thinking Across the Curriculum: A Vision. *Topoi*, *37*(1). https://doi.org/10.1007/s11245-016-9401-4

Fikriyati, A., Agustini, R., & Sutoyo, S. (2022). Critical thinking cycle model to promote critical thinking disposition and critical thinking skills of pre-service science teacher. *Cypriot Journal of Educational Sciences*, *17*(1). https://doi.org/10.18844/cjes.v17i1.6690

Housner, L. D., & Griffey, D. C. (1985). Teacher Cognition: Differences in Planning and Interactive Decision Making between Experienced and Inexperienced Teachers. *Research Quarterly for Exercise and Sport*, *56*(1), 45–53. https://doi.org/10.1080/02701367.1985.10608430

Hsu, Y. M., Chang, T. S., Chu, C. L., Hung, S. W., Wu, C. J., Yeh, T. P., & Wang, J. Y. (2022). Effectiveness of Multimedia-Based Learning on the Improvement of Knowledge, Attitude, and Behavioral Intention toward COVID-19 Prevention among Nurse Aides in Taiwan: A Parallel-Interventional Study. *Healthcare (Switzerland)*, *10*(7). https://doi.org/10.3390/healthcare10071206

Huber, C. R., & Kuncel, N. R. (2016). Does College Teach Critical Thinking? A Meta-Analysis. *Review of Educational Research*, *86*(2). https://doi.org/10.3102/0034654315605917

Jang, S. (2010). Integrating the interactive whiteboard and peer coaching to develop the TPACK of secondary science teachers. *Computers and Education*, *55*(4), 1744–1751. https://doi.org/10.1016/j.compedu.2010.07.020

Khofifah, K., & Kamalia, P. U. (2022). Pengembangan Media Pembelajaran Powtoon Pada Mata Pelajaran Ekonomi Kelas XI IPS 1 SMAN 1 Cerme. *Jurnal Teknologi Pendidikan (JTP)*, *15*(2). https://doi.org/10.24114/jtp.v15i2.36144

Massofia, F. D., & Yolanda, R. (2023). Powtoon sebagai Media Interaktif pada Pembelajaran Bahasa Arab di Era Society 5.0. *ICONITIES (International Conference on Islamic Civilization and Humanities)*.

Mayer, P. (2019a). Physics Teachers' Acceptance of Multimedia Applications—Adaptation of the Technology Acceptance Model to Investigate the Influence of TPACK on Physics Teachers' Acceptance Behavior of Multimedia Applications. *Frontiers in Education*, *4*. https://doi.org/10.3389/feduc.2019.00073

Mayer, P. (2019b). Physics Teachers' Acceptance of Multimedia Applications—Adaptation of the Technology Acceptance Model to Investigate the Influence of TPACK on Physics Teachers' Acceptance Behavior of Multimedia Applications. *Frontiers in Education*, *4*. https://doi.org/10.3389/feduc.2019.00073

O'Reilly, C., Devitt, A., & Hayes, N. (2022). Critical thinking in the preschool classroom - A systematic literature review. *Thinking Skills and Creativity*, *46*. https://doi.org/10.1016/j.tsc.2022.101110

Raj, T., Chauhan, P., Mehrotra, R., & Sharma, M. (2022). Importance of Critical Thinking in the Education. *World Journal of English Language*, *12*(3). https://doi.org/10.5430/wjel.v12n3p126

Reding, K. F. (2017). Improving critical thinking through data analysis. *Strategic Finance*, *June 2017*.

Rivas, S. F., Saiz, C., & Ossa, C. (2022). Metacognitive Strategies and Development of Critical Thinking in Higher Education. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.913219

Safitri, M., & Aziz, M. R. (2022). ADDIE, sebuah model untuk pengembangan multimedia learning. *Jurnal Pendidikan Dasar*, *3*(2).

Sania, K., Yogica, R., Ristiono, R., & Selaras, G. H. (2022). Pengembangan Media Pembelajaran Audio-visual Bermuatan Literasi Sains Menggunakan Aplikasi Powtoon tentang Materi Keanekaragaman Hayati. *BIODIK*, *8*(1). https://doi.org/10.22437/bio.v8i1.17011

Shen, P., & Yodkhumlue, B. (2012). A Case Study of Teacher's Questioning and Students' Critical Thinking in College EFL Reading Classroom. *International Journal of English Linguistics*, *2*(1), 199–206. https://doi.org/10.5539/ijel.v2n1p199

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A Comparative Study of the ADDIE Instructional Design Model in Distance Education. In *Information (Switzerland)* (Vol. 13, Issue 9). https://doi.org/10.3390/info13090402

Zacharia, Z. C. (2005). The Impact of Interactive Computer Simulations on the Nature and Quality of Postgraduate Science Teachers ' Explanations in Physics The Impact of Interactive Computer Simulations on the Nature and Quality of Postgraduate Science Teachers ' Explanations in. *International Journal of Science Education*, *27*(14), 1741–1767. https://doi.org/10.1080/09500690500239664