



# Analysis of E-Comic Needs Based on Conceptual Changes in Solar System Material for Class VII MTS

Rina Aprilia<sup>1</sup>, Ida Sriyanti<sup>2\*</sup>, Apit Fathurohman<sup>2</sup>

<sup>1</sup>Master of Physics Education Study Program, Universitas Sriwijaya, Palembang, Indonesia.

<sup>2</sup>Physics Education Study Program, Universitas Sriwijaya, Palembang, Indonesia.

Received: February 07, 2026

Revised: April 25, 2026

Accepted: May 25, 2026

Published: May 31, 2026

Corresponding Author:

Ida Sriyanti

[ida\\_sriyanti@unsri.ac.id](mailto:ida_sriyanti@unsri.ac.id)

DOI: [10.29303/jppipa.v12i5.14539](https://doi.org/10.29303/jppipa.v12i5.14539)

 Open Access

© 2026 The Authors. This article is distributed under a (CC-BY License)



**Abstract:** Students often find the solar system challenging due to its abstract nature and vast spatial and temporal scales. Students are unable to directly observe phenomena such as planetary revolution or the internal structure of the sun in the classroom. This often leads to misconceptions or incomplete conceptual understanding. For example, many students still assume that planetary orbits are perfectly circular or misunderstand the causes of seasonal changes. This study aims to analyze the need to develop an e-comic as a conceptual change-based learning medium for seventh-grade students of Islamic Junior High Schools (MTs). Conceptual change is an important approach in science learning that helps students replace incorrect initial concepts with correct scientific concepts. Using a needs analysis method, 51 students responded to various questions posed to identify gaps in students' understanding of the solar system concept. Data were collected through observations, interviews with teachers, and student questionnaires. The results indicate that a conceptual change-based e-comic is highly needed as an alternative learning medium that can facilitate a more effective and enjoyable learning process. This research provides a strong basis for the development of e-comic media that is appropriate to the characteristics of grade VII MTs students in understanding solar system material.

**Keywords:** Conceptual change; E-Comic; Solar system

## Introduction

The Solar System, particularly Chapter VII, is a crucial topic in Natural Science (IPA) learning at the junior high school/Islamic junior high school (SMP/MTs) level. This material is quite abstract and complex, encompassing structural features and the phenomena of rotation and revolution, which are difficult for students to grasp directly. This hinders student learning if it only involves conventional learning, such as lectures and textbooks (Martin-Alguacil et al., 2024; Beigzadeh et al., 2024). This hindered understanding often leads to the emergence of problems. Therefore, learning media are needed that can present material visually and interactively to make it easier for students to understand and internalize these concepts (Ramadanti & Bektiningsih, 2023). Effective learning media must be able to visualize concepts in an

engaging way to increase student interest and motivation (Agustin et al., 2025). Clear and engaging visualizations significantly support students' understanding of abstract and complex material, making the learning process more meaningful and less monotonous. E-comics, as a digital learning tool, integrate images and text in a structured and communicative narrative, facilitating students' understanding of information and learning concepts more easily and enjoyably (Indriasih et al., 2020; Didisyahrir et al., 2023). Furthermore, e-comics can improve student retention because the visual and narrative presentation of material can simultaneously stimulate students' cognitive and affective aspects (Schneider et al., 2023; Ginting et al., 2024; Sridhar & Nanayakkara, 2020). The use of e-comics as a learning medium is also highly relevant to current developments in digital technology, which require teachers to adapt to

## How to Cite:

Aprilia, R., Sriyanti, I., & Fathurohman, A. (2026). Analysis of E-Comic Needs Based on Conceptual Changes in Solar System Material for Class VII MTS. *Jurnal Penelitian Pendidikan IPA*, 12(5), 349-354. <https://doi.org/10.29303/jppipa.v12i5.14539>

delivering material in innovative and interactive ways. This medium not only captures students' attention but can also improve teachers' competence in utilizing technology for more effective learning (Ghifary et al., 2024).

Research shows that e-comics are effective in improving students' conceptual understanding and motivation to learn due to their easy-to-understand nature, visual appeal, and ability to present material in a step-by-step manner tailored to students' needs (Harisman et al., 2023; Wewengkang et al., 2024). Therefore, the development of e-comics learning media is crucial to support a more active and meaningful learning process, particularly for materials requiring in-depth conceptual understanding (Amiruddin et al., 2023). Furthermore, e-comics also help teachers adapt their learning to current digital technological developments while simultaneously enhancing their professional competence in using technology-based learning media. With strong visual features and coherent narratives, e-comics can address student misconceptions in a more communicative and engaging manner, enabling more effective conceptual change (Mukramah et al., 2023). Therefore, needs analysis and development of e-comic learning media based on conceptual change are strategic steps to produce valid, practical, and effective media to improve the quality of learning in schools, particularly in materials that require in-depth conceptual understanding, such as the Solar System (Masduki et al., 2024).

Conceptual change is essential in learning the Solar System because many students still have erroneous understandings or misconceptions about the basic concepts in the material. These misconceptions occur because students often bring initial concepts that are inconsistent with scientific concepts, which they develop based on everyday experiences or inaccurate information prior to formal learning. For example, some students assume that Earth is the largest object in the Solar System or that the planets orbit Earth, when in fact, scientifically, the planets orbit the Sun, which is the center of the Solar System (Siregar & Adlini, 2025). This condition hinders correct understanding and requires learning strategies capable of replacing these misconceptions with appropriate scientific concepts (Sartika et al., 2022; Yenita et al., 2022). A conceptual change approach is crucial to addressing these misconceptions, making them crucial in the learning process. Conceptual change aims to dissuade students from settling for incorrect concepts and replace them with correct ones through specially designed learning strategies. Research shows that implementing a conceptual change-based learning strategy can significantly improve conceptual understanding and reduce student misconceptions in science material,

including the Solar System (Udayani et al., 2021; Hasnawati et al., 2022). Thus, conceptual change not only improves student understanding but also enhances the overall quality of learning.

**Method**

The research conducted to produce a final product in this study is a type of research and development (R&D), where the output of the final product produced is a learning media in the form of e-comic (digital comic) which contains the material of the Solar System for grade VII MTs students. Meanwhile, the development model carried out in this study was adopted from the model formulated by Alessi and Trollip where there are three main steps carried out, namely the planning stage, the design stage and finally the development stage.

**Result and Discussion**

The preliminary study results include literature and fieldwork. Literature study results were obtained from books and various reading sources related to this research, such as journals and articles. The fieldwork revealed that many students have not yet utilized Conceptual Change-Based E-comic Development for the solar system topic because teachers still use outdated concepts. The learning media used are still printed books, PowerPoint presentations, quizzes, and so on. Therefore, students perceive the need for Conceptual Change-Based E-comic development. Data collection was conducted through pre-test and post-test questions. The questions were used to determine students' abilities related to conceptual change in the comic-based solar system material being developed. The questions were calculated using a formula.

$$N_{\text{gain}}(g) = \frac{S_{\text{post}} - S_{\text{pre}}}{S_{\text{max}} - S_{\text{pretest}}} \tag{1}$$

The N-gain scores obtained are interpreted according to Table 1.

**Table 1.** Effectiveness categories based on N-gain

N-gain Value	Category
$N - \text{gain} \geq 0.70$	High
$0.70 > N - \text{gain} \geq 0.30$	Medium
$N - \text{gain} < 0.30$	Low

*Discussion*

The use of e-comics based on conceptual change in solar system material presented electronically, where each learning activity is linked to an application as navigation, making students more interactive with the program and enriching their learning experience (Mena-Guacas et al., 2025; Navas-Bonilla et al., 2025), is one of

the benefits of technology considered crucial for keeping up with current developments and meeting students' literacy demands in information and communication technology (Laar et al., 2020; Alenezi et al., 2023), conducted a study analyzing the needs of teachers and students for e-comics based on conceptual change in solar system material. Effectiveness testing was conducted by implementing e-comics based on the theory of conceptual change in physics learning at school to determine its impact on students' conceptual understanding. The effectiveness testing phase involved conducting a pre-test before treatment and a post-test after treatment using a conceptual understanding instrument that has been proven valid and reliable. The effectiveness testing was conducted by calculating the N-gain scores of students' pre- and post-test results on their critical thinking skills, as shown in Table 2.

**Table 2.** Analysis of student N-gain results

Number of Students	%	N-gain Category
27	65.90	High
13	31.70	Medium
1	2.40	Low

Table 2 shows the results of the analysis of students' conceptual understanding gains. Of the 34 students, 27 (65.90%) experienced a significant increase in conceptual understanding. Thirteen (31.70%) were in the moderate improvement category. One (2.40%) was in the low improvement category. These data indicate that the majority of students experienced significant improvement in their conceptual understanding, with most at the high and moderate levels. The table below shows the n-gain scores for each aspect of students' conceptual understanding.

**Table 3.** Students' N-gain scores for each aspect

Aspects	Pre	Post	N-gain
Interpreting	25.61	75.61	0.67
Giving examples	81.71	93.90	0.66
Classifying	39.02	87.80	0.80
Summarizing	51.22	85.37	0.70
Drawing inferences	0.00	90.24	0.90
Comparing	9.76	73.17	0.70
Explaining	12.20	78.05	0.75
Average	31.36	83.45	0.75

Table 3 shows the results of the comparison of the pre-test and post-test of students' conceptual understanding in seven aspects: interpreting, exemplifying, classifying, summarizing, drawing inferences, comparing, and explaining. In interpreting, the average pre-test score was 25.61 and increased to 75.61 in the post-test, with an N-Gain of 0.67, which is in the medium category. For the aspect of giving examples,

the average pre-test score was 81.71 and increased significantly to 93.90 in the post-test, with an N-Gain of 0.66, which is in the medium category. In the aspect of classifying, the average pre-test score was 39.02 and increased to 87.80 in the post-test, with an N-Gain of 0.80, which is in the high category. The aspect of summarizing showed an increase from an average pre-test score of 51.22 to 85.37 in the post-test, with an N-Gain of 0.70, which is in the high category. For the inference drawing aspect, the average pre-test score was 0.00 and increased significantly to 90.24 in the post-test, with an N-Gain of 0.90, which is considered high. For the comparison aspect, the average pre-test score was 9.76 and increased significantly to 73.17 in the post-test, with an N-Gain of 0.70, which is considered high. For the explanation aspect, the average pre-test score was 12.20 and increased significantly to 78.05 in the post-test, with an N-Gain of 0.75, which is considered high.

Overall, the average score increase from pre-test to post-test was 52.09 points, with an average N-Gain of 0.74, indicating that this learning program successfully improved students' conceptual understanding in the high category. This indicates that the use of e-comics based on the theory of conceptual change in the solar system is effective in improving students' critical thinking conceptual understanding. Effectiveness Test. This test serves to check the level of effectiveness of this E-Comic product on students' conceptual changes, especially in conceptual understanding. Initially, researchers analyzed the Gain scores of the students. The results showed that the majority of respondents with a total of 27 students had an increase in conceptual understanding with a high category (65.90%). Research by Ndibalema (2025), showed that the use of e-comic media can increase effectiveness in the learning process, with the results of the N-Gain score test in the experimental class reaching 74.47%, compared to 51.44% in the control class, this is in line with what the researchers studied. Then 13 students produced scores with a medium category (31.70%) and only 1 person with a low category score (2.40%). Then, the results of the pre-test and post-test also showed a significant development in each aspect.

There are seven aspects tested, namely interpreting, giving examples, classifying, summarizing, drawing inferences, comparing and explaining. The most significant increase was obtained by the aspect of drawing inferences, where the pre-test score showed 0.00, while the post-test score was 90.24. Conversely, the lowest score increase was shown in the exemplifying aspect, where the pre-test showed a score of 81.71, while the post-test score did not increase significantly, reaching 93.90. This occurred because the pre-test score for exemplifying was already in the high category, leaving little room for significant improvement.

Furthermore, the test results also showed the N-Gain for each aspect tested. Of the seven aspects, five produced high Gain scores (> 70), with the highest being drawing inferences (90%), followed by classifying (80%), comparing (75%), explaining (74%), and summarizing (70%). The other two aspects produced medium Gain scores: interpreting (67%) and providing examples (66%). The average Gain score for all these aspects was 74%, categorized as high. Therefore, it can be concluded that the development of an e-comic based on the theory of conceptual change in the solar system has proven effective in improving students' critical thinking conceptual understanding (Nursyaidah et al., 2025; Zuniari et al., 2022).

In line with a study by Alwi et al. (2024) and Saputri et al. (2025), found that the use of e-comic learning media significantly improved students' understanding of mathematical concepts, with an N-Gain value of 0.56 in the high category indicating the effectiveness of this media in improving students' conceptual understanding. E-comic teaching media can be used individually or in groups by involving students (Ananda et al., 2024). This is because in e-comic teaching media the learning concept emphasizes the independence of all students in understanding the content of the material provided by the teacher (Fahreza et al., 2022; Indriana et al., 2024), so that students can easily understand the content of the material provided by the teacher, so that various kinds of thoughts and diverse understandings will be realized for students (Setiawan et al., 2025). Therefore, the existence of teaching media in the science learning process is very important (Pantiwati et al., 2024; Staneviciene & Žekienė, 2025). Students still stated that the teaching media used made it difficult for them to learn the solar system (Ervana et al., 2022). This proves that existing teaching media are not yet capable of presenting the components of each material with implications for everyday life (Amelia et al., 2025; Kartika et al., 2025). Therefore, the development of e-comic learning media based on conceptual changes in solar system material is still needed (Serevina et al., 2021; Novelita et al., 2024).

## Conclusion

The needs analysis for e-comics based on conceptual changes in the solar system material consists of an analysis of teacher needs and an analysis of student needs. Based on the research results, there is a need for e-comics based on conceptual changes in the solar system material for teachers and students. Therefore, the next step is to develop learning tools to meet these needs. In the later stages of e-comic development, it is recommended to pay special attention to interactivity. Ensure the comic's narrative is not only informative but

also stimulates students' cognitive challenges to correct common misconceptions about the solar system.

## Acknowledgments

Thanks to all parties who have supported the implementation of this research. I hope this research can be useful.

## Author Contributions

Conceptualization, investigation, writing—reviewing and editing, visualization, obtaining funding, R.A.; methodology, resources, supervision, I.S.; formal analysis, writing—preparation of original draft, project administration, A, F. All authors have read and approved the published version of the manuscript.

## Funding

The authors declare no conflict of interest.

## Conflicts of Interest

The authors declare no conflict of interest.

## References

- Agustin, M., Wibawa, I. M. C., & Paramartha, W. E. (2025). Interactive Learning Multimedia to Increase Student Motivation in Science Learning on the Photosynthesis Topic for Grade IV Elementary School. *Jurnal Media dan Teknologi Pendidikan*, 5(2), 351–362. <https://doi.org/10.23887/jmt.v5i2.99685>
- Alenezi, M., Wardat, S., & Akour, M. (2023). The Need of Integrating Digital Education in Higher Education: Challenges and Opportunities. *Sustainability*, 15(6), 4782. <https://doi.org/10.3390/su15064782>
- Alwi, N. A., Fitria, A., Adlini, L., & Yenni, T. D. H. (2024). Comic Media Impact: Improving Reading Science Literacy Through Exciting Adventures in Picture Worlds. *Jurnal Penelitian Pendidikan IPA*, 10(9), 7038–7045. <https://doi.org/10.29303/jppipa.v10i9.8232>
- Amelia, R., Ermayanti, E., & Meilinda, M. (2025). Need Assessment of Teaching Material for Classification Living Things at Junior High School. *Jurnal Penelitian Pendidikan IPA*, 11(11), 898–908. <https://doi.org/10.29303/jppipa.v11i11.12834>
- Amiruddin, A., Baharuddin, F. R., Takbir, T., & Setialaksana, W. (2023). May Student-Centered Principles Affect Active Learning and Its Counterpart? An Empirical Study of Indonesian Curriculum Implementation. *Sage Open*, 13(4), 21582440231214375. <https://doi.org/10.1177/21582440231214375>
- Ananda, V. N., Yudianta, K., & Ujjanti, P. R. (2024). Feasibility of Digital Comic Media in Enhancing Early Reading Skills for First-Grade Elementary School Students. *Jurnal Edutech Undiksha*, 12(2), 364–371. <https://doi.org/10.23887/jeu.v12i2.69140>

- Beigzadeh, A., Baziyar, H., Delzende, M., Razmi, M. H., & Sharifi, N. (2024). Comparing the Effect of Lecture Method and Cooperative Teaching Method on the Learning, Communication Skills, and Attitudes of Students: A Quasi-Experimental Study. *Frontiers in Education*, 9, 1449538. <https://doi.org/10.3389/educ.2024.1449538>
- Didisyahrir, D., Firman, F., & Desyandri, D. (2023). The Effectiveness of Media Technology Assisted Webbed Thematic Learning Model on Learning Outcomes in Social Studies, Healthy Food Theme of Students in Class V. *Journal of Digital Learning and Distance Education*, 2(1), 423-432. <https://doi.org/10.56778/jdlde.v2i1.70>
- Ervana, D. S., Raharjo, R., & Munasir, M. (2022). The Effectiveness 3D Models Online Modules to Practice Mastery of Solar System Conceptual Knowledge. *IJORER: International Journal of Recent Educational Research*, 3(2), 162-181. <https://doi.org/10.46245/ijorer.v3i2.199>
- Fahreza, V., Sumilat, J. M., Anggraheni, D., Wayansari, C., & Leonard, L. (2022). The Development of E-Comic Learning Media for Elementary School Mathematics Learning. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, 12(2). <https://doi.org/10.30998/formatif.v12i2.14238>
- Ghifary, D. H. A., Subroto, W. T., & Mustaji, M. (2024). Development of Digital Comic Interactive Media Toward Primary Students' Understanding of Concepts. *IJORER: International Journal of Recent Educational Research*, 5(1), 117-127. <https://doi.org/10.46245/ijorer.v5i1.439>
- 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>
- Harisman, Y., Dwina, F., Nasution, M. L., Amiruddin, M. H., & Syaputra, H. (2023). The Development of Proton-Electron Math E-Comic to Improve Special Needs Students' Mathematical Concepts Understanding. *Infinity Journal*, 12(2), 359-376. <https://doi.org/10.22460/infinity.v12i2.p359-376>
- Hasnawati, H., Syazali, M., & Widodo, A. (2022). Analysis of Understanding Science Concepts for Prospective Elementary School Teacher Candidates. *Jurnal Penelitian Pendidikan IPA*, 8(6), 2954-2960. <https://doi.org/10.29303/jppipa.v8i6.2438>
- Indriana, I., Umar, I., Nofrion, N., & Novio, R. (2024). The Effectiveness of E-Comic Utilization as a Learning Media for Tsunami Disaster Mitigation at SMA 1 Pertiwi Padang City. *Journal of Education and Teaching Learning (JETL)*, 6(1), 51-61. <https://doi.org/10.51178/jetl.v6i1.1725>
- Indriasih, A., Sumaji, S., Badjuri, B., & Santoso, S. (2020). Pengembangan E-Comic sebagai Media Pembelajaran untuk Meningkatkan Kecakapan Hidup Anak Usia Dini. *Refleksi Edukatika: Jurnal Ilmiah Kependidikan*, 10(2), 154-162. <https://doi.org/10.24176/re.v10i2.4228>
- Kartika, D. A. B., Agustika, G. N. S., & Sujana, I. W. (2025). Development of Interactive PowerPoint Teaching Materials Based on Open-Ended Problems to Improve Students' Problem-Solving Skills in Mathematics Content for Grade V Elementary School. *Jurnal Media dan Teknologi Pendidikan*, 5(1), 168-177. <https://doi.org/10.23887/jmt.v5i1.92007>
- Laar, E. V., Deursen, A. J. A. M. V., Dijk, J. A. G. M. V., & Haan, J. D. (2020). Determinants of 21st-Century Skills and 21st-Century Digital Skills for Workers: A Systematic Literature Review. *Sage Open*, 10(1), 2158244019900176. <https://doi.org/10.1177/2158244019900176>
- Martin-Alguacil, N., Avedillo, L., Mota-Blanco, R., & Gallego-Agundez, M. (2024). Student-Centered Learning: Some Issues and Recommendations for Its Implementation in a Traditional Curriculum Setting in Health Sciences. *Education Sciences*, 14(11), 1179. <https://doi.org/10.3390/educsci14111179>
- Masduki, L. R., Ngastiti, P. T. B., & Khasanah, D. R. A. U. (2024). Analysis of the Validity of E-Comic Video Media on the Basic Isometry Theorem Material with a Realistic Approach to Educational Mathematics. *AIP Conf. Proc.*, 3148, 040017. <https://doi.org/10.1063/5.0241581>
- 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>
- Mukramah, W. A. N., Halim, A., Winarni, S., Yusrizal, Y., Safrida, S., Jannah, M., & Wahyuni, A. (2023). Effect of Using Comic-based E-Module Assisted by the Flipbook Maker for Remediation of Newton's Law Misconceptions. *Jurnal Penelitian Pendidikan IPA*, 9(8), 6384-6392. <https://doi.org/10.29303/jppipa.v9i8.4389>
- Navas-Bonilla, C. D. R., Guerra-Arango, J. A., Oviedo-Guado, D. A., & Murillo-Noriega, D. E. (2025). Inclusive Education Through Technology: A Systematic Review of Types, Tools and Characteristics. *Frontiers in Education*, 10, 1527851. <https://doi.org/10.3389/educ.2025.1527851>
- Ndibalema, P. (2025). Digital Literacy Gaps in Promoting 21<sup>st</sup> Century Skills Among Students in Higher Education Institutions in Sub-Saharan Africa: A Systematic Review. *Cogent Education*,

- 12(1), 2452085.  
<https://doi.org/10.1080/2331186X.2025.2452085>
- Novelita, W., Yeni, F., Jasrial, J., & Hakim, R. (2024). Development of Android-based Comic Learning Media for Grade VII Science Subject in Junior High School. *Jurnal Penelitian Pendidikan IPA*, 10(6), 3334–3341. <https://doi.org/10.29303/jppipa.v10i6.6686>
- Nursyaidah, D., Rochintaniawati, D., Winarno, N., & Sihombing, R. A. (2025). Bringing Space into the Classroom: An AR-Integrated E-Book on the Solar System for Students in Elementary School. *Jurnal Penelitian Pendidikan IPA*, 11(8), 498–507. <https://doi.org/10.29303/jppipa.v11i8.12562>
- Pantiwati, Y., Permana, F. H., Aminudin, A., Nurrohman, E., & Sari, T. N. I. (2024). Representation of the Use of Media and Teaching Materials in Science Learning for Junior High School Students. *Jurnal Penelitian Pendidikan IPA*, 10(3), 1075–1082. <https://doi.org/10.29303/jppipa.v10i3.6168>
- Ramadanti, A. R., & Bektiningsih, K. (2023). Pengembangan Media Pembelajaran Komik Digital Berbasis Flipbook pada Muatan IPAS untuk Meningkatkan Hasil Belajar Siswa. *Journal for Lesson and Learning Studies*, 6(3), 506–515. <https://doi.org/10.23887/jlls.v6i3.68053>
- Saputri, M., Junaidi, J., & Mahendra, Y. (2025). Enhancing Elementary Students' Learning Outcomes Through Digital Comic-Based Media: A Systematic Literature Review. *International Journal of Elementary Education*, 9(3), 566–576. <https://doi.org/10.23887/ijee.v9i3.101835>
- Sartika, D., Widadah, S., & Ayuningtyas, N. (2022). Comic Media Development to Improve Students' Understanding of Comparative Concepts. *Desimal: Jurnal Matematika*, 5(1), 39–50. <https://doi.org/10.24042/djm.v5i1.11172>
- Schneider, S., Krieglstein, F., Beege, M., & Rey, G. D. (2023). Successful Learning with Whiteboard Animations - A Question of Their Procedural Character or Narrative Embedding? *Heliyon*, 9(2), e13229. <https://doi.org/10.1016/j.heliyon.2023.e13229>
- Serevina, V., Astra, I. M., & Syahida, A. F. (2021). The Development of Digital Comic as Learning Media Based on Picture-And-Picture Learning Model on Global Warming Materials During Distance Learning. *Journal of Physics: Conference Series*, 2019(1), 012014. <https://doi.org/10.1088/1742-6596/2019/1/012014>
- Setiawan, J., Nurwansyah, M. T., & Yahya, D. (2025). Developing E-Comic Media for Teaching the History of the Banten Kingdom in High Schools. *AL-ISHLAH: Jurnal Pendidikan*, 17(3). <https://doi.org/10.35445/alishlah.v17i3.7293>
- Siregar, S. N., & Adlini, M. N. (2025). Comics Integrated with Islamic Values as a Learning Media to Enhance Student's Understanding. *Jurnal Mangifera Edu*, 9(2), 96–107. <https://doi.org/10.31943/mangiferaedu.v9i2.218>
- Sridhar, P. K., & Nanayakkara, S. (2020). Progression of Cognitive-Affective States During Learning in Kindergarteners: Bringing Together Physiological, Observational and Performance Data. *Education Sciences*, 10(7), 177. <https://doi.org/10.3390/educsci10070177>
- Staneviciene, E., & Žekienė, G. (2025). The Use of Multimedia in the Teaching and Learning Process of Higher Education: A Systematic Review. *Sustainability*, 17(19), 8859. <https://doi.org/10.3390/su17198859>
- Udayani, N. K. R. T. K., Wibawa, I. M. C., & Rati, N. W. (2021). Development of E-Comic Learning Media on the Topic of the Human Digestive System. *Journal of Education Technology*, 5(3). <https://doi.org/10.23887/jet.v5i3.34732>
- Wewengkang, N. D., Rahmat, R., Rohim, R., Saefuddin, S., Ramadhan, I., & Al-Amin, A.-A. (2024). Development of E-Comic Teaching Materials with a Local Wisdom Theme to Enhance High School Student's Historical Awareness. *AL-ISHLAH: Jurnal Pendidikan*, 16(4), 4323–4335. <https://doi.org/10.35445/alishlah.v16i4.5974>
- Yenita, Y., Syuhendri, S., & Siahaan, S. M. (2022). Development of Conceptual Change Theory-Based E-Modules Equipped with Conceptual Change Texts on the Solar System Topics. *Jurnal Penelitian Pendidikan IPA*, 8(4), 1963–1973. <https://doi.org/10.29303/jppipa.v8i4.1826>
- Zuniari, N. I., Ridlo, Z. R., Wahyuni, S., Ulfa, E. M., & Dharmawan, M. K. S. (2022). The Effectiveness of Implementation Learning Media Based on Augmented Reality in Elementary School in Improving Critical Thinking Skills in Solar System Course. *Journal of Physics: Conference Series*, 2392(1), 012010. <https://doi.org/10.1088/1742-6596/2392/1/012010>