Integrating realistic mathematics education and deep-learning approaches into an e-comic

Febby Ayuni Esya Putri ⓘ*, **Ditia Erika Febriani, Resyarusyda Parandrengi**

Elementary School Teacher Education Program, Faculty of Teacher Training and Education, Jambi University, Jambi, Indonesia
*Korespondensi: febbyayuniesya.p@unja.ac.id

Abstract

At the upper primary level, mathematics becomes more abstract and can be particularly difficult for students, especially when learning integers. Teachers, therefore, need effective media to support students' conceptual understanding. One such medium is the use of e-comics that integrate real-life contexts through the Realistic Mathematics Education (RME) approach and are supported by deep-learning principles to promote deeper understanding. This study explores teachers' and students' responses to the use of RME- and deep-learning-based e-comics in classroom learning and examines their effectiveness in improving students' understanding of integer concepts, in SDN 188/IV Jambi. Data were collected using practical questionnaires, pre- and post-tests, and interviews. Quantitative data were analyzed descriptively and using N-gain analysis, while qualitative data were analyzed through data reduction and interpretation. The results indicate that the e-comic is practical for classroom use and effective in enhancing students' conceptual understanding.

Keywords: E-comic, RME approach, Deep-learning approach, Practicality criteria

Abstrak

Pada jenjang sekolah dasar kelas atas, pembelajaran matematika menjadi semakin abstrak dan sering menimbulkan kesulitan bagi siswa. Oleh karena itu, guru memerlukan media pembelajaran yang efektif untuk mendukung pemahaman konseptual siswa. Salah satu media yang dapat digunakan adalah e-komik yang mengintegrasikan *Realistic Mathematics Education* dan didukung oleh prinsip pembelajaran mendalam. Penelitian ini bertujuan untuk mengkaji respons guru dan siswa terhadap penggunaan e-komik berbasis RME dan pembelajaran mendalam dalam pembelajaran di kelas serta menelaah keefektifannya dalam meningkatkan pemahaman konsep bilangan bulat siswa yang diadakan di SDN 188/IV Jambi . Data dikumpulkan melalui angket kepraktisan, *pre-test* dan *post-test,* serta wawancara. Data kuantitatif dianalisis secara deskriptif dan menggunakan analisis *N-gain*, sedangkan data kualitatif dianalisis melalui reduksi dan interpretasi data. Hasil penelitian menunjukkan bahwa e-komik tersebut praktis efektif dalam meningkatkan pemahaman konsep siswa.

Kata kunci: E-komik, Pendekatan RME, Pendekatan pembelajaran mendalam, Kriteria kepraktisan

INTRODUCTION

In the Indonesian Merdeka Curriculum, fourth-grade mathematics emphasizes enabling students to work confidently with numbers up to 10,000, to read, write, compare, and represent positive and negative integers using number lines or contextual problems (Putra et al., 2024). The learning outcomes (CP) also require students to perform addition and subtraction across zero and understand relational meanings such as "greater than" and "less than" for both positive and negative values. However, the abstract nature of integer notation and values below zero commonly leads to learning difficulties, as students require targeted scaffolding to comprehend integer concepts before engaging in word problems and higher-order-thinking tasks (Kurniasi et al., 2024). These challenges highlight the need for instructional media that embed integer ideas in meaningful real-life contexts, enabling learners to connect abstract symbols with everyday experiences.

Given that fourth-grade learners are in Piaget's concrete-operational stage, they can reason logically with concrete objects but struggle with abstract representations such as integers, making visual, contextual, and story-based supports essential. Research shows that comics provide these supports through relatable narratives and visual scaffolds that help students transition from concrete reasoning to abstract mathematical understanding (Ferrugine et al., 2022; Zaimah, 2020). Their narrative-driven format enhances curiosity, participation, and problem-solving interest (Al-ghifary & Subroto, 2024; Ferrugine et al., 2022). When comics are designed according to Realistic Mathematics Education (RME), they strengthen this process by guiding learners from real-world situations toward more formal mathematical structures. Studies report that comic-based media significantly improve numeracy, engagement, and conceptual mastery when multimodal visuals are combined with authentic contexts (Purba et al., 2026; Rosenfeld et al., 2019), and experimental evidence shows that such materials enhance performance in whole-number operations and other number topics (Ashari et al., 2024; Nugraha & Samsudin, 2024; Sipayung et al., 2023).

The development of digital learning media is further mandated by national policy, as Ministerial Regulation No. 16 of 2022 (Permendikbud) requires learning processes to meaningfully integrate digital technologies, aligning with modern pedagogical practices. This regulation emphasizes that digital tools are essential and not optional for creating interactive and meaningful learning experiences suited to 21st-century learners (Fitriani & Jailani, 2024). Consequently, primary teachers are obligated to adopt digital media to enhance engagement and instructional quality (Wahyuni et al., 2024). These policy directions reinforce the urgency of developing innovative digital resources such as e-comics grounded in RME, which can provide

contextual, interactive, and pedagogically aligned learning experiences that effectively support students' understanding of integer concepts.

In the Merdeka Curriculum, deep-learning is emphasized as a pedagogical stance that promotes mindful, meaningful, and joyful learning, aligning with the curriculum's focus on learner autonomy, competency-based outcomes, and the use of digital media (Alim et al., 2025; Syaifulloh, 2025). Empirical studies show that deep-learning-enhanced mathematics instruction improves conceptual understanding, critical thinking, and engagement among primary students (Cholifatunisa et al., 2025; Dewi & Juandi, 2025; Fahma et al., 2025). The deep-learning approach encourages students to build comprehension, engage in critical analysis, and solve problems grounded in real-world contexts, a process consistent with RME principles (Aryanto et al., 2025; Sulasmi, 2025). Creative learning media, such as comics, can support this by increasing effectiveness and engagement while aligning with the objectives of the Merdeka Curriculum (Dewi & Juandi, 2025; Nurul et al., 2025; Syaifulloh, 2025).

Integrating comics with the RME framework and deep-learning principles creates a synergistic learning environment where authentic contexts, conceptual development, and adaptive support intersect. Comics naturally embed everyday storylines and visual narratives that align with RME principles, enabling learners to view integers as tools for solving relatable problems rather than as abstract symbols (Dewi & Juandi, 2025). Through this integration, RME-driven storytelling combined with deep-learning adaptivity turns e-comics into an effective learning medium that not only strengthens students' meaningful mathematical reasoning but also fosters learning experiences that are mindful, meaningful, and joyful.

METHODS

This study employed a quantitative and qualitative research method to examine teachers' and students' responses to the use of RME- and deep-learning-integrated e-comics in classroom learning, as well as to investigate the effectiveness of this media in improving students' understanding of integer concepts. The research was conducted from September to November during the odd semester in SD Negeri 188/IV Jambi. The population in this study included all fourth-grade students and mathematics teachers at the school, while the sample consisted of two mathematics teachers and 30 fourth-grade students who used this e-comic. The subjects of the study consisted of two mathematics teachers and 30 fourth-grade students who responded, while the object of this research was the RME and deep-learning-based e-comic developed for fourth-grade mathematics learning.

This research uses practicality questionnaires for teachers and students, pre-test and post-test, and interview guidelines. The practicality questionnaire was developed based on the criteria of instructional practicality for teachers and students and was aligned with the characteristics of RME and the deep-learning approach. The questionnaire for teachers uses a Likert scale with 5 categories, namely: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree, while 2 categories

for students, namely Agree and Disagree. The questionnaire's score was analyze using this formula (Lovisia & Febrianti, 2024).

$$Percentage\ practical = \frac{total\ scores\ gained}{total\ maximum\ score} \times 100\%$$

(1)

After finding the percentage, it's important to convert the percentage to the practicality criteria. The criteria can be seen in Table 1 (Heinich, 2022). The statistical technique used in this study is descriptive percentage analysis, which serves to determine the level of practicality of the RME- and deep-learning-based e-comic by referring to the criteria categories established for media practicality assessment (Heinich, 2022). This study also uses interview guidelines to support the quantitative data obtained from the practicality questionnaire.

Table 1. Practicality Criteria

Percentage	Criteria
$85\% < score \leq 100\%$	Very Practical
$70\% < score \leq 85\%$	Quite Practical
$55\% < score \leq 70\%$	Less Practical
$score \leq 55$	Impractical

After analyzing the data from the practicality questionnaire, the pre-test and post-test data were analyzed using the N-gain formula.

$$N - gain = \frac{S_{Post} - S_{Pre}}{Max\ Score - S_{pre}}$$

(2)

The interpretation of the N-Gain shows an improvement in students' learning outcomes after receiving the treatment, as presented in Table 2.

Table 2. N-Gain Criteria

Percentage	Criteria
$N - gain \leq 0.7$	Very effective
$0.3 < N - gain \leq 0.7$	Quite effective
$N - gain \leq 70\%$	Not effective

RESULTS AND DISCUSSION

The data collected in this study consist of responses from teachers and students. Teacher response data were obtained from two mathematics teachers who completed the practicality questionnaire for the RME and deep-learning-based e-comic, while student response data were gathered from thirty students who filled out the same questionnaire, as shown in Table 3 and Table 4. Before the trial began, the researcher provided a brief explanation to the teachers regarding the implementation procedure and how to operate the e-comic. The researchers also conducted interviews with

teachers to explore their experiences in teaching mathematics using the RME and deep-learning approaches and to gather suggestions regarding the e-comic prior to its classroom implementation. In addition, the researchers collaborated with the teachers to discuss strategies for implementing the e-comic in lessons and jointly developed a teaching module with a deep-learning approach to support its use before the implementation phase. Following the interviews, the researchers received feedback indicating that the e-comic required revision, particularly in clarifying the definitions of odd and even numbers.

After the interview stage, the researchers revised the e-comic based on the suggestions obtained. The teachers then implemented the revised e-comic independently in teaching fourth-grade students. After the classroom implementation, both teachers and students were asked to complete a questionnaire to provide their evaluations, feedback, and comments regarding the e-comic. Subsequently, follow-up interviews were conducted to further explore teachers' and students' responses after completing the questionnaires.

Table 3. Teachers' Response to Using E-Comic

No	Criteria	Average Percentage (%)
1	Curriculum Alignment	95
2	Clear Explanations and Modelling	85
3	Classroom Management Feasibility	80
4	Time Efficiency	80
5	Specific Feedback	75
6	Differentiation Capacity	85
7	RME Approach Alignment	93
8	Deep-Learning Approach Alignment	87
Average Percentage of All Criteria		85

Based on Table 3, the results of the practicality questionnaire completed by two teachers indicate that the e-comic integrating RME and deep-learning principles attains a consistently high level of practicality across all evaluated aspects. The Curriculum Alignment criterion average scored 95%, demonstrating that the e-comic is highly consistent with the Merdeka Curriculum and effectively supports the targeted fourth-grade learning outcomes (AERO, 2025). Clear Explanations and Modelling also achieved strong results, which is 95% showing that both the instructional steps and the RME-based representations were considered easy to understand (AERO, 2025; NSW Government, 2025). For Classroom Management and Time Efficiency, the scores of 80% suggest that the media is feasible to use within standard classroom routines and does not require extensive preparation time for teachers (Ferguson et al., 2015; OECD, 2025). Additionally, Specific Feedback received 75% and Differentiation received an average score of 85%, indicating that the e-comic offers sufficient opportunities for immediate corrective feedback and can be tailored to students with varying learning profiles (AERO, 2025; NSW Government, 2025). The RME-related indicators, including progressive mathematization, student contributions, and real-

world contextualization, also performed well, with an average score 93% confirming that the e-comic effectively links mathematical ideas to authentic situations (Cholifatunisa et al., 2025; Dewi & Juandi, 2025; Fahma et al., 2025), aligning. Deep-learning indicators, such as reflective thinking, conceptual understanding, and mindful-meaningful-joyful learning, were received by 87%. Overall, the mean practicality score of 85% places the e-comic in the "very practical" category and shows that it is well-suited for classroom implementation (Umamah et al., 2023; Wulandari et al., 2023).

The interview results with teachers indicate that the e-comic positively impacted students and supported deep-learning principles, as teachers observed enhanced critical thinking, creativity, collaboration, communication, citizenship, and character (the 6C skills) through frequent discussion and problem-solving activities (Belda-medina, 2024; Jannah & Putra, 2024). Participants noted that the contextual stories made learning more mindful, meaningful, and joyful, with students appearing more focused, engaged, and motivated while interacting with the comic narratives (Dwiastuti et al., 2025). Teachers also emphasized that the clear, step-by-step instructions embedded in the e-comic enabled learners to understand tasks independently, reducing the need for continual teacher scaffolding (Jannah & Putra, 2024). The structured learning flow provided by the comic helped maintain effective time management within regular class periods, preventing lesson overruns and supporting smooth classroom transitions (Belda-medina, 2024). Overall, the interview findings confirm that the e-comic not only deepened conceptual understanding but also cultivated a positive, well-managed learning environment.

Table 4. Students' Response to Using E-Comic

No	Criteria	Average Percentage (%)
1	Relevance and Engagement	92
2	Transparent Success Criteria	90
3	Active Participation and Collaboration	94
4	Immediate Feedback Loops	84
5	Low Technical Barriers	94
6	Scaffolded Autonomy	92
7	Relevance of e-comics to students' everyday life contexts	92
8	The e-comic helps students stay engaged, understand the material, and enjoy the lesson	88
	Average Percentage of All Criteria	**91**

Based on Table 4, students' responses toward the RME and deep-learning-based e-comic show consistently high percentages across all practicality criteria, indicating that the media is highly acceptable and effective from the learners' perspective. The Relevance and Engagement category received very strong scores (92%), showing that students found the real-life contexts and storylines in the e-comic highly interesting and motivating, which is aligned with recommendations for fostering classroom interaction (NSW Government, 2025). The Transparent Success Criteria items also

scored well (90%), suggesting that learners clearly understood the goals, expectations, and success indicators, consistent with the principles of explicit teaching (AERO, 2025). The Active Participation and Collaboration indicators obtained a score of 94% reflecting that the e-comic effectively encouraged discussion, cooperation, and active involvement during lessons, key elements of captivating and conferencing within classroom practice (Ferguson et al., 2015). In terms of Immediate Feedback Loops, students rated the items between 84%, indicating that the built-in feedback mechanisms helped them quickly identify and correct mistakes, supporting effective feedback strategies (NSW Government, 2025). The Low Technical Barriers category also scored highly (94%), demonstrating that students could operate the e-comic smoothly on their devices with minimal technical difficulties, fulfilling the OECD guidelines for accessible digital learning tools (OECD, 2025). Scaffolded Autonomy received strong ratings as well (92%), suggesting that the e-comic supported gradual independence in solving integer problems while still providing adequate guidance (AERO, 2025). Overall, the mean practicality score of 91% places the e-comic in the "very practical" category and shows that it is well-suited for classroom implementation.

The interview results with students further illustrate the e-comic's positive impact on classroom learning, with many pupils reporting that the lessons felt more mindful, meaningful, and joyful because the contextual stories and visuals helped them focus and enjoy mathematics (Anggraini et al., 2025). One student remarked, "*Belajarnya jadi lebih seru karena ceritanya mirip dengan kehidupan sehari-hari, jadi lebih mudah paham bilangan negatif,*" reflecting how real-world contexts facilitate understanding of abstract concepts (Jannah & Putra, 2024). Another noted, "*Langkah-langkahnya jelas, jadi saya tahu harus mengerjakan apa tanpa bingung,*" confirming that the clear, step-by-step instructions support independent task completion (Syamsiah et al., 2025). Students also described more active participation, saying, "*Kami jadi sering berdiskusi dengan teman karena soal-soalnya ada ceritanya,*" which aligns with the development of the 6C skills—communication, collaboration, and critical thinking (Dwiastuti et al., 2025). Suggestions for improvement, such as adding answer keys for self-checking, highlight the desire for immediate feedback to promote self-reflection and autonomous learning.

To identify students' initial abilities before the learning process using instructional multimedia, a pre-test was administered. The pre-test consisted of 10 questions and was given to 30 students. The results indicated that students' initial understanding of integer concepts was relatively low, with an average score of 70.19. After determining students' prior knowledge, learning activities were conducted using an RME- and deep-learning-based e-comic. Once the instructional process was completed, a post-test was administered to measure students' learning outcomes after using the e-comic. The post-test results showed a substantial improvement, with the average score increasing to 91.14, which is considerably higher than the pre-test mean score. Based on the normalized gain analysis, the score is 0.71, and reached a high category, indicating that the RME- and deep-learning-based e-comic is effective in

enhancing students' understanding and learning experiences related to integer concepts.

The findings of this study indicate that the RME- and deep-learning-based e-comic is effective in improving students' understanding of integer concepts, which is consistent with previous research. Learning media evaluated through pre-test and post-test with an N-Gain score of 0.70 or higher fall into the great improvement category and are considered effective in enhancing students' learning outcomes (Irsan, 2023; Pratini & Prihartini, 2020). In this study, the improvement in students' conceptual understanding was reflected in the significant increase between pre-test and post-test scores. The use of e-comics enabled students to engage actively with contextual representations and learning activities, allowing them to directly observe and reflect on the learning process.

In addition, the interactive feedback embedded in the e-comic supported students in identifying and correcting their mistakes during the learning process, thereby strengthening conceptual understanding (Astri et al., 2022). Furthermore, the e-comic facilitated independent learning and allowed students to revisit the material based on their individual needs, as observed when several students chose to repeat the learning activities after completing them. Interactive media encourage self-directed learning and repeated practice, leading to improved learning outcomes (Ziatdinov & Valles, 2022). The integration of contextual exercises within the e-comic also helped students recognize problem patterns and apply integer concepts more effectively, making learning more meaningful and enjoyable. These results confirm that RME- and deep-learning-based e-comics effectively support mindful, meaningful, and joyful learning in the mathematics classroom.

CONCLUSION

The findings of this study indicate that the e-comic integrating Realistic Mathematics Education (RME) and a deep-learning approach is highly practical and feasible for use in fourth-grade mathematics learning, thereby fully addressing the research questions. The results from teachers show an average practicality score of 83.33%, categorized as very practical, demonstrating that the e-comic aligns well with the Merdeka Curriculum, provides clear explanations and modelling, supports efficient classroom management, and effectively incorporates RME and deep-learning principles. Student responses further confirm its practicality, with an average score of 92.22%, indicating strong engagement, clear learning expectations, active participation, smooth technical operation, scaffolded autonomy, and meaningful learning experiences connected to real-world contexts. Suggestions from teachers and students, such as revising the odd-even number definition and adding an answer key, serve as minor improvements rather than fundamental issues. Overall, the results conclude that the developed e-comic is not only practical but also pedagogically effective for supporting conceptual understanding, reflective thinking, and joyful learning, thus affirming that the e-comic

successfully meets the needs of both teachers and students in classroom implementation.

REFERENCES

AERO. (2025). *Teaching for how students learn: Practice guides*. Organisation, Australian Education Research. https://www.edresearch.edu.au/resource-collections/teaching-how-students-learn-practice-guides

Al-ghifary, D. H., & Subroto, W. T. (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

Alim, S. F., Prayitno, H. J., Mu'ti, A., Sutopo, A., & Hastuti, W. (2025). Fundamental Concepts of Deep Learning: Principles in Advancing Holistic Education Practices. *Journal of Deep Learning*, *1*(2), 81–94.

Anggraini, D. N., Yunanta, F., & Pratiwi, D. E. (2025). Pengembangan Media Pembelajaran Komik Digital Materi Persatuan dan Kesatuan Pada Siswa Kelas V Di SDN Pakis V Surabaya. *Indo-Math Edu Intellectual Journal*, *6*(4), 6161–6170. https://doi.org/10.54373/imeij.v6i4.3728

Aryanto, S., Amelia, D., Maharbid, D. A., Gumala, Y., & Gildore, P. J. E. (2025). Pembelajaran Literasi dan Numerasi Melalui Deep Learning: Pendekatan Transformasional Di Sekolah Dasar. *Journal of Professional Elementary Education (JPEE)*, *1*(1), 49–57. https://doi.org/10.46306/jpee.v1i1

Ashari, R., Juariah, Sugilar, & Hamdan. (2024). Development of Mathematics Comic Teaching Materials Based on Pixton Applications on Ability of Students' Mathematical Concepts Understanding. *AIP Conference Procedings*. 3058, 060025. https://doi.org/10.1063/5.0200970

Astri, N. K. D., Wiarta, I. W., & Wulandari, I. G. A. A. (2022). Pengembangan Multimedia Interaktif Berbasis Pendekatan Kontekstual Pada Mata Pelajaran Matematika Pokok Bahasan Bangun Datar. *Jurnal Pendidikan Dan Konseling*, *4*(3), 575–585. https://doi.org/10.31004/jpdk.v4i3.4371

Belda-medina, J. (2024). Inclusive Education through Digital Comic Creation in Higher Learning Environments. *Social Sciences*, *13*(5), 252. https://doi.org/10.3390/socsci13050272

Cholifatunisa, A., Aulia, L., Marlina, N., & Iskandar, S. (2025). Pengembangan Kurikulum Merdeka Dengan Pendekatan Deep Learning Dalam Meningkatkan Kompetensi Siswa Sekolah Dasar. *Jurnal Pedagogik Pendidikan Dasar*, *12*(1), 128–136. https://doi.org/10.17509/jppd.v12i1.84240

Dewi, R. A., & Juandi, D. (2025). Analysis of Deep Learning Approach in Grade 8 Mathematics. *Jurnal Pendidikan Progresif*, *15*(2), 1098–1111. https://doi.org/10.23960/jpp.v15i2.pp1098-1111

Dwiastuti, D., Febianti, K., & Yuliana. (2025). Webtoon Comic Improves Eighth Graders' Mystery Text Comprehension. *Academia Open*, *10*(2). https://doi.org/10.21070/acopen.10.2025.11467

Fahma, R., Saputra, A., Ridha, M., & Sulaimon, J. T. (2025). Deep Learning Applications in Primary Education : A Systematic and Opportunities. *Jurnal Pendidikan Progresif*, *15*(3), 1785–1810. https://doi.org/10.23960/jpp.v15i3.pp1785-1810

Ferguson, R. F., Phillips, S. F., Rowley, J. F. S., & Friedlander, J. W. (2015). *The Influence of Teaching Beyond Standardized Test Scores: Engagement, Mindsets, and Agency*. The Achievement Gap Initiative at Harvard University.

Ferrugine, S. S., Silva, M. V. da, Evangelista, D. H. R., & Evangelista, C. J. (2022). Construction of Comics in Mathematics Teaching: Experience Report with Elementary School Students. *The Journal of Engineering and Exact Sciences*, *8*(5), 1–11. https://doi.org/10.18540/jcecvl8iss5pp14311-01e

Fitriani, A., & Jailani. (2024). Designing a PMRI Electronic Pocketbook for Enhanced Algebra Conceptual Understanding and Learning Interest in Junior High School Students. *Al-Ishlah: Jurnal Pendidikan*, *16*(2), 1805–1815. https://doi.org/10.35445/alishlah.v16i2.4827

Heinich, R. (2022). *Instructional Media and Technologies for Learning (7 ed.)*.

Irsan, M. (2023). Pengembangan Media Pembelajaran Matematika Berbasis Adobe Flash Professional CS6 Pada Materi Segitiga dan Segiempat. *Indonesian Journal of Teaching and Learning*, *2*(1), 123–136. https://doi.org/10.56855/intel.v2i1.200

Jannah, R. R., & Putra, G. M. C. (2024). Feasibility of Augmented Reality Integrated E-Comics to Improve Learning Outcomes. *Mimbar Sekolah Dasar*, *11*(3), 557–571. https://doi.org/10.53400/mimbar-sd.v11i3.75215

Kurniasi, R., Nurjannah, & Cahya, E. (2024). Students ' learning obstacle in operations of integer. *Educenter : Jurnal Ilmiah Pendidikan*, *3*(1), 59–67. https://doi.org/https://doi.org/10.55904/educenter.v3i1.1107

Lovisia, E., & Febrianti, Y. (2024). Analisis Kepraktisan Modul Usaha dan Energi Berbasis Problem Based Learning. *SPEJ (Science and Phsics Education Journal)*, *8*(1), 12–21. https://doi.org/10.31539/spej.v8i1.13320

NSWGovernment. (2025). *About What Works Best*. New South Wales Government. https://education.nsw.gov.au/about-us/education-data-and-research/what-works-best/about-what-works-best

Nugraha, T., & Samsudin, A. (2024). Enhancing Mathematical Disposition in Geometry Instruction : The Role of E-Comics in Realistic Mathematics Education. *Paedagogia: Jurnal Penelitian Pendidikan*, *27*(1), 129–136. https://doi.org/10.20961/paedagogia.v27i1.83787

Nurul, A., Iskandar, S., Amalia, M., & Naziha, P. F. (2025). Konsep dan Implementasi Pendekatan Deep Learning Di Sekolah Dasar. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *10*(2), 1661–1672. https://doi.org/10.23969/jp.v10i2.25562

OECD. (2025). *What works: evidence for quality teaching practice*. https://school-education.ec.europa.eu/en/discover/publications/what-works

Pratini, H. S., & Prihartini, E. Y. R. (2020). Pengembangan Media Pembelajaran Bangun Ruang Sisi Datar Berbasis Adobe Flash Professional CS5. *Jurnal Ilmiah Pendidikan Matematika*, *8*(1), 121–132. https://doi.org/http://dx.doi.org/10.31941/delta.v8i1.971

Purba, N., Wondal, R., Yuliantina, I., Chandra, A., Sagala, D., Budiarti, E., Susanti, D., & Herman, H. (2026). Bringing Numbers to Life through Numeracy Literacy : Practical Use of E- Comic Media in Early Education. *RedFame: Studies in Media and Communication*, *14*(1), 15–25. https://doi.org/10.11114/smc.v14i1.7933

Putra, I. G. D., Suastra, I. W., & Gunamantha, I. (2024). Mathematics Teaching Tools for Implementing Independent Curriculum Stage B Class 4. *Jurnal Imiah Pendidikan Dan Pembelajaran*, *8*(3), 422–430. https://doi.org/10.23887/jipp.v8i3.68726

Rosenfeld, D., Dominguez, X., Llorente, C., Pasnik, S., Moorthy, S., Hupert, N., Gerard, S., & Vidiksis, R. (2019). Early Childhood Research Quarterly A curriculum supplement that integrates transmedia to promote early math learning : A randomized controlled trial of a PBS KIDS intervention. *Early Childhood Research Quarterly*, *49*, 241–253. https://doi.org/10.1016/j.ecresq.2019.07.003

Sipayung, T. N., Simanjuntak, S. D., & Wijaya, A. (2023). The Effect of Comic - Based Realistic Mathematics Approach on Improving Skill of Students ' Concept Understanding. *International Journal of Trends in Mathematics Education Research*, *6*(1), 82–89. https://doi.org/10.33122/ijtmer.v6i1.185

Sulasmi, E. (2025). Can Deep Learning Provide Solutions to The Challenges of 21 st - Century Education in Indonesia ? *International Journal of Computational and Experimental Science and Engineering*, *11*(2), 3682–3690. https://doi.org/10.22399/ijcesen.2636

Syaifulloh, A. (2025). Integrasi Prinsip Deep Learning Dalam Implementasi Kurikulum Merdeka: Analisis Tantangan Dan Strategi Inovatif Di Pendidikan Indonesia. *Pedagogia*, *2*(1), 58–72. https://doi.org/10.010125/y280m209

Syamsiah, R., Alifah, N., Nurfitriani, M., Pratiwi, A. S., Fahmi, M., Mulyani, N. L. S., Lubis, M., Ghazali, P. L., & Badak, K. G. (2025). Innovation In Learning Media : The Effectiveness Of Interactive Digital Comics On The Speaking Skills Of Fifth- Grade Elementary School Students. *Malaysian Journal of Computing and Applied Mathematics*, *8*(2), 22–31. https://doi.org/10.37231/myjcam.2025.8.2.166

Umamah, C., Diraya, I., & Andi, H. J. (2023). The Effectiveness and Practicality of Web-based Learning Media with Wix Platform in Vocational High Schools. *Jurnal Pendidikan Fisika*, *11*(1), 115–126. https://doi.org/10.26618/jpf.v11i1.9720

Wahyuni, I., Suwarno, & Afdhila, D. (2024). Realistic Mathematics-Based E-Booklets to Improve Students ' Mathematical Literacy Ability. *Mosharafa: Jurnal Pendidikan Matematika*, *13*(1). https://doi.org/10.31980/mosharafa.v13i1.1983

Wulandari, A. P., Salsabila, A. A., Cahyani, K., & Shofiah, T. (2023). Pentingnya Media Pembelajaran dalam Proses Belajar Mengajar. *Journal on Education*, *5*(2), 3928–3936. https://doi.org/10.31004/joe.v5i2.1074

Zaimah, H. (2020). Development of Comic Learning Media for Buying and Selling Practices on Social Arithmetic. *Southeast Asia Mathematics Education Journal*, *10*(1), 1–11. https://doi.org/10.46517/seamej.v10i1.88

Ziatdinov, R., & Valles, J. R. (2022). Synthesis of Modeling , Visualization , and Programming in GeoGebra as an Effective Approach for Teaching and Learning. *Mathematics*, *10*(398). https://doi.org/10.3390/math10030398