EDUTECH

Jurnal Teknologi Pendidikan

Journal homepage https://ejournal.upi.edu/index.php/edutech

Bridging Abstract Earth Structure Concepts through E-Comics: Effects on Scientific Literacy and Student Engagement

Imroatun Nadifah, Faiq Sayyida Nasa, Sabar Nurohman, Ismail Fikri Natadiwijaya*
Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
*Correspondence: E-mail: imroatunnadifah.2024@student.uny.ac.id

ABSTRACT

The material on the structure of the earth at the Junior High School level is often difficult for students to understand because the concepts are abstract and cannot be observed directly. This study was conducted to determine the influence of the use of e-comic media on scientific literacy and student engagement in learning the structure of the earth. The study was conducted among eighth-grade students (VIII D) at SMP Muhammadiyah 3 Depok for four meetings using a pre-experimental method through a one-group pretest-posttest design. Data were collected using scientific literacy tests and student engagement questionnaires. Data analysis was carried out by the Shapiro–Wilk normality test, the Wilcoxon Signed Rank Test, descriptive analysis, and the Spearman correlation test. The results showed that the use of e-comic was able to significantly increase students' scientific literacy with a $p <$ value of 0.001. In addition, the level of student engagement during learning is in the high category based on the results of the questionnaire. However, the association between scientific literacy and student engagement showed only a weak and insignificant positive correlation ($r = 0.188$; $p = 0.427$). These findings show that e-comics are effective in helping students understand abstract concepts of the earth's structure through visual presentations and engaging stories. However, high student engagement does not necessarily have a direct effect on improving cognitive abilities in scientific literacy. Therefore, e-comics can be used as one of the innovative learning media to support science learning, especially in abstract materials.

ARTICLE INFO

Article History:
Submitted/Received 12 Aprl 2025
First Revised 26 Mei 2026
Accepted 15 June 2026
First Available online 30 June 2026
Publication Date 30 June 2026

Keyword:
e-comic
scientific literacy
student engagement
earth structure
science learning

DOI: https://doi.org/10.17509/e.v25i2.102330
p-ISSN 0852-1190 e-ISSN 2502-0781

1. INTRODUCTION

Natural Science learning at the junior high school level has its own challenges, especially in abstract materials such as the Earth's Structure and Its Development Dynamics (Ummah et al., 2025). Concepts such as the Earth's internal layers, asthenosphere, and the movement of tectonic plates cannot be observed directly by students, thus demanding high visualization and reasoning skills (Gattullo et al., 2022). This condition often causes students to only memorize terms without understanding the relationship between concepts, so that scientific literacy has not developed optimally. Referring to the Organisation for Economic Co-operation and Development (OECD, 2019), scientific literacy includes three main components, namely: the ability to explain phenomena through scientific concepts, the ability to evaluate and design scientific investigation processes, and the ability to interpret data and evidence scientifically. These three aspects are essential to prepare students to face complex global challenges and demand science-based solutions. Therefore, mastery of scientific literacy is the key to success not only in the context of education, but also in community life.

Based on the results of class observations carried out in junior high schools in one of the Yogyakarta junior high schools, it was found that science learning conditions that have challenges in terms of scientific literacy and student engagement. In general, schools have transformed into digital-based schools with very adequate facilities, such as the availability of projectors in each class, smart interactive boards, and the use of gadgets in learning activities. Science teachers are also known to be competent and communicative in the learning process and have tried to integrate various digital media such as PowerPoint, learning videos from YouTube, to three-dimensional visualization applications. However, behind the support of the complete digital facilities, the reality in the classroom shows that there is a gap in scientific literacy achievement and student engagement levels.

Responding to these conditions, several main challenges were found in achieving ideal learning goals. The first challenge has to do with visualization of abstract concepts. The material structure of the Earth demands that students understand geological processes that cannot be directly observed. Teachers reported that the biggest difficulty lies in explaining the origin and movement of the Earth's layers in the absence of a medium capable of dynamically describing the process (Puspitasari & Vivianti, 2026). This is in line with multimedia learning theory which states that abstract concepts in science require strong visual representations so as not to cause misconceptions (Mayer, 2021). Without the right media, students' scientific literacy tends to stop at the level of memorization (Wijayati, 2024).

The second challenge is the low engagement of students in the midst of adequate technological facilities. Although digital facilities are available, students tend to feel overwhelmed by one-way informative media such as PowerPoint presentations. Therefore, media that is not only technologically sophisticated, but also has narrative power that is able to attract students' attention emotionally and cognitively (Fitriana & Muthi, 2024). The use of comics in science learning is considered effective because it is able to present scientific concepts in the form of interesting and easy-to-understand stories (Tatalovic, 2023; Ramadhan, 2024).

The third challenge is the need to present material that is detailed but still in accordance with the characteristics of junior high school students. Teachers suggest that learning media be able to present a more in-depth explanation of the characteristics of each layer of the Earth and its dynamics of movement, without making students feel burdened by information that is too complex (Robani & Vivianti, 2025). This requires a

DOI: https://doi.org/10.17509/e.v25i2.102330
p-ISSN 0852-1190 e-ISSN 2502-0781

balance between the depth of the material and the readability. Research shows that the use of visual media combined with narrative can help students build a better understanding of abstract concepts (Fenezaa & Widodob, 2025).

Based on these challenges, learning innovations are needed that are able to bridge abstract concepts into more concrete, increase student engagement, and strengthen scientific literacy. One of the solutions developed in this study is the use of e-comics as a digital learning medium. E-comics combine text, images, and storylines in a single unit that allows students to understand concepts through visualization and narrative simultaneously (Rahmasari et al., 2024). This approach is in line with multimedia theory which states that the integration between visual and verbal representations can significantly improve conceptual understanding (Mayer, 2021).

In addition, the use of e-comics is also expected to be able to increase student engagement through a more contextual and interesting approach. By presenting characters, dialogues, and illustrations that are relevant to students' lives, e-comics can create a more meaningful learning experience (Laksmi & Suuniasih, 2021). Although e-comics are widely used to support science learning, research examining their application to earth structure materials remains relatively limited. Most previous studies have tended to focus on a single aspect of learning outcomes; thus, the simultaneous influence of e-comics on scientific literacy and student engagement has not been widely investigated. Furthermore, the relationship between these two variables within a digital science learning environment remains unclear. Therefore, this study aims to analyze the influence of the use of e-comics on scientific literacy and student engagement in the material structure of the Earth and its developmental dynamics, as well as examine the relationship between the two variables in the context of digital-based learning.

Picture 1. E-comic media display on earth structure material

2. METHODS

This study uses a pre-experimental method with a one group pretest-posttest design, where the target school is SMP Muhammadiyah 3 Depok with material on the structure of the Earth and its development dynamics during four meetings. Pretests, learning activities and posttest were carried out. The participants consisted of 20 eighth-grade students of VIII D. A purposive sampling technique was employed to select the participants. The sampling was chosen because they were studying earth structure topics during the research period and had not previously experienced e-comic-based learning. These characteristics made the class suitable for examining the effectiveness of e-comics in improving scientific literacy and student engagement. This study aims to analyze the

DOI: https://doi.org/10.17509/e.v25i2.100167
P-ISSN 0852-1190 E-ISSN 2502-0781

influence of e-comic use on scientific literacy and student engagement, as well as examine the relationship between the two variables in the context of digital-based learning. The instruments used were scientific literacy questions and student engagement questionnaires. The questions given are formed by pretest and posttest which are compiled based on scientific literacy indicators, namely identifying problems, explaining phenomena scientifically and using scientific evidence (PISA in Rini et al., 2021). The student engagement indicators used are adjusted to behavioral, emotional and cognitive engagement (Syahfitri et al., 2025). The implementation was carried out in four meetings; the first meeting students were given a pretest and an introduction related to the material. The second and third meetings were carried out with learning activities using e-comics on earth structure materials and tectonic plate activity by presenting the problem first, namely earthquakes. In the learning process, a problem-based learning model is used with discussion and question and answer methods related to geological phenomena that occur. At the last meeting, students reflected on their learning and did posttest and filled out student engagement questionnaires that had been distributed.

Data analysis was carried out with the SPSS Statistics 27 application by conducting a normality test with Shapiro-Wilk, Wilcoxon Signed Rank Test, Effect Size Test and Student Engagement Analysis Using Excel. In addition, the correlation test uses the spearman correlation test. For further results and analysis related to the data obtained, it will be explained below.

Picture 2. students use e-comics

3. RESULTS AND DISCUSSION

Improving Scientific literacy

The first test was a normality test using Shapiro-Wilk because the sample size was less than 50 students. The results of the normality test were the significance value of the pretest of 0.002 and the posttest of <0.001, which means that the data was not normally distributed (sig < 0.05). Therefore, a nonparametric test, namely the Wilcoxon Signed Rank Test, is used. Based on the Wilcoxon test, a significance value of <0.001 was obtained with the H0 decision rejected, this shows a significant difference between the pretest and posttest values. Therefore, science learning using e-comics is effective in improving students' understanding of concepts. The results of the Wilcoxon signed-rank test showed a standardized test statistic value Z = 3.957, with a significance level of p < 0.001. To determine the magnitude of the impact of e-comic usage, the effect size was calculated using the following formula:

$$r = \frac{|Z|}{\sqrt{N}}$$

DOI: https://doi.org/10.17509/e.v25i2.100167
P-ISSN 0852-1190 E-ISSN 2502-0781

Source: Rosenthal (1991)

The calculation yielded an effect size value of 0.885. Based on Cohen's criteria, this value falls into the large effect category. These findings demonstrate that the use of e-comics has a robust influence on improving students' scientific literacy regarding earth structure concepts. Thus, the treatment provided in this study has a strong impact on improving students' scientific literacy outcomes.

The results above are in line with what the students showed in class. During the learning process from the initial students could not explain the relationship between the movements of tectonic plates, it was obtained after treatment that students were able to explain straightforwardly and were able to distinguish the characteristics of the earth's layers and explain the convection currents that occurred. In addition, it can also relate learning materials to phenomena that occur, for example earthquakes that often occur in Jogja. This finding may be attributed to the innovation of e-comic media that supports students' scientific literacy. It is also strengthened by the significant increase in posttest scores. Where the average pretest score of students is in the range of around 50-60, while the average posttest score increases to around 79-84. Based on Table 1, the students' average scientific literacy score increased from 43.00 on the pretest to 84.00 on the posttest. Additionally, the minimum score rose from 20 to 70, and the maximum score increased from 60 to 100. These results indicated an improvement in scientific literacy skills following the implementation of e-comics.

Variabel	Mean	SD	Minimum	Maximum
Pretest	43.00	16.26	20	60
Posttest	84.00	10.46	70	100

Table 1. Descriptive Statistics of Students' Scientific Literacy

Previous research revealed that comics are indeed effective in improving scientific literacy, this is because comics that have interesting pictures and stories make it easy for students to understand science concepts. This is in line with increasing scientific literacy (Rahma & Kusumawati, 2024). Comics have been used in educational institutions as an independent learning medium that can facilitate students to understand the concept of science with or without the guidance of teachers (Nursholihat, et al., 2017). In addition, students' visual thinking skills can be improved using comic media as well as a means of entertainment (Wicaksono et al., 2020).

DOI: https://doi.org/10.17509/e.v25i2.100167
P-ISSN 0852-1190 E-ISSN 2502-0781

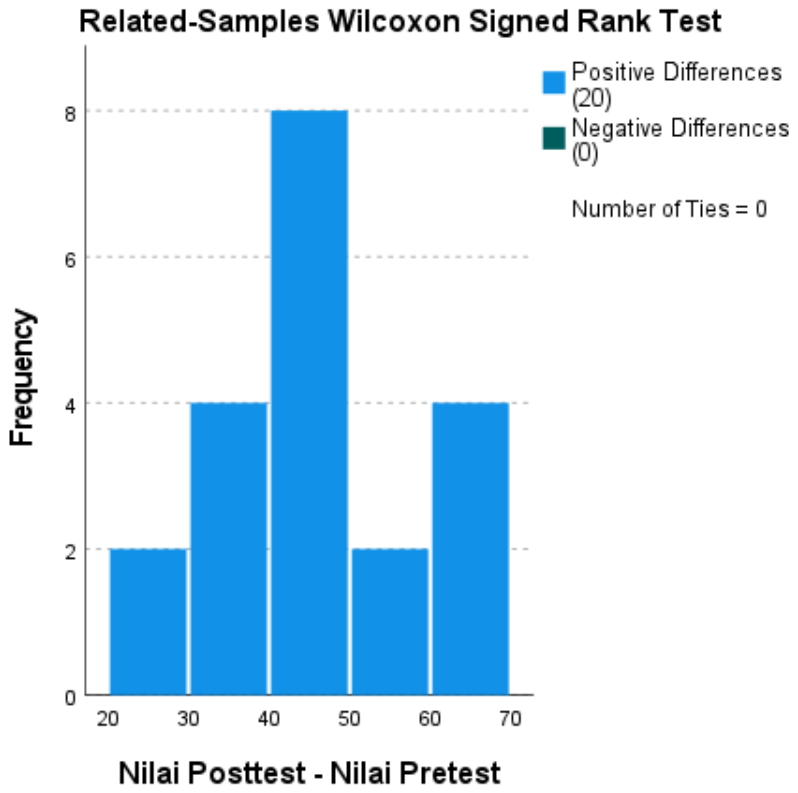

Figure 3: Distribution of students' score gains (Posttest – Pretest) following e-comic based learning

Figure 3 illustrates the distribution of score gains (Posttest – Pretest) after utilizing e-comics for earth structure topics. The horizontal axis represents the magnitude of improvement achieved by individual students. The visual data reveals that every student experienced a performance gain, indicated by 20 positive differences, with zero negative differences or ties. The majority of students demonstrated a score increase spanning 40 to 50 points. This upward trend is statistically backed by the Wilcoxon signed-rank test ($Z = 3.957$, $p < 0.001$), confirming that the integration of e-comics significantly enhances students' scientific literacy in earth structure concepts.

Student Engagement

Questionnaire data processed through Excel and SPSS. Most students were in the high to very high category, with an average engagement score of around 3.0–3.7 (scale 1–4). This questionnaire shows that most students are in the high category, which indicates that students are active and engaged in the learning process. This proves that one of the impacts of e-comics is also making students more involved in learning compared to learning using conventional media. Student engagement during learning includes behavioral engagement which can be seen through the process of discussion and question and answer. While emotional engagement can be seen from how students are enthusiastic about learning to use e-comics, it can also be related to increasing students' curiosity. Meanwhile, this cognitive engagement can be seen when students try to criticize the phenomenon and can answer questions from teachers contextually.

These results show that e-comics are able to create a more interactive and fun learning atmosphere. These findings support previous research from Aryani et al. (2025) that e-comics are able to help simplify abstract material to be easier to understand. The

DOI: https://doi.org/10.17509/e.v25i2.100167
P-ISSN 0852-1190 E-ISSN 2502-0781

implementation of E-comic is considered effective in increasing learning engagement, reducing boredom, and supporting contextual delivery of material. This is also in line with the research of Rasyika et al. (2025) that e-comic media provides a learning context that is relevant to students' lives, thereby increasing their motivation and engagement in the learning process.

The Relationship between Scientific literacy and Student Engagement

To see the relationship, a Spearman correlation test was carried out. The results obtained showed that the relationship between scientific literacy and student engagement was not significant, with a coefficient value of 0.188 and significance of 0.427. The coefficient value shows a very weak relationship because it is close to 0. Because the value is positive, the direction of the relationship is in the same direction (if one variable goes up, the other tends to go up), but the effect is very insignificant in practical terms. The result is considered significant if the Sig. value < 0.05. Since 0.427 > 0.05, it can be concluded that there is no significant relationship between scientific literacy and student engagement in this sample. For this reason, although student engagement is high, it does not directly correlate with an increase in scientific literacy.

According to Fredricks et al. (2004), student engagement consists of behavioral, emotional, and cognitive aspects, where not all forms of engagement directly contribute to deep understanding. Mayer (2009) stated that multimedia-based learning requires active cognitive processing in order to produce meaningful understanding. Therefore, high engagement needs to be balanced with learning activities that encourage analysis, reflection, and problem-solving. Because high interest does not necessarily indicate high understanding either (Sinatra et al., 2015).

Based on the results obtained, the use of e-comic as an innovation in learning media has a positive impact on the learning process and outcomes of students. Students showed increased understanding of concepts and higher engagement than before the use of e-comics. This is in line with previous research that states that visual media can improve the understanding of abstract concepts (Volioti, 2022). However, there are several things that need to be considered. First, although student engagement is high, not all students experience the same increase in scientific literacy. This shows that engagement alone is not enough, but needs to be supported by effective learning strategies. Second, limited learning time is an obstacle in optimizing the use of e-comics. Therefore, more careful planning is needed so that learning can run more effectively. Third, teachers' ability to manage technology-based learning is also an important factor. Teachers need to continue to develop competence in the use of digital media in order to provide a better learning experience for students.

Correlations

			Science Literacy	Student Engagement
Spearman's rho	Scientific literacy	Correlation Coefficient	1,000	,188
		Sig. (2-tailed)	.	,427
		N	20	20
	Student Engagement	Correlation Coefficient	,188	1,000
		Sig. (2-tailed)	,427	.
		N	20	20

Table 2. Spearman Correlation Test Output between Scientific literacy and Student Engagement

DOI: https://doi.org/10.17509/e.v25i2.100167
P-ISSN 0852-1190 E-ISSN 2502-0781

4. CONCLUSION

This study shows that the use of e-comic in science learning is able to significantly increase scientific literacy and student engagement. Although the relationship between the two is not statistically significant, e-comics remain an effective medium in bridging the understanding of abstract concepts. Therefore, the use of e-comics is recommended as an alternative to innovative learning media in schools. For further research, it is hoped that it can further create interactive learning innovations that can better support students with visual, auditory and kinesthetic types.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

6. REFERENCES

Fitriana Fitriana, & Ibnu Muthi. (2025). Penerapan Media Komik Bergambar untuk Meningkatkan Nilai Tanggung Jawab Siswa pada Mata Pelajaran Bahasa Indonesia Kelas II SD. Mutiara : Jurnal Penelitian Dan Karya Ilmiah, 3(4), 25–36. https://doi.org/10.59059/mutiara.v3i4.2626

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. Review of Educational Research, 74(1), 59–109. https://doi.org/10.3102/00346543074001059

Gattullo, M., Laviola, E., Boccaccio, A., Evangelista, A., Fiorentino, M., Manghisi, V. M., & Uva, A. E. (2022). Design of a Mixed Reality Application for STEM Distance Education Laboratories. Computers, 11(4), 11040050. https://doi.org/10.3390/computers11040050

Laksmi, N. L. P. A., & Suniasih, N. W. (2021). Pengembangan Media Pembelajaran E-Comic Berbasis Problem Based Learning Materi Siklus Air pada Muatan IPA. Jurnal Ilmiah Pendidikan Dan Pembelajaran, 5(1), 56–64. https://doi.org/10.23887/jipp.v5i1.32911

Mayer, R. E. (2009). Multimedia learning (2nd ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511811678

Mayer, R. E. (2021). Multimedia Learning (3rd ed.). Cambridge University Press.

Nursholihat, K., Sujana, A., & Karlina, D. A. (2017a). Peran Media Komik Terhadap Literasi Sains Siswa Sd Kelas V Pada Materi Daur Air. Jurnal Pena Ilmiah, 2(1). https://doi.org/10.17509/jpi.v2i1.10110

OECD. (2019). PISA 2018 Assessment and Analytical Framework. In OECD Publishing.

Puspitasari, V., & Vivianti, V. (2026). PENGEMBANGAN MEDIA PEMBELAJARAN INTERAKTIF AUGMENTED REALITY STRUKTUR LAPISAN BUMI MATA PELAJARAN IPA KELAS 8. EDUTECH, 25(1), 352-368. https://doi.org/10.17509/e.v25i1.91944

Rahma, A., & Kusumawati, P. R. D. (2024). Efektivitas Media Komik Sains terhadap Literasi Sains Peserta Didik. Jurnal Basicedu, 8(4), 3455–3464. https://doi.org/10.31004/basicedu.v8i4.8047

Rahmasari, A., Handayani, D. E., & Sundari, R. S. (2024). Pengembangan Media Pembelajaran E-Comic Berbasis Steam Materi Perpindahan Kalor Konveksi di Sekitar Kita pada Muatan IPA Kelas V Sekolah Dasar. Jurnal Wawasan Pendidikan, 4(1), 102-114. https://doi.org/10.26877/wp.v4i1.16682

DOI: https://doi.org/10.17509/e.v25i2.100167
P-ISSN 0852-1190 E-ISSN 2502-0781

Ramadhan, F. (2024). Penerapan media pembelajaran komik untuk meningkatkan motivasi belajar siswa pada pembelajaran Bahasa Indonesia Kelas V MIN 3 Labuhanbatu (Doctoral dissertation, UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan).

Rasyika, A., Sabilah, A. N., Istiana, A. W., & Nisak, F. (2025). Pengaruh media pembelajaran E-Komik berbasis kearifan lokal terhadap kemampuan literasi membaca siswa kelas V SDN Karangduak II. Jurnal Ilmiah Research Student, 2(1), 138-144. https://doi.org/10.61722/jirs.v2i1.3632

Rini, R., Candra, P., Saktian, D. H., & Aam, A. (2021). Analisis KemampuanLiterasi Sains Pada Aspek Kompetensi Mahasiswa PGSD FKIP Universitas Muhammadiyah Tangerang. Jurnal Pendidikan Dasar Nusantara, 6(2):166–79. doi: 10.29407/jpdn.v6i2.15320.

Robani, M. M., & Vivianti, V. (2025). PENGEMBANGAN MEDIA PEMBELAJARAN LAPISAN BUMI BERBASIS AUGMENTED REALITY UNTUK SISWA KELAS 8. EDUTECH, 24(1), 308-323. https://doi.org/10.17509/e.v24i1.79366

Sinatra, G. M., Heddy, B. C., & Lombardi, D. (2015). The challenges of defining and measuring student engagement in science. Educational Psychologist, 50(1), 1–13. https://doi.org/10.1080/00461520.2014.1002924

Syahfitri, A. R., Fahri, Z., Handayani, N., Mila, M., & Masyitah, M. (2025). Analisis Faktor-faktor yang Mempengaruhi Keterlibatan Siswa dalam Belajar di TPQ Ats-Tsaqofah. EDU SOCIETY: JURNAL PENDIDIKAN, ILMU SOSIAL DAN PENGABDIAN KEPADA MASYARAKAT, 5(2), 1255-1261. https://doi.org/10.56832/edu.v5i2.1494

Tatalovic, M. (2009). Science comics as tools for science education and communication: a brief, exploratory study JCOM 8(04), A02. https://doi.org/10.22323/2.08040202

Ummah, S., Agustin, L. R., Kumalasari, D., Nafila, F., Hendratmoko, A. F., Nurita, T., & Widodo, W. (2025). Pemanfaatan Media NASA Space Place dalam Pembelajaran STEM pada Materi Struktur Bumi: Studi Literatur. Lensa (Lentera Sains): Jurnal Pendidikan IPA, 15(2), 90-99. https://doi.org/10.24929/lensa.v15i2.871

Volioti, C., Keramopoulos, E., Sapounidis, T., Melisidis, K., Kazlaris, G. C., Rizikianos, G., & Kitras, C. (2022). Augmented Reality Applications for Learning Geography in Primary Education. Applied System Innovation, 5(6), 111. https://doi.org/10.3390/asi5060111

Wicaksono, A. G., Jumanto, J.,& Irmade, O. (2020). Pengembangan Media Komik Komsa Materi Rangka Pada Pembelajaran Ipa Di Sekolah Dasar. Premiere Educandum : Jurnal Pendidikan Dasar Dan Pembelajaran, 10(2), 215. Https://Doi.Org/10.25273/Pe.V10i2.6384

Wijayati, I. W. (2024). Efektivitas media augmented reality (AR) berbasis kearifan lokal terhadap peningkatan literasi sosial siswa sekolah dasar. Jurnal Jendela Pendidikan, 4(04), 487-509. https://doi.org/10.57008/jjp.v4i04.1886

DOI: https://doi.org/10.17509/e.v25i2.100167
P-ISSN 0852-1190 E-ISSN 2502-0781