






# Effectiveness of Using Digital Comic Media in Environmental Education

Desy Safitri<sup>1</sup><sup>a</sup>, Sujarwo<sup>1</sup><sup>b</sup>, Arita Marini<sup>2</sup><sup>c</sup>, Nurzengky Ibrahim<sup>3</sup><sup>d</sup> and Parulian Irwansyah<sup>4</sup><sup>e</sup>

<sup>1</sup>Department of Social Science Education, Universitas Negeri Jakarta, Jl. Rawamangun Muka No: 1, Jakarta, Indonesia

<sup>2</sup>Department of Elementary School Teacher Education, Universitas Negeri Jakarta, Jl. Rawamangun Muka No: 1, Jakarta, Indonesia

<sup>3</sup>Department of History Education, Universitas Negeri Jakarta, Jl. Rawamangun Muka No: 1, Jakarta, Indonesia

<sup>4</sup>SMPN 2 Badau Belitung, Jl. Petikan, Bangka Belitung, Indonesia

**Keywords:** Digital Comic Media, Environmental Education, Learning Outcomes, Junior High School Students.


**Abstract:** This study examines the effectiveness of using digital comic media on learning outcomes in environmental education. Data was collected through a pre-experimental method using a pretest and posttest one-group design model. Hypothesis testing was carried out after fulfilling the prerequisite test using the Paired Sample T-test to see the effectiveness of digital comic media on the learning outcomes of Environmental Education of seventh-grade students. Then, the N-Gain score of the effectiveness of using digital comic media will be tested. Sampling was done by cluster random sampling. This research was conducted in 2024. The sample of this study amounted to 46 students of SMPN 70 grade VII in the 2024/202 school year in Central Jakarta, Indonesia. The results of the paired sample T-test showed that the sig. p value <0.05 or 0.00 <0.05. This shows a significant effect of digital comic media on Environmental Education learning outcomes. This research aims to improve Environmental Education for junior high school students through digital media to create motivation and interest in students to absorb the information the teacher conveys.


## 1 INTRODUCTION


Environmental education can elevate awareness and deepen comprehension of ecological challenges. By fostering a nuanced understanding of environmental dynamics, students are more likely to develop a profound sense of care and responsibility, ultimately inspiring sustainable action. A synergistic approach can be adopted to revitalise environmental education by weaving diverse environmental themes into social studies curricula. This can be accomplished through innovative mediums like digital comics, which illuminate ecological concepts and issues and captivate students' interest, transforming learning into an engaging and impactful journey. Environmental education helps develop a caring attitude towards the environment. Students will learn to appreciate nature,


conserve limited natural resources, and protect biodiversity. Digital comic learning media can impact environmental education given to students, making students think critically about understanding environmental material integrated into learning so that the transmission of ecological material becomes optimal.


Research indicates that environmental education can positively impact the environment and tackle specific conservation challenges by fostering ecological values, attitudes, and knowledge. It also equips individuals and communities with the skills to work together toward proactive environmental solutions (Ardoyn *et. al.*, 2020). Ecological education enhances students' knowledge of ecology by fostering active participation and a comprehensive understanding of the environment (Charatsari &

<sup>a</sup> <https://orcid.org/0000-0001-8018-1136>

<sup>b</sup> <https://orcid.org/0000-0002-1809-1663>

<sup>c</sup> <https://orcid.org/0000-0002-4947-996X>

<sup>d</sup> <https://orcid.org/0009-0000-4624-4121>

<sup>e</sup> <https://orcid.org/0009-0001-4088-6729>

Lioutas, 2017). Environmental education in the curriculum can facilitate the development of ecological thinking among students. Environmental education integrated into social studies learning is provided formally in the classroom. Learning in the school is related to teaching media as a tool for teachers to clarify student understanding. Learning media becomes one of the integral parts of learning in the classroom. In the modern era, mobile technology has emerged as a catalyst for educational innovation, transforming classrooms into dynamic spaces of creativity (Sarifah *et al.*, 2025). It empowers educators to push boundaries, sparking inspiration and fostering the creation of engaging, fresh, and imaginative opportunities for students to engage in meaningful and educational activities that promote growth, understanding, and skill development.

Learning media is designed to optimize the achievement of learning objectives while providing students with engaging and meaningful experiences. One effective medium that boosts students' motivation and interest in learning is comics. Comics naturally draw readers' attention with their visual appeal and captivating imagery, fostering enthusiasm and a greater desire to learn (Septaria & Fatharani, 2022). Comics can present concrete experiences obtained through images that clarify the message to be conveyed and reduce verbality in classroom learning so that readers can focus more on understanding the message conveyed by the author. (Subroto, *et al.*, 2018). Comics are a powerful tool for education and can greatly enhance students' learning outcomes.

## 2 LITERATURE REVIEW

Environmental education is critical to improving environmental literacy so that attitudes and characters that care about and respect the environment will be formed. Environmental education can increase students' understanding of the significance of preserving the environment and provide knowledge about maintaining a good environment. This research discusses the model of environmental education in social studies learning through digital comics for students who care about the environment, where students are brought to contextual conditions casuistic and fun through visual media in the form of pictures and interesting storylines that are entertaining and educational so that fostering and reinforcing values leads to the development of optimal skills for responding to the environment. Incorporating environmental education into social

studies learning ensures it aligns effectively with its intended objectives according to what has been set.

Research indicates that environmental knowledge plays a crucial role in influencing pro-environmental attitudes. Findings suggest that greater environmental knowledge significantly enhances positive attitudes toward the environment. (Liu, Teng, & Han, 2020 & Janmaimool, & Khajohnmanee, 2019). A study states that environmental education enhances students' knowledge about the environment, fostering their participation and promoting a comprehensive understanding of environmental issues. (Charatsari & Lioutas, 2017). Environmental education in the educational curriculum can facilitate students' development of environmental thinking. Furthermore, environmental awareness is assessed in both cognitive and affective domains, making it a key factor in predicting changes in environmental behaviour. One approach to behaviour change is the ecological dynamics model (EDM), which shares several characteristics with eco-pedagogic-based outdoor experiential education (EOEE) (Berberoglu & Emel, 2017). The study found that the participants developed environmental awareness and tended to have a holistic perspective at the end of their education. Environmental education can consistently affect students' environmental attitudes, awareness, and behavioural intentions in initiatives that support environmental education designed at the classroom level (Bergman, 2016).

Environmental education is related to three factors: intention for environmental learning and behaviour, appreciation of the environment, and awareness of the potential impacts of nature. Incorporating environmental education in schools can enhance students' understanding through three key approaches. The first involves critically examining the connections between natural, social, and cultural environments. The second focuses on providing factual knowledge about environmental issues. The third emphasizes capacity building by fostering a process-oriented, participatory, and action-driven approach to learning, particularly concerning energy and natural resource management (Spahiu, Korcha, Lindemann-Matthies, 2014). Environmental education is central to the action plan for sustainable development, as it is incorporated into the curriculum across all levels of education. Students can develop critical environmental thinking skills by embedding environmental education into the learning system. This approach fosters improved environmental attitudes and a stronger connection to nature among learners (Sellmann & Bogner, 2013). Environmental education is effective in providing cognitive learning. Computer technology applications

offer a variety of tools for education (Alqahtani & Mohammad, 2015). Teachers' selection of computer technology applications can improve learner performance and educational effectiveness and make teaching more effective.

Classroom learning is closely tied to the use of learning media, as it enhances the effectiveness and efficiency of educational activities. Learning media can clarify the teacher's learning material from abstract to concrete through the images presented. Learning media can stimulate students' interest, motivation, and thinking power to learn because there is a variety of learning in the classroom. A study states that comics are images juxtaposed with other images that are deliberately made in sequence to convey a message and give a deep impression to the readers; the images presented can provide a good picture and have art so that readers can be carried away with the message conveyed (Aulia, Nisa, & Wuryandani, 2019). Furthermore, comics are images that are juxtaposed with other images that are deliberately made in sequence to convey a message and give a deep impression to the readers; the images presented can provide a good picture and have art so that readers can be carried away with the message conveyed (Mustikasari *et al.*, 2020). Next, comics that are arranged with various series of images contain a message that wants to be conveyed from the creator to the readers; comics tend to have a message tailored to their needs (Sari *et al.*, 2021). If comics are prepared with educational messages, the making of images and storylines will be adjusted to the learning needs to be conveyed. Other research suggests that comics can be effective learning tools and boost students' interest in reading (Kusumadewi *et al.*, 2020).

In addition, comics possess a unique quality as a visual learning tool, using colourful images to convey information. This approach helps readers better comprehend and retain the material, as the brain processes images more efficiently than sounds (Sinta, Norma, I., 2021). Next, comics are suitable for communicating a message to readers because they can focus attention on a design arranged in mind. In contrast, comics in learning can convey material differently, namely concisely with pictures (Hong Yi *et al.*, 2020). Comics have the potential to inspire motivation and excitement for learning through visually appealing images. Digital comics can be a powerful educational resource for content and language-integrated learning, offering an engaging, user-friendly, and thoroughly educational approach that emphasizes collaboration (Rutta *et. al.*, 2021). Digital comics can enhance students' cognitive learning results, with significant differences in

students' cognitive outcomes between online learning with comic assistance and online learning without comics, favouring the use of comics in the learning process (Damopolii *et al.*, 2021).

Digital comic-based learning media can effectively deliver educational content, enabling teachers to conduct more diverse and engaging teaching activities. This form of media also enhances students' interest in learning, preventing boredom during lessons and improving their learning outcomes. The flexibility of digital comics allows students to independently review the material being taught or revisit previously covered content, as they can access the comics anytime and anywhere. Moreover, if students encounter difficulties answering questions, they can easily refer to the material in the digital comics for clarification.

### 3 METHODS

This research employs a pre-experimental quantitative approach with a one-group pretest-posttest design, as shown in Table 1. The Shapiro-Wilk test assesses normality, while Levene's test is applied to check for homogeneity. The hypothesis is tested using the Paired Sample T-test to evaluate the effectiveness of Digital Comics media on the learning outcomes of Environmental Education.

Table 1: Experimental Research Design.

Pretest	Treatment	Posttest
O1	X	O2

Description:

O1: Pretest score before treatment

X: Treatment using digital comic media

O: Posttest score after treatment.

The sampling method used in this study was cluster random sampling. The research was conducted in 2024, with a population of 182 seventh-grade students at SMPN 70 for the 2024/2025 school year in Central Jakarta, Indonesia. A sample of 46 seventh-grade students was selected. This study employed a pre-experimental quantitative research approach, utilizing a one-group pretest and posttest design.

### 4 RESULTS AND DISCUSSIONS

Data were collected using questionnaires and semi-structured interviews with seventh-grade teachers at SMPN 70 in Central Jakarta, Indonesia. This phase of

the research involves a pretest, treatment, and posttest. The pretest was administered to assess the condition of the sample prior to any intervention, specifically to evaluate the Environmental Education learning outcomes of seventh-grade students before using digital comic media. Subsequently, the teacher provided treatment by using digital comic media in Environmental Education lessons. The effectiveness of the treatment was assessed by the posttest, which was conducted to determine the difference in learning outcomes compared to the pretest. The pretest and posttest statements on student learning outcomes in environmental education are presented in Tables 2 and 3.

Table 2: Table of pretest instruments of comic's digital media.

Indicators	Sub-indicators	Total
Environmental knowledge	Not knowing the cleanliness of the toilet	1
	It does not reduce the use of plastic	2
	Not familiar with 3 R's (reuse, reduce, recycle)	1
	Not aware of tree planting at school	1
	Do not know how to use natural resources in moderation	1
	Unable to distinguish between types of waste	1
Environmental attitude	Do not reprimand friends who litter	1
	Not cultivating environmental ethics	1
	Not inviting friends to beautify the classroom with plants	2
	Does not participate in keeping the school environment clean	2
	Does not participate in conducting class cleaning pickets	1

Environmental skills	Not disposing of garbage according to the type of garbage	1
	Not doing community service at school	2
	Not keeping the school environment clean	1
	Do not flush the toilet after using it	2
	Do not participate in maintaining the river	1
	Not saving the use of clean water	1
	Do not recycle garbage	1
	Not carrying out class cleaning pickets	1
	Not committing vandalism	1

Table 3: Table of posttest instruments of comic's digital media.

Indicators	Sub indicators	Total
Environmental knowledge	Knowing the cleanliness of the toilet	1
	Reducing the use of plastic	2
	Familiar with 3 R's (reuse, reduce, recycle)	1
	Know about tree planting at school	1
	Know how to use natural resources in moderation	1
	Can distinguish the types of waste	1
Environmental attitude	Reprimanding friends who litter	1
	Fostering environmental ethics	1
	Inviting friends to beautify the classroom with plants	2
	Participating in keeping the school	2

Environmental skills	environment clean	
	Participate in conducting class cleaning pickets	1
	Disposing of garbage according to the type of garbage	1
	Doing community service at school	2
	Keeping the school environment clean	1
	Flushing the toilet after using it	2
	Participating in keeping the river clean	1
	Save the use of clean water	1
	Recycling garbage	1
	Carrying out class cleaning pickets	1
	Committing vandalism	1

Next, a normality test and homogeneity test were conducted. The Paired Sample T-test was performed to evaluate the effectiveness of using digital comics in Environmental Education learning outcomes, followed by the N-Gain test to assess the strength of digital comic media's effectiveness in learning.

This study conducted a normality test to determine whether the data obtained followed a normal or abnormal distribution, which would guide appropriate statistical selection. The normality test aimed to measure the distribution's normality, ensuring the correct statistical method was used. The Shapiro-Wilk test was used for this study, and the following test criteria were used:

If the significance value (sig) is more significant than 0.05, the data follows a normal distribution, meaning H0 is accepted, and H1 is rejected.

Conversely, if the significance value (sig) is less than 0.05, it suggests that the data does not follow a normal distribution, leading to the acceptance of H1 and the rejection of H0.

Based on the Q-Q Plot shown in Figure 1, the points are clustered around and closely follow the diagonal line. The diagram's bell-shaped pattern, with no significant skew to the right or left, further

indicates that the control data follows a normal distribution.

Table 4: Normality test results.

Test of Normality			
Kolmogorov-Smirnov			
	Statistic	df	Sig.
Pretest	0.965	46	0.181
Posttest	0.970	46	0.287

According to the one-sample Kolmogorov-Smirnov Test results in Table 4, the significance values (sig) exceed the  $\alpha = 0.05$  threshold, with  $0.200 > 0.05$  for the pretest and  $0.979 > 0.05$  for the posttest. As a result, based on the established test criteria, H0 is accepted, indicating that both the pretest and posttest data follow a normal distribution.

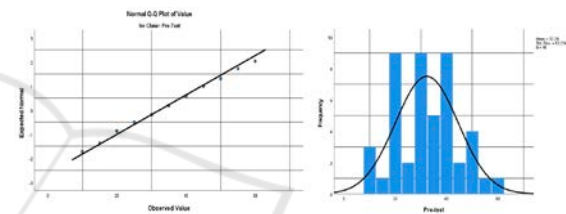


Figure 1: Normal distribution of the pretest data.

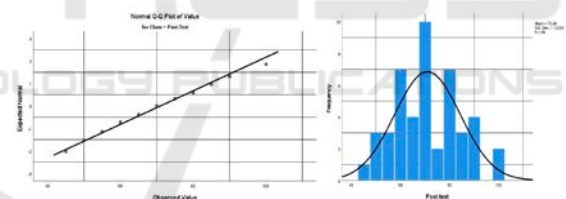


Figure 2: Normal distribution of the experiment group.

Based on the experiment data shown in the Q-Q Plot graph in Figure 3, the points are clustered around and closely follow the diagonal line. The diagram's bell-shaped distribution, without significant skew to the right or left, suggests that the post-test data follows a normal distribution, as illustrated in Figure 3.

In addition, a homogeneity test is performed to assess whether the variances of the data populations are the same or different across two or more groups. The following testing rules are used: If the significance value (sig) is more significant than 0.05, the data distribution is homogeneous, meaning H0 is accepted, and H1 is rejected.

If the significance value (sig) is less than 0.05, it suggests that the data distribution is not



homogeneous, leading to the acceptance of H1 and rejection of H0.

Table 5: Homogeneity test results of pretest and posttest.

Test of Homogeneity of Variance				
	Levene Statistic	df1	df2	Sig.
Based on Mean	.247	1	90	0.620
Based on Median	.160	1	90	0.690
Based on the Median and with adjusted df	.160	1	89.146	0.690
Based on trimmed mean	.213	1	90	0.645

Based on the analysis presented in the Test of Homogeneity of Variances Output in Table 5, the significance value (sig) is 0.620, more significant than the  $\alpha = 0.05$  threshold. As a result, according to the established test criteria, H0 is accepted, indicating that the data distribution is homogeneous.

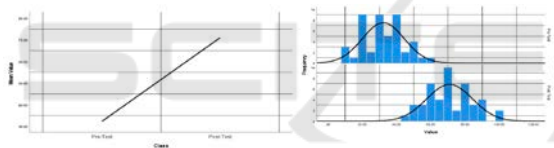


Figure 3: Graphs and histograms of control and experiment homogeneity test.

In addition, hypothesis testing was conducted using the paired sample T-test to assess whether there were any changes in environmental education learning outcomes between the pretest scores (before using digital comic media) and the posttest scores (after using digital comic media). This can be observed from the average cognitive abilities of students, as indicated by the pretest and posttest scores. The average posttest score of 70.98 is higher than the pretest score of 27.28, as shown in Figure 4.

The Paired T-test was conducted using the test criteria as follows:

If the significance value (sig) is greater than 0.05 or the count is less than the table value, it can be concluded that there is no difference between the average pretest and posttest environmental education learning outcomes, meaning H0 is accepted, and H1 is rejected.

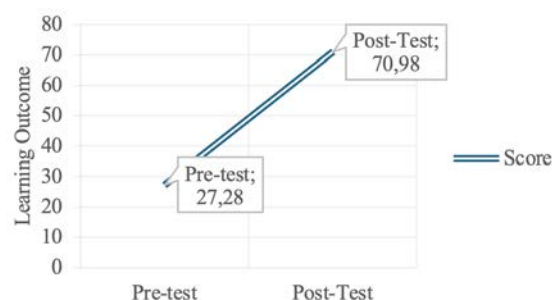


Figure 4: Pretest and posttest of learning outcomes.

If the significance value (sig) is less than 0.05 or the t-count exceeds the t-table value, it can be concluded that there is a difference between the average pretest and posttest environmental education learning outcomes, meaning H1 is accepted and H0 is rejected.

Table 6: Paired sample statistics.

Paired Samples Statistics				
	Mean	N	Std. Deviation	Std. Error Mean
Pretest	27.28	46	12.234	1.804
Posttest	70.98	46	13.401	1.976

The analysis of the paired samples statistics, shown in Table 6, summarizes the descriptive statistics for the two samples studied: students' pretest and posttest learning outcomes. The sample consisted of 46 students. The average pretest score was 27.28, while the average posttest score was 70.98. The standard deviation for the pretest was 12.234, and for the posttest, it was 13.401. Descriptively, there is an observable difference in the environmental education learning outcomes between the pretest and posttest, indicating an improvement after using digital comics.

Following this, the N-Gain test was conducted to assess the effectiveness of digital comic media. The N-Gain value categorizes the effectiveness based on its score or percentage. Tables 15 and 16 provide the criteria and interpretation for the N-Gain values.

Table 7: N-Gain score criteria.

Score Gain	Criterion
$g > 0,7$	High
$0,3 < g \leq 0,7$	Medium
$g \leq 0,3$	Low

N-Gain score criteria and the effectiveness of N-Gain categories are presented in Tables 7 and 8. Based on the N-Gain results in Table 9, the difference

between the pretest and posttest average scores was increased. The pretest value was 27.28, and the posttest value was 70.98. Furthermore, the percent N-Gain test obtained a result of 0.58 or an increase of 58% from the pretest and posttest scores. The assessment criteria include the N-Gain score of  $0.3 < g < 0.7$  in the moderate category. This proves that digital comic media is effective, with a moderate category in the learning outcomes of VII grade junior high school students.

Table 8: Effectiveness of N-Gain categories.

Percentage (%)	Interpretation
<40	Ineffective
40-55	Less Effective
56-75	Quite Effective
> 76	Effective

Table 9: N-Gain results.

Descriptive Statistics						
	N	Min.	Max.	Mean	Std. Deviation	N
Pretest	46	5.00	55	27.28	12.2341	46
Posttest	46	45.00	100	70.98	13.4007	46
NGain score	46	.18	1	.58	.2043	46
NGain %	46	1818	100	58.45	20.4298	46
Valid N						

Recent studies have illuminated the transformative impact of integrating technology into educational practices (Nuraini *et al.*, 2023; Abustang *et al.*, 2024; Aliyyah *et al.*, 2024; Lestari *et al.*, 2024; Sintawati *et al.*, 2023; Safitri *et al.*, 2023; *et al.*, 2023; Arum *et al.*, 2023; Nuraini *et al.*, 2023; Rihatno *et al.*, 2023). Specifically, using technology as an interactive learning medium has demonstrated a marked ability to ignite student motivation. This surge in interest enhances the learning process's effectiveness and cultivates critical skills among students. Moreover, leveraging technology in teaching methods extends beyond intellectual stimulation; it fosters a holistic engagement by invigorating students physically and emotionally, streamlining their overall educational experience.

Technology has the incredible power to transform learning into a more engaging, efficient, and impactful experience. From interactive tools to AI-driven platforms, it bridges the gap between traditional education and innovative possibilities,

empowering both educators and learners to thrive (Zakiah *et al.*, 2023; Hadi *et al.*, 2022; Rihatno *et al.*, 2020; Edwita *et al.*, 2020; Umasih *et al.*, 2020; *et al.*, 2020; Nuraini *et al.*, 2020; Batubara *et al.*, 2022; *et al.*, 2022; Safitri *et al.*, 2022; Susanto *et al.*, 2022; Sarifah *et al.*, 2022; Wahyudi *et al.*, 2019; Edwita *et al.*, 2019; Kaban *et al.*, 2019; Safitri *et al.*, 2019; Safitri *et al.*, 2019).

The use of learning media continues to evolve, adapting to meet students' unique and diverse needs (Edwita *et al.*, 2019). These tools are crucial in shaping and enhancing students' positive behaviours by providing engaging and meaningful learning experiences. One of the key areas of focus in this development lies in refining the visual aspects, such as fonts and displays, ensuring that they are aesthetically pleasing, functional and accessible for learners. The process of evaluating and improving these materials is ongoing. With each assessment, an opportunity emerges to make the media even more effective and aligned with the goals of modern education. Comic media, for instance, stands out as a dynamic alternative for teaching complex or abstract concepts. By transforming these ideas into relatable and tangible scenarios, comics bring learning to life, connecting theory to students' everyday experiences.

This innovative approach not only bridges the gap between the abstract and the concrete but also captures the imagination of learners, making education not just informative but also entertaining and memorable (Hadi *et al.*, 2022). Through thoughtful design and creative storytelling, learning media can revolutionize how students interact with knowledge, sparking curiosity and encouraging active engagement.

The application of information and technology innovations integrated into learning helps convey accurate, authentic, and contextual casuistic problem-solving information to students regarding environmental materials that have not been optimally carried out; aiming to be informative to keep students engaged and interested, we proceeded with the N-Gain value test, which evaluates the effectiveness of digital comic media. The N-Gain value can be classified either by its numerical value or as a percentage. The criteria and interpretation of N-Gain values are shown in Table 15 and Table 16. (Safitri *et al.*, 2023; *et al.*, 2024). It will improve the understanding, attitudes, and skills of students as a young generation who will continue development for sustainable environmental quality, as well as the formation of student characters who care about the environment. Environmental education in social studies, using digital comics as a learning tool for

students concerned about the environment, not only imparts knowledge and understanding but also fosters problem-solving skills and ethical awareness. This approach, particularly focused on environmental topics integrated into social studies, will ultimately promote a deeper and more comprehensive understanding of environmental issues.

## 5 CONCLUSIONS

Digital comics simplify students' grasp of a wide range of environmental topics integrated into social studies. Using an approach that presents environmental issues and case studies through engaging and visually appealing images and concept explanations, students can build their understanding through real-life experiences. This method motivates students to engage more actively in their learning. It sparks their interest and encourages participation, enhancing their cognitive skills and fostering creativity to develop innovative and thoughtful solutions for environmental challenges within social studies. Furthermore, environmental education in social studies can increase students' comprehension, awareness, and commitment to addressing environmental issues, promoting early environmental conservation efforts.

## ACKNOWLEDGEMENTS

LPPM Universitas Negeri Jakarta supported this study under International Collaborative Research Grants Number: 40/KI/LPPM/III/2024.

## REFERENCES

- Abustang, P., B., ., A., & Wibowo, F., C., 2024. Creative thinking skills in the elementary education bibliometric study literature. *AIP Conference Proceedings*, Vol. 3116, No. 1.
- Aliyyah, R., R., Rasmitadila, Fauziah, S., P., Widyasari, ., A., & Ruhimat, 2024. Digital library: Lecturers' perceptions of facilitating learning resources in the industrial era 4.0. *Journal of Education and e-Learning Research*. Vol. 11, No. 1, pp. 203-210.
- Alqahtani, M., & Mohammad, H., 2015. Mobile applications' impact on student performance and satisfaction. *The Turkish Online Journal of Educational Technology*, Vol. 14, Issue 4, pp. 102-112.
- Arum, W., S., A., Ramadhina, K., ., A., Safitri, D., & Dewiyan, L., 2023. Managing fourth-grade elementary school students' learning motivation through scrapbook media-based QR code in social studies. *Eurasian Journal of Educational Research*, Vol. 106, pp. 232-250.
- Aulia, Nisa, & Wuryandani, W., 2019. Multicultural Strip Comic as a Learning Media to Improve the Caring Character in Primary School. *Journal of Education and Learning*, Vol. 13, No. 4, pp. 527-533.
- Ardoin, N., M., Bowers, A., W., Gaillard, E., 2020. Environmental education outcomes for conservation: A systematic review. *Biological Conservation*. Vol. 241, pp. 1-13.
- Batubara, H., H., Sumantri, M., S., &, A., 2022. Developing an Android-Based E-Textbook to Improve Learning Media Course Outcomes. *International Journal of Interactive Mobile Technologies*, Vol. 16, No. 17, pp. 4-19.
- Berberoglu, O., & Emel, 2017. Ecological Dynamics Model and Ecopedagogy-Based Outdoor Experiential Education. *International Electronic Journal of Environmental Education*. Vol. 7, No. 2, pp. 134-151.
- Bergman, B., G., 2016. Assessing impacts of locally designed environmental education projects on students' environmental attitudes, awareness, and intention to act. *Environmental Education Research*. Vol. 22, Issue 4, pp. 480-503.
- Charatsari, C., & Lioutas, E., D., 2017. Environmental education in university schools: A study in a logistics faculty. *Applied Environmental Education & Communication*. Vol. 17, Issue 2, pp. 124-135.
- Damopolii, I., Lumembang, T., & Ilhan, G., O., 2021. Digital Comics in Online Learning During COVID-19: Its Effect on Student Cognitive Learning Outcomes. *International Journal of Interactive Mobile Technologies*, Vol. 15, No., 19, pp. 33-47.
- Edwita, Safitri, D., Maksum, A., Yunaz, H., ., A., & Muda, I., 2019. The effect of student cultural enculturation on student art appreciation. *International Journal of Education and Practice*, Vol. 7, No. 4, pp. 469-478.
- Edwita, Safitri, D., Nuraini, S., Rihatno, T., Sudrajat, A., ., A., & Apriwahyudi, 2020. Six years old elementary school student character enhancement through implementation of character building based on stop motion animation. *International Journal of Advanced Science and Technology*, Vol. 29, No. 6, pp. 1125-1128.
- Hadi, W., Yuksafa, R., Yarmi, G., Safitri, D., Lestari, I., Suntari, Y., Umasih, ., A., Sudrajat, A., & Iskandar, R., (2022). Enhancement of students' learning outcomes through interactive multimedia. *International Journal of Interactive Mobile Technologies*, Vol. 16, No. 7, pp. 82-98.
- Janmaimool, P., & Khajohnmanee, S., 2019. Roles of Environmental System Knowledge in Promoting University Students' Environmental Attitudes and Pro-Environmental Behaviors. *Sustainability*, Vol. 11, No. 16, pp. 1-18.
- Kaban, S., Sakmal, J., Auliaty, Y., ., A., & Wahyudi, A., 2019. Model of creative thinking skills for elementary school students. *International Journal of Control and Automation*, Vol. 12, No. 4, pp. 70-76.



- Kusumadewi, R., F., Neolaka, A., & Yasin, M., 2020. *Jurnal Phenomenon*, Vol. 10, No. 1, pp 85–101.
- Lestari, I., Merrita, D., Imaningtyas, ., A., & Yurniwati, 2024. Learning loss analysis on science literacy for elementary school students in the Covid-19 pandemic. *AIP Conference Proceedings*, Vol. 2982, No. 1.
- Liu, P., Teng, M., & Han, C., 2020. How does environmental knowledge translate into pro-environmental behaviors?: The mediating role of environmental attitudes and behavioral intentions. *The Science of the Total Environment*, Vol. 728, No.138126.
- ., A., Safitri, D., ., Zahari, M., Lestari, I., Rihatno, T., Nuraini, S., Iskandar, R., & Ibrahim, N., 2021. Model of character building applied in physical education and sport class: Case in Indonesia. *Journal of Physical Education and Sport*, Vol. 21, No. Suppl. Issue 4.
- Mustikasari, L., Priscylio, G., Hartati, T., & Sopandi, W., 2020. The Development of Digital Comic on Ecosystem for Thematic Learning in Elementary Schools. *Journal of Physics: Conference Series*, Vol. 1469, No. 1.
- Nuraini, S., Safitri, D., Rihatno, T., ., A., Putra, Z., E., F., F., & Apriwahyudi, 2020. Character building model in extracurricular activities using simulation games for elementary school students. *International Journal of Advanced Science and Technology*, Vol. 29, No. 8s, pp. 97-102.
- Nuraini, S., Inggriyani, F., Albar, J., Muchtar, F., Y., Sandi, N., V., Rezaki, & ., A., 2023. Games-based interactive multimedia to increase student creativity in physical education course. *Eurasian Journal of Educational Research*, Vol. 104, pp. 73-86.
- Phoon, H., Y., Roslan, R., Shahrill, M., & Said, H., N., 2020. The Role of Comics in Elementary School Science Education. *Jurnal Ilmiah Pendidikan MIPA*, Vol. 10, No. 2, pp. 67-76.
- Rihatno, T., Safitri, D., Nuraini, S., ., A., Putra, Z., E., F., F., & Apriwahyudi, 2020. The development of character education model using stop motion animation for elementary school students in Indonesia. *International Journal of Advanced Science and Technology*, Vol. 29, No. 8s, pp. 103-109.
- Rihatno, T., Putri, F., N., ., A., Sagita, J., Safitri, D., & Dewiyan, L., 2023. QR code-based interactive e-book in increasing interest in physical education. *Eurasian Journal of Educational Research*, Vol. 104, pp. 125-141.
- Rosyida, A., Mustaji, & Subroto, W., 2018, The Development of Contextual Teaching and Learning-Based Comic as a Learning Media for Elementary School Students. *Advances in Social Science, Education and Humanities Research*, Vol. 173, pp. 13–16.
- Rutta, C., B., Schiavo, G., Zancanaro, M., & Rubegni, E., 2021. Comic-based Digital Storytelling for Content and Language Integrated Learning. *Educational Media International*, Vol. 58, No. 1.
- Safitri, D., Awalia, S., Sekaringtyas, T., Nuraini, S., Lestari, I., Suntari, Y., ., A., Iskandar, R., Sudrajat, A., 2022. Improvement of student learning motivation through word-wall-based digital game media”, *International Journal of Interactive Mobile Technologies*, Vol. 16, No. 06, pp. 188–205.
- Safitri, D., ., A., Auliya, A., F., ., & Wardhani, P., A., 2023. Development of augmented reality-based interactive learning media to increase interest in environmental education. *Eurasian Journal of Educational Research*, Vol. 106, pp. 101-117.
- Safitri, D., ., ., A., Fitrisia, A., Sudarmiani, Widodo, S., & Meyers, K., F., 2023. Model of virtual reality in social studies to improve student learning outcomes. *Eurasian Journal of Educational Research*, Vol. 105, pp. 103-118.
- Safitri, D., Umasih, Yunaz, H., ., A., & Wahyudi, A., 2019. Model of environmental education. *International Journal of Control and Automation*, Vol. 12, No. 4, pp. 49-55.
- Safitri, D., Yunaz, H., Umasih, ., A., & Wahyudi, A., 2019. Effect of environmental education on ecotourism: Evidence from Jakarta. *International Journal of Control and Automation*, Vol. 12, No. 4, pp. 37-48.
- Sari, Y., Sari, R., P., Sumantri, M., S., & ., A., 2021. Development of Digital Comic for Science Learning in Elementary School.” *IOP Conference Series: Materials Science and Engineering*, Vol. 1098, No. 3.
- Sarifah, I., Rohmaniar, A., ., A., Sagita, J., Nuraini, S., Safitri, D., Maksum, A., Suntari, Y., & Sudrajat, A., 2022. Development of Android Based Educational Games to Enhance Elementary School Student Interests in Learning Mathematics. *International Journal of Interactive Mobile Technologies*, Vol. 16, No. 18, pp. 149–161.
- Sarifah, I., Muhajir, A., ., A., Yarmi, G., Safitri, D., & Dewiyan, L., 2025. Mobile games and learning interest: For fifth graders in mathematics. *Journal of Education and Learning*, Vol. 19, No. 1, pp.151-157.
- Sellmann, D., & Bogner, F., X., 2013. Effects of a 1-day environmental education intervention on environmental attitudes and connectedness with nature. *European Journal of Psychology of Education*, Vol. 28, pp. 1077-1086.
- Septaria, K., & Fatharani, A., 2022. Manga versus Webtoon: Alternative Science Learning Module. *Jurnal Inovasi Pendidikan IPA*, Vol. 8, No. 1, pp. 11–22.
- Sinta, I., N., Wardani, S., & Kurniawan, C., 2021. The Influence of Comic Media on Students’ Concept Understanding on Chemical Bonding Materials. *International Journal of Active Learning* (2021) Vol. 6 No. 2, pp. 85-90.
- Sintawati, M., Sukma, H., H., ., A., & Safitri, D., 2023. Number trace book for slow learners. *AIP Conference Proceedings*, Vol. 2733, No. 1.
- Spahiu, M., H., Korch, B., & Lindemann-Matthies, P., 2014. Environmental Education in High Schools in Kosovo-A teachers' perspective. *International Journal of Science Education*. Vol. 36, No. 16, pp. 2750-2771.
- ., Herawati, S., N., Sekaringtyas, T., Safitri, D., Lestari, I., Suntari, Y., Umasih, Iskandar, R., Sudrajat, A., 2022.

- Android-Based Interactive Media to Raise Student Learning Outcomes in Social Science. *International Journal of Interactive Mobile Technologies*, Vol. 16, No. 07, pp. 4–21.
- ., Japar, M., Sumantri, M., S., Safitri, D., & ., A., 2023. Enhancement of students' learning outcomes through virtual reality based on case-based learning in social studies. *Eurasian Journal of Educational Research*, Vol. 106, pp. 171-191.
- Susanto, T., T., D., Dwiyantri, P., B., ., A., Sagita, J., Safitri, D., & Soraya, E., 2022. E-Book with Problem Based Learning to Improve Student Critical Thinking in Science Learning at Elementary School. *International Journal of Interactive Mobile Technologies*, Vol. 16, No. 20, pp. 4–17.
- Umasih, Safitri, D., Nuraini, S., Rihatno, T., Maksu, A., ., A., & Apriwahyudi, 2020. Enhancing student behavior through implementation of web-based character building for students at history education study program in Universitas Negeri Jakarta. *International Journal of Advanced Science and Technology*, Vol. 29, No. 6, pp. 1136-1139.
- Wahyudi, A., Zulela, ., A., Marzuki, I., Barokah, S., N., & Mahmudi, 2019. Implementation evaluation of the Family Hope program in support of basic education. *Opcion*, Vol. 35, No. 21, pp. 1028-1043.
- Zakiah, L., Sarkadi, & ., A., 2023. Teachers' strategies in teaching social tolerance to elementary school students in Jakarta, Indonesia. *Issues in Educational Research*, Vol. 33, No. 2, pp. 839-855.