

# Transformation of Food Web Learning: A Study of Canva-Assisted Interactive Multimedia Implementation at Elementary School Level

Lilis Tasmayanti<sup>1\*</sup>, LR. Retno Susanti<sup>1</sup>, Erna Retna Safitri<sup>1</sup>

<sup>1</sup>Educational Technology, Universitas Sriwijaya, Palembang, Indonesia.

Received: March 23, 2025

Revised: June 06, 2025

Accepted: July 25, 2025

Published: July 31, 2025

Corresponding Author:

Lilis Tasmayanti

[06032622428030@student.unsri.ac.id](mailto:06032622428030@student.unsri.ac.id)

DOI: [10.29303/jppipa.v11i7.12039](https://doi.org/10.29303/jppipa.v11i7.12039)

© 2025 The Authors. This open access article is distributed under a (CC-BY License)



**Abstract:** The background of this research is based on the importance of using digital learning media that is engaging, interactive, and appropriate to the characteristics of 21st-century students to improve the effectiveness of the science learning process. The learning process is a stage of positive behavioral change in students, encompassing cognitive, affective, and psychomotor aspects that are oriented towards progress. This study aims to produce interactive learning multimedia using Canva on food web material in elementary schools that is valid, practical, and effective. The presence of learning media is the key to the success of the learning process in the classroom. The study used the Research and Development (R&D) method with the ADDIE model which includes five stages: Analyze, Design, Develop, Implement, and Evaluate. Data collection techniques included observation, interviews, questionnaires, and tests. The validation results showed that the media was considered very valid by material experts (92%), media (86%), and language (93.33%). Practicality tests through one-to-one and small groups produced an average of 93.72% with a very practical category. The effectiveness of the media is shown by the N-Gain value of 0.90 which is included in the high category. Thus, this learning multimedia is proven to be valid, practical, and effective for use in learning in elementary schools.

**Keywords:** Canva; Development; Food webs; Interactive learning multimedia

## Introduction

The learning process is a stage of positive behavioral change in students, encompassing cognitive, affective, and psychomotor aspects oriented toward progress (Dharmayani et al., 2022). Effective learning activities will result in changes in knowledge, understanding, and attitudes. To achieve an engaging learning process and desired learning outcomes, the availability of enjoyable learning media is essential (Rahmawati & Atmojo, 2021). The quality of learning is reflected in the high level of active engagement and creativity of students (Ekaputra et al., 2024; Sari et al., 2024). Quality students will demonstrate a strong sense

of curiosity, problem-solving skills, and the ability to generate innovative ideas. Quality education is inseparable from the role of educators in selecting and using appropriate materials, strategies, and learning media. Today, the presence of learning media is key to the success of the classroom learning process. The paradigm shift from teacher-centered to student-centered learning demands innovation in material delivery.

Learning media, both conventional and digital, play a vital role in visualizing abstract concepts, presenting interactive simulations, and sparking students' interest and motivation to learn (Schoenherr et al., 2024). With the right media, information can be absorbed more

## How to Cite:

Tasmayanti, L., Susanti, L. R., & Safitri, E. R. (2025). Transformation of Food Web Learning: A Study of Canva-Assisted Interactive Multimedia Implementation at Elementary School Level. *Jurnal Penelitian Pendidikan IPA*, 11(7), 1165–1171. <https://doi.org/10.29303/jppipa.v11i7.12039>

easily, classroom interactions become more dynamic, and learning experiences become more meaningful, ultimately optimizing the achievement of learning objectives. Even though textbooks are available, their use alone is not enough to create quality learning because each student's needs are different (Dwivedi et al., 2021; Zain et al., 2022). Furthermore, the learning patterns of today's children have shifted drastically; they tend to absorb information more easily through electronic devices such as gadgets (Yaseen et al., 2025; Shanmugasundaram & Tamilarasu, 2023). Therefore, the presence of effective, interactive, and adaptive digital learning media is crucial to meeting the diverse needs of modern learners (Mufaziah & Fauziah, 2020; Ningsi & Hartono, 2025).

Interactive learning multimedia is a tool that combines text, images, audio, video, animation, and simulations, enabling active user interaction (Jannah et al., 2023). This interaction makes learning more engaging, motivating, aids understanding of difficult concepts, and improves information retention (Feng et al., 2023; Ginting et al., 2024; Zhai et al., 2024). Canva, an easy-to-use online design tool, offers various graphic design features such as presentations, banners, and photo editing. Its advantages, such as attractive design, good resolution, and time efficiency, make it a potential tool for presenting material smoothly and reaching all students (Sari et al., 2023). The use of Canva is expected to increase student interest and motivation, particularly in the science material on food webs, which is often difficult to understand using textbooks alone (Prihatiningtyas & Astuti, 2024; Fernqvist et al., 2024).

Based on interviews with the principal and teachers of grades 4, 5, and 6 at SD Negeri 2 Sumber Rezeki, the use of learning media is still limited to textbooks or simple, home-made media. Most educators have not yet mastered creating engaging digital media, resulting in substandard learning. This impacts student understanding and learning outcomes, particularly in science. Of 30 students, only 65% achieved the Minimum Competency (KKM) because unengaging media and monotonous teaching methods led to boredom and a lack of motivation. Several studies have demonstrated the effectiveness of Canva-based interactive learning multimedia in elementary schools. Research by Pulungan et al. (2024), found that Canva media is valid, practical, and effective in enhancing critical thinking. Meanwhile, Ristanti & Isdaryanti (2024) stated the practicality and validity of Canva for fourth-grade students.

Overall, these studies support Canva's potential as an effective, practical, and valid tool for elementary school learning. Based on the existing problems and support from previous research, this study aims to develop and evaluate the effectiveness of interactive

learning multimedia using Canva on food webs in fifth grade students at SD Negeri 2 Sumber Rezeki. This research is expected to significantly contribute to improving students' understanding and motivation in the science subject.

## Method

This study used the Research and Development (R&D) method with the ADDIE model to develop and test Canva-based interactive learning multimedia for the topic of food webs in fifth-grade students at SD Negeri 2 Sumber Rezeki.

### *Development Procedure*

Analysis: Identifying student and teacher needs through questionnaires and school documents; Design: Designing flowcharts, storyboards, and interactive media prototypes, and selecting relevant materials; Development: Creating the product, validating it with subject, media, and language experts, and then revising it based on feedback; Implementation: Trialing the product on a limited basis with three students (one-to-one) and eight students (small group); Evaluation: Measuring the product's effectiveness through a pretest-posttest design on 30 students to assess learning outcomes.

### *Subjects and Instruments*

The subjects of this study were fifth-grade students at SD Negeri 2 Sumber Rezeki. Data were collected using various instruments, such as questionnaires (for needs assessment and validation), interviews, observations, and tests (pretest-posttest) to measure learning outcomes.

### *Data Analysis*

Data was analyzed qualitatively (for feedback) and quantitatively (for numerical data). Product effectiveness was measured using the N-gain score to determine the extent of improvement in student learning outcomes after using interactive media.

The formula for calculating the N-gain score is as follows:

$$N_{\text{gain}} = \frac{S_{\text{posttest}} - S_{\text{pretest}}}{S_{\text{maximum}} - S_{\text{pretest}}} \quad (1)$$

Note:

N-Gain = normalized gain score

Initial test score = average pretest score

Posttest score = average posttest score

Maximum score = maximum score

The high or low  $N_{\text{gain}}$  can be clarified as follows:

**Table 1.** N<sub>gain</sub> value criteria

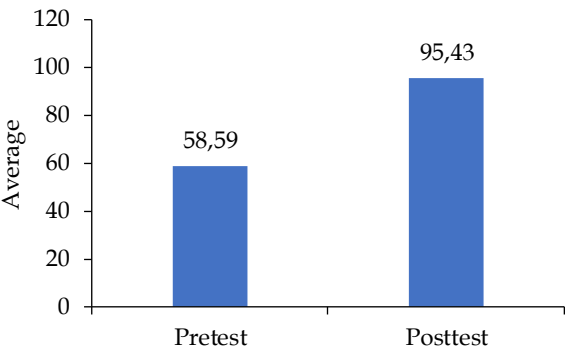
Gain Index (g)	Criteria
$g \geq 0.70$	High
$0.70 > g \geq 0.30$	Medium
$g < 0.30$	Low

Result and Discussion

After going through a series of comprehensive research processes, starting from an in-depth analysis of the needs of students and educators to the careful development of interactive multimedia, the research team finally arrived at the crucial stage of the field test. This process is the final validation to see the effectiveness of the product that has been developed directly on fifth-grade students of SD Negeri 2 Sumber Rezeki. The trial was conducted through a pre-test and post-test method, which was designed to objectively measure the increase in understanding and learning outcomes of students after being exposed to this interactive learning media. The results of this field test will be presented in Figure 1 to provide a concrete picture of the positive impact of interactive multimedia on the learning process.

Figure 1 shows a comparison of the average field test scores, revealing a very convincing finding. The average pretest score for students was 58.59, indicating a suboptimal initial understanding of the food web topic. However, after the intervention and the use of

interactive learning multimedia using Canva, there was a dramatic increase in the average posttest score to 95.43. This substantial increase, which nearly reached the maximum score, explicitly demonstrates that the developed learning media is highly effective in facilitating knowledge transfer and enhancing student understanding. The striking difference between these two averages is not merely a numerical difference, but a concrete representation of the interactive media's success in creating a more meaningful and efficient learning experience, significantly bridging the gap in students' prior knowledge. Next, the N-Gain Score will be calculated using IBM SPSS. The results of the data processing are displayed in Table 2.



**Figure 1.** Comparison of average pretest and posttest scores

**Table 2.** Results of pretest and posttest score processing

	N	Minimum	Maximum	Mean	Std. Deviation
N-gain score	19	.67	1.00	.9091	.12085
N-gain score percent	19	66.67	100.00	90.90	12.08
Valid N(listwise)	19				

From the N-Gain Score calculations presented in the tables and figures, it can be concluded that the use of interactive learning media demonstrated highly effective results in improving student learning outcomes. Most participants demonstrated significant improvement from pretest to posttest scores, with the N-Gain score categorized as "High." The average N-Gain score was 0.90, approaching 1, the upper limit of the N-Gain score. This demonstrates that the average increase in student understanding falls within the High category. Based on these results, it can be concluded that learning implemented using interactive learning media has proven highly effective in improving student understanding and learning outcomes. This is evidenced by the average N-Gain score of 0.90, which falls within the High category. This interactive learning media product was successful and feasible for implementation in learning.

Discussion

This study holistically demonstrates the potential for transforming food web learning through the implementation of interactive multimedia supported by Canva at the elementary school level. The results obtained not only confirm the product's effectiveness but also solidify its relevance in a modern educational context that adapts to student needs and technological developments. Empirical data from the field test showed a significant increase in the average post-test score (95.43) compared to the pre-test (58.59). This substantial increase, confirmed by an average N-Gain Score of 0.90 (categorized as "High"), strongly demonstrates that Canva-assisted interactive multimedia is capable of facilitating knowledge transfer and significantly improving student understanding. An N-Gain score approaching 1 reflects that the media is not merely helpful but also successfully induces profound cognitive changes, transforming suboptimal initial understanding

into solid knowledge. This transformation is particularly relevant given the complexity of food webs, which are often abstract for elementary school students.

The concepts of producers, consumers, decomposers, and energy flow in ecosystems are often difficult to visualize using conventional textbooks alone. The presence of interactive multimedia fills this gap by presenting information dynamically through a combination of text, images, animations, and the potential for simulation. This aligns with the view of Abdulrahman et al. (2020), Baah et al. (2024), and Skulmowski & Xu (2022), who stated that the integration of visual elements and interactivity in learning media can activate cognitive engagement, strengthen the internalization of concepts, and ultimately significantly improve learning outcomes. The success of this transformation is inseparable from Canva's role as a development tool (Buonocore et al., 2024; Purnomo et al., 2024). The needs analysis results indicate that students have a predominantly visual learning style and a strong preference for digital media accessed through devices (Fatimah & Muamar, 2024; Pascu, 2024). Canva, with its intuitive interface and diverse visual templates and interactive features, effectively addresses this preference. Canva's ease of use enables educators, even those not yet proficient in graphic design, to create engaging and relevant learning media (Fatimah & Muamar, 2024; Argunsah et al., 2025).

This represents a significant breakthrough. While previously developing interactive media required high technical expertise and expensive software, Canva presents a democratizing creative tool that allows teachers to focus on pedagogical and content aspects. Canva's ability to present information visually and interactively also aligns with the characteristics of digital native students, who are accustomed to fast-paced visual content (Ammar et al., 2024). The use of appropriate technology like Canva has proven effective in improving conceptual understanding while also opening up opportunities for educators to be more innovative in delivering material (Sartika & Hadi, 2021; Irshid et al., 2023). This learning transformation is not limited to improving cognitive outcomes. The results of one-to-one and small group trials showed a "Very High" level of practicality (average 93.72%), with very positive engagement and motivational aspects.

This indicates that the media is not only cognitively effective but also capable of enhancing students' affective and psychomotor aspects, such as interest, motivation, and active participation. When students are motivated and engaged, the learning process becomes more enjoyable, and information retention tends to be higher. Furthermore, this media's ability to bridge gaps in students' prior knowledge demonstrates its significant potential for reducing learning gaps and

creating an inclusive environment. By providing constructive feedback and a more engaging assessment format, this media supports independent learning and differentiation, accommodating diverse student learning needs, which are at the heart of quality education. This implementation study provides empirical evidence that Canva-assisted interactive multimedia can be a transformative solution for improving the quality of science learning in elementary schools, particularly in complex topics such as food webs (Gunawardena et al., 2024; Lankers et al., 2023).

These findings are not only relevant to SD Negeri 2 Sumber Rezeki but also offer a model of good practice that can be replicated in other schools with similar conditions. The implications extend to educational policies related to the use of technology, adaptive curriculum development, and teacher training programs to improve digital literacy and the ability to create innovative learning media (Haleem et al., 2022; Marnita et al., 2023). In the future, further development could involve the integration of adaptive features that allow the media to adapt to individual student learning progress, as well as exploring Canva's potential in other materials that require high visualization and interaction (Plooy et al., 2024; Contrino et al., 2024). Thus, this research not only highlights current successes, but also paves the way for continued contributions in transforming education towards a more dynamic, interactive, and effective learning environment in the digital age (Mena-Guacas et al., 2025; Zou et al., 2025).

## Conclusion

Based on the research results, it can be concluded that Canva-based interactive learning multimedia has been successfully developed as an innovative solution for teaching food webs in elementary schools. Overall, Canva-based interactive multimedia has proven effective and practical in creating dynamic and relevant learning experiences, making it suitable for widespread application to transform science and science learning.

## Acknowledgments

The author expresses his sincere gratitude and highest appreciation to the various parties who have provided support, guidance, and inspiration in the completion of this research. In particular, he extends his deepest gratitude to: Dr. L.R. Retno Susanti, M.Hum., for her guidance, direction, and unwavering support that shaped the framework and direction of this research; Dr. Erna Retna Safitri, M.Pd., for her valuable input, insightful insights, and tireless enthusiasm throughout every stage of the development of this learning media; Dr. Makmum Raharjo, M.Sn., as Coordinator of the Educational Technology Study Program, for her guidance, constructive suggestions, and helpful administrative support; and Dr. Hartono, M.A., as Dean of the Faculty of Teacher Training and



Education, Sriwijaya University, for the support and facilities provided during the research. The guidance and support of these supervisors were the main pillars that led to the completion of this research. The author also expresses his gratitude to the entire academic community of Sriwijaya University, especially SD Negeri 2 Sumber Rezeki for the permission and facilities provided during the research, as well as to all fifth-grade students of SD Negeri 2 Sumber Rezeki who actively participated in this research. Hopefully, the results of this research can make a real contribution to the advancement of education, particularly in the development of learning media.

#### Author Contributions

Conceptualization, methodology, formal analysis, L.T., L.R.R.S., and E.R.S.; investigation, writing – original draft, L.T.; writing – review & editing, supervision, L.R.R.S. and E.R.S.

#### Funding

No funding supports this research.

#### Conflicts of Interest

No Conflict of Interest.

#### References

- Abdulrahman, M. D., Faruk, N., Oloyede, A. A., Surajudeen-Bakinde, N. T., Olawoyin, L. A., Mejabi, O. V., Imam-Fulani, Y. O., Fahm, A. O., & Azeez, A. L. (2020). Multimedia Tools in the Teaching and Learning Processes: A Systematic Review. *Heliyon*, 6(11), e05312. <https://doi.org/10.1016/j.heliyon.2020.e05312>
- Ammar, M., Al-Thani, N. J., & Ahmad, Z. (2024). Role of Pedagogical Approaches in Fostering Innovation Among K-12 Students in STEM Education. *Social Sciences & Humanities Open*, 9, 100839. <https://doi.org/10.1016/j.ssaho.2024.100839>
- Argunsah, H., Altıntaş, L., & Şahiner, M. (2025). Eye-Tracking Insights into Cognitive Strategies, Learning Styles, and Academic Outcomes of Turkish Medicine Students. *BMC Medical Education*, 25(1), 276. <https://doi.org/10.1186/s12909-025-06855-y>
- Baah, C., Govender, I., & Subramaniam, P. R. (2024). Enhancing Learning Engagement: A Study on Gamification's Influence on Motivation and Cognitive Load. *Education Sciences*, 14(10), 1115. <https://doi.org/10.3390/educsci14101115>
- Buonocore, F., Annosi, M. C., Gennaro, D. D., & Riemma, F. (2024). Digital Transformation and Social Change: Leadership Strategies for Responsible Innovation. *Journal of Engineering and Technology Management*, 74, 101843. <https://doi.org/10.1016/j.jengtecman.2024.101843>
- Contrino, M. F., Reyes-Millán, M., Vázquez-Villegas, P., & Membrillo-Hernández, J. (2024). Using an Adaptive Learning Tool to Improve Student Performance and Satisfaction in Online and Face-to-Face Education for a More Personalized Approach. *Smart Learning Environments*, 11(1), 6. <https://doi.org/10.1186/s40561-024-00292-y>
- Dharmayani, N. P. A. G., Agung, A. A. G., & Wiyasa, I. K. N. (2022). Multimedia Interaktif Berbasis Pendekatan Saintifik Efektif Meningkatkan Kompetensi Pengetahuan IPA. *Jurnal Penelitian dan Pengembangan Pendidikan*, 7(2), 317-327. <https://doi.org/10.23887/jppp.v7i2.54767>
- Dwivedi, Y. K., Ismagilova, E., Hughes, D. L., Carlson, J., Filieri, R., Jacobson, J., Jain, V., Karjaluto, H., Kefi, H., Krishen, A. S., Kumar, V., Rahman, M. M., Raman, R., Rauschnabel, P. A., Rowley, J., Salo, J., Tran, G. A., & Wang, Y. (2021). Setting the Future of Digital and Social Media Marketing Research: Perspectives and Research Propositions. *International Journal of Information Management*, 59, 102168. <https://doi.org/10.1016/j.ijinfomgt.2020.102168>
- Ekaputra, F., Fuldijatman, F., Rusdi, M., Dewi, F., & Theis, R. (2024). Pelatihan Pengembangan Keterampilan Guru SMA Melalui Pembuatan Flipbook sebagai Sumber Belajar Mandiri. *I-Com: Indonesian Community Journal*, 4(3), 1843-1850. <https://doi.org/10.33379/icom.v4i3.5095>
- Fatimah, F., & Muamar, M. R. (2024a). Analysis of Students' Needs and Characteristics toward Science to Support Differentiated Learning of Kurikulum Merdeka. *Jurnal Penelitian Pendidikan IPA*, 10(5). <https://doi.org/10.29303/jppipa.v10i5.6731>
- Feng, R., Alsager, H. N., Azizi, Z., & Sarabani, L. (2023). Impact of Mind-Mapping Technique on EFL Learners' Vocabulary Recall and Retention, Learning Motivation, and Willingness to Communicate. *Heliyon*, 9(6), e16560. <https://doi.org/10.1016/j.heliyon.2023.e16560>
- Fernqvist, F., Spendrup, S., & Tellström, R. (2024). Understanding Food Choice: A Systematic Review of Reviews. *Heliyon*, 10(12), e32492. <https://doi.org/10.1016/j.heliyon.2024.e32492>
- Ginting, D., Woods, R. M., Barella, Y., Limanta, L. S., Madkur, A., & How, H. E. (2024). The Effects of Digital Storytelling on the Retention and Transferability of Student Knowledge. *Sage Open*, 14(3), 21582440241271267. <https://doi.org/10.1177/21582440241271267>
- Gunawardena, M., Bishop, P., & Aviruppola, K. (2024). Personalized Learning: The Simple, the Complicated, the Complex and the Chaotic. *Teaching and Teacher Education*, 139, 104429. <https://doi.org/10.1016/j.tate.2023.104429>
- Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the Role of Digital Technologies in

- Education: A Review. *Sustainable Operations and Computers*, 3, 275–285. <https://doi.org/10.1016/j.susoc.2022.05.004>
- Irshid, M. M. B., Khasawneh, A. A., & Al-Barakat, A. A. (2023). The Effect of Conceptual Understanding Principles-Based Training Program on Enhancement of Pedagogical Knowledge of Mathematics Teachers. *Eurasia Journal of Mathematics, Science and Technology Education*, 19(6), em2277. <https://doi.org/10.29333/ejmste/13215>
- Jannah, F. N. M., Nuroso, H., Mudzanatun, M., & Isnuryantono, E. (2023). Penggunaan Aplikasi Canva dalam Media Pembelajaran Matematika di Sekolah Dasar. *Jurnal Pendidikan Dasar*, 11(1). <https://doi.org/10.20961/jpd.v11i1.72716>
- Lankers, A., Timm, J., & Schmiemann, P. (2023). Students' Systems Thinking While Modeling a Dynamic Ecological System. *Frontiers in Education*, 8, 1187237. <https://doi.org/10.3389/feduc.2023.1187237>
- Marnita, M., Nurdin, D., & Prihatin, E. (2023). The Effectiveness of Elementary Teacher Digital Literacy Competence on Teacher Learning Management. *Journal of Innovation in Educational and Cultural Research*, 4(1), 35–43. <https://doi.org/10.46843/jiecr.v4i1.444>
- Mena-Guacas, A. F., López-Catalán, L., Bernal-Bravo, C., & Ballesteros-Regaña, C. (2025). Educational Transformation Through Emerging Technologies: Critical Review of Scientific Impact on Learning. *Education Sciences*, 15(3), 368. <https://doi.org/10.3390/educsci15030368>
- Mufaziah, E., & Fauziah, P. (2020). Kendala Orang Tua dalam Mendidik Anak Usia Dini pada Saat Pandemi Covid 19. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 5(2), 1045–1051. <https://doi.org/10.31004/obsesi.v5i2.746>
- Ningsi, N., & Hartono, H. (2025). Developing Interactive Learning Media to Enhance Elementary School Students' Learning Motivation. *EDUCARE: Journal of Primary Education*, 6(1), 81–96. <https://doi.org/10.35719/educare.v6i1.291>
- Pascu, M. (2024). The Contribution of Students' Learning Styles to Competences Development Through the Use of Kahoot Learning Platform. *Cogent Education*, 11(1), 2352320. <https://doi.org/10.1080/2331186X.2024.2352320>
- Plooy, E. D., Casteleijn, D., & Franzsen, D. (2024). Personalized Adaptive Learning in Higher Education: A Scoping Review of Key Characteristics and Impact on Academic Performance and Engagement. *Heliyon*, 10(21), e39630. <https://doi.org/10.1016/j.heliyon.2024.e39630>
- Prihatiningtyas, M., & Astuti, T. (2024). The Effect the Canva Based Problem Based Learning Model on Student Motivation and Learning Outcomes in Science and Technology Subjects. *Jurnal Penelitian Pendidikan IPA*, 10(8), 5734–5740. <https://doi.org/10.29303/jppipa.v10i8.7948>
- Pulungan, E. D., Ananda, R., Rifa'i, M., & Mousthofa, E. (2024). Development of Canva-Based Interactive Teaching Materials to Enhance Students' Critical Thinking Skills in Fiqh Learning at Islamic High School. *Scaffolding: Jurnal Pendidikan Islam dan Multikulturalisme*, 6(1), 142–158. <https://doi.org/10.37680/scaffolding.v6i1.4845>
- Purnomo, E. N., Imron, A., Wiyono, B. B., Sobri, A. Y., & Dami, Z. A. (2024). Transformation of Digital-Based School Culture: Implications of change management on Virtual Learning Environment integration. *Cogent Education*, 11(1), 2303562. <https://doi.org/10.1080/2331186X.2024.2303562>
- Rahmawati, F., & Atmojo, I. R. W. (2021). Analisis Media Digital Video Pembelajaran Abad 21 Menggunakan Aplikasi Canva pada Pembelajaran IPA. *Jurnal Basicedu*, 5(6), 6271–6279. <https://doi.org/10.31004/basicedu.v5i6.1717>
- Ristanti, S., & Isdaryanti, B. (2024). Development of Canva-Based Science Infographic Learning Media to Improve Students' Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 10(10), 7984–7992. <https://doi.org/10.29303/jppipa.v10i10.9506>
- Sari, A. M., Rakimahwati, R., Suryana, D., Jamna, J., & Jasrial, J. (2024). Pengembangan Model Pembelajaran Berbasis Proyek Berbantu Game Edukasi di Taman Kanak-kanak. *Aulad: Journal on Early Childhood*, 7(1), 130–140. <https://doi.org/10.31004/aulad.v7i1.598>
- Sari, M. I., Utari, S. D., & Arfiandhani, P. (2023). Creating English Learning Media Using Canva: EFL Students' Perspective. *Teaching English as a Foreign Language Journal*, 2(2), 85–96. <https://doi.org/10.12928/tefl.v2i2.467>
- Sartika, R. P., & Hadi, L. (2021). The Improvement of Students' Conceptual Understandings Through the PQ4R Aided the 5E Learning Cycle Model on the Topic of Salts Hydrolysis. *Journal of Physics: Conference Series*, 1788(1), 012036. <https://doi.org/10.1088/1742-6596/1788/1/012036>
- Schoenherr, J., Strohmaier, A. R., & Schukajlow, S. (2024). Learning with Visualizations Helps: A Meta-Analysis of Visualization Interventions in Mathematics Education. *Educational Research Review*, 45, 100639. <https://doi.org/10.1016/j.edurev.2024.100639>
- Shanmugasundaram, M., & Tamilarasu, A. (2023). The Impact of Digital Technology, Social Media, and Artificial Intelligence on Cognitive Functions: A

- Review. *Frontiers in Cognition*, 2, 1203077.  
<https://doi.org/10.3389/fcogn.2023.1203077>
- Skulmowski, A., & Xu, K. M. (2022). Understanding Cognitive Load in Digital and Online Learning: A New Perspective on Extraneous Cognitive Load. *Educational Psychology Review*, 34(1), 171–196.  
<https://doi.org/10.1007/s10648-021-09624-7>
- Yaseen, H., Mohammad, A. S., Ashal, N., Abusaimeh, H., Ali, A., & Sharabati, A.-A. A. (2025). The Impact of Adaptive Learning Technologies, Personalized Feedback, and Interactive AI Tools on Student Engagement: The Moderating Role of Digital Literacy. *Sustainability*, 17(3), 1133.  
<https://doi.org/10.3390/su17031133>
- Zain, Z. M., Jasmani, F. N. N., Haris, N. H., & Nurudin, S. M. (2022). Gadgets and Their Impact on Child Development. *International Academic Symposium of Social Science* 2022, 6.  
<https://doi.org/10.3390/proceedings2022082006>
- Zhai, C., Wibowo, S., & Li, L. D. (2024). The Effects of Over-Reliance on AI Dialogue Systems on Students' Cognitive Abilities: A Systematic Review. *Smart Learning Environments*, 11(1), 28.  
<https://doi.org/10.1186/s40561-024-00316-7>
- Zou, Y., Kuek, F., Feng, W., & Cheng, X. (2025). Digital Learning in the 21st Century: Trends, Challenges, and Innovations in Technology Integration. *Frontiers in Education*, 10, 1562391.  
<https://doi.org/10.3389/educ.2025.1562391>