

DEVELOPING INTERACTIVE E-MODULE BASED COMIC AI TO IMPROVE MATHEMATICAL LITERACY IN ELEMENTARY STUDENTS

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Abstract

The aims of this investigation include 1) To elucidate the procedure for creating an AI-enhanced comic-based interactive e-module focused on plane geometry, and 2) To assess the efficacy of the AI-enhanced comic-based interactive e-module in enhancing the mathematical literacy competencies of fourth-grade elementary children. This study employed the Research and Development (R&D) approach using the ADDIE model. The research results were categorized as “highly feasible” based on validation by subject matter experts (82.14%) and media experts (93.18%). The effectiveness of the E-module was measured by an N-Gain score with an average of 0.65, falling into the “medium” category, indicating an improvement in students’ mathematical literacy skills. Moreover, interviews with educators indicated that the implementation of the e-module enhanced student engagement, learning motivation, and mathematical literacy skills, while also rendering the learning process more captivating, fun, and interactive. The AI-driven comic-based interactive e-module was determined to meet feasibility criteria and has demonstrated efficacy as a mathematics educational tool, especially for teaching plane figures in elementary education.

Keywords: interactive e-module, comics AI, mathematical literacy, plane geometry

Abstrak

Tujuan dari penelitian ini yaitu 1) untuk mendeskripsikan proses pengembangan E-Module Interaktif berbasis Comic AI pada materi Bangun Datar, 2) mengetahui keefektifan E-Module interaktif berbasis Comic AI dalam meningkatkan kemampuan literasi matematika murid kelas IV Sekolah Dasar. Penelitian ini menggunakan pendekatan Research and Development/R&D model ADDIE yang melalui lima tahapan, yaitu ada Analyze, Design, Development, Implementation, dan Evaluation. Hasil penelitian memperoleh kategori “sangat layak” berdasarkan hasil validasi ahli materi dengan persentase 82,14% dan ahli media 93,18%. Efektivitas dari penggunaan E-Modul memperoleh nilai N-Gain dengan rata-rata 0,65 termasuk kategori sedang yang menunjukkan adanya peningkatan kemampuan literasi matematika murid. Selain itu, hasil wawancara dengan guru menunjukkan bahwa penggunaan E-Module membantu meningkatkan keaktifan, motivasi belajar, dan kemampuan literasi matematika murid serta menjadikan proses pembelajaran lebih menarik, menyenangkan, dan interaktif. E-Module Interaktif berbasis Comic AI dinyatakan memenuhi standar kelayakan dan terbukti efektif untuk dimanfaatkannya sebagai media bahan ajar matematika, terutama pada materi bangun datar di tingkat sekolah dasar.

Kata kunci: e-modul interaktif, komik ai, literasi matematika, bangun datar

INTRODUCTION

Literacy skills are crucial for students to master and serve as essential competencies that must be applied practically to prepare them to face the challenges of the digital age and the changes of the 21st century. In line with the needs identified by the Pacific Policy Research Center (Mboeik, 2023) which states that education must equip students with the critical skills

needed to achieve success in the future, such as creative thinking, adaptability, problem solving, collaboration, and innovation. According to (Harahap et al., 2022) basic literacy is the most fundamental skill among the six core learning skills that students must master in the 21st century and encompasses the competence to solve complex problems as well as a conceptual understanding of how to cope with ongoing change.

Recently education in Indonesia, mathematical literacy has become one of the measures of students' mathematical abilities in schools. This is because, in addition to assessing students' overall abilities, it also strengthens their basic mathematical concepts in understanding mathematical problems without needing to solve them abstractly. According to the (OECD, 2023) Mathematical literacy describes an individual's skill in thinking analytically and their capability to formulate, apply, and interpret mathematical concepts in solving problems in the context of real-world diversity. This ability is considered essential for every individual's life, as it is relevant to daily tasks and life situations. Kusumah (in Hayati & Jannah, 2024) notes that the utility of this literacy is not limited to an understanding of arithmetic alone but is oriented toward mastering problem solving that requires logical reasoning in decision making.

Indonesia engages in international educational evaluation programs, including PISA (OECD, 2023), TIMSS, and PIRLS, to measure and assess its education system globally. According to the 2022 PISA report, Indonesia's mathematics literacy score was only 366, far below the international average of 476, placing Indonesia at 69th out of 80 countries. This data points out the importance of efforts to improve students' mathematics literacy (Sumliyah et al., 2025).

Limited diversity of teaching resources and minimal use of digital technology are some of the causes of low mathematical literacy skills. Hasanah et al., (2023) identified that constraints in instructional resources and technology hinder students' ability to relate abstract mathematical concepts to real-life situations, a conclusion supported by the observation that educators have not fully leveraged interactive digital media. These non-systematic and inconsistent changes over time require teachers to continuously innovate (Utami & Laili, 2019). Furthermore Arsanti (in Wahyuningsih et al., 2025) asserts that the restricted utilization of

instructional materials will adversely affect the quality of the teaching-learning process within the classroom.

Therefore, innovation and collaboration are essential to ensure that education in Indonesia does not fall behind the times (Hasibuan et al., 2022) teachers play an important role in providing innovative and creative learning opportunities to consistently refine students' creative thinking abilities. One way to do this is using technology-based learning media. Processes that motivate students and equip them with the necessary skills, knowledge, and attitudes can achieve effective learning. For this reason, the use of technology is essential in designing, analyzing, developing, evaluating, and implementing instructional materials, as the way these media are used has a significant impact on students' academic achievement.

Technology based media such as E-Modules are a component of e-learning where the learning process utilizes information and communication technology through electronic devices. According to Chong (Aryawan et al., 2018) E-Modules present content that makes it easier for students to grasp the subject matter through interactivity and the integration of various multimedia elements. Interactive E-Modules are developed using the Canva application, which simplifies the process of designing instructional materials for teachers because Canva offers a wide variety of attractive templates, features, and design categories. Canva's attractive designs make the learning process enjoyable. The E-Module also includes comics as a medium for presenting material on plane figures, Aggleton, (2019) states that interactive digital comics are a form of visual storytelling published in digital format, consisting of a series of interconnected illustrations. These digital comics are designed not only to be visual but also to incorporate both visual and auditory elements, so that their use can increase students' interest in learning, which in turn can help improve their literacy skills.

Marselina & Muhtadi, (2019) stated that interactive e-modules can serve as a platform for students to learn independently and are designed with specific objectives aligned with learning goals and the current curriculum. These interactive e-modules consist of various multimedia elements such as images, videos, animations, and interactive quizzes. The interactive elements in this e-module reflect a communication process that demonstrates the extent to which interaction and content can influence students in improving their mathematical literacy through the use of this interactive e-module in learning.

Learning that utilizes interactive e-modules like this is highly relevant for implementation in teaching activities, particularly in the instruction of mathematics or mathematics learning, because its multimedia elements and interactive components strongly support the two-way communication process. Through this interaction, students not only receive information but are also taught to formulate, apply, and interpret mathematical concepts particularly those related to plane figures independently, ultimately leading to positive outcomes in the improvement of their mathematical literacy skills.

With the rapid development of artificial intelligence (AI) technology, its application is growing rapidly across educational settings, including in the development of digital learning media in the form of comic based E-Modules. Comic-based e-modules in education particularly in mathematics are an effective teaching tool for presenting abstract mathematical concepts, as they convey mathematical ideas through images and narratives that are easier for students to understand. Thus, the use of AI in developing E-Modules based comics has the potential to create a more attractive and interactive learning experience in the classroom.

Teachers can utilize artificial intelligence (AI), specifically the ChatGPT chatbot as a tool to help design story scenarios and scripts for comics. By entering specific prompts, ChatGPT will generate comic scripts tailored to specific needs and produce attractive images for learning materials. In this case, teachers need to develop their creativity and knowledge to create prompts that align with the mathematics learning objectives, to ensure that the comics created are appropriate and relevant to the goals of mathematics education. The use of comics in learning is also supported by Brunner, Brunner in (Rahmania et al., 2025) stated that the learning process consists of three phases: enactive, iconic, and symbolic. In the context of learning using AI comics, the relevant phase is the iconic phase, a phase in which students master knowledge through visuals that depict real-life situations, thereby making it easier for them to understand abstract mathematical concepts.

The storyline and illustrations from the AI-generated comics in this e-module serve as visual aids and a bridge to the symbolic phase. This is because students are gradually taught to associate images with the names, shapes, characteristics, and geometric terms related to plane figures. Through this approach, students not only recognize the shapes of two-dimensional figures but also learn to represent them using the correct symbols and language. Thus,

the AI comics in this e-module not only help students understand concepts related to two-dimensional figures but also contribute positively to improving their mathematical literacy.

Research conducted by Ismail (2025) concluded that the implementation of the E-Module has been proven to enhance the critical thinking abilities of students in mathematics and digital math literacy. Thanks to its success, this E-Module serves as a digital learning resource that promotes active, collaborative learning in accordance Merdeka Curriculum. Additionally, research conducted by Astuti et al., (2024) resulted in an ethnomathematics-based E-Module, the effectiveness of which was tested on sixth grade students.

Based on previous research, there has been no integration of Artificial Intelligence (AI) technology specifically Comic AI in the development of interactive E-Modules to improve mathematical literacy. The presentation of material becomes more attractive when using AI Comic in interactive E-Modules, thereby enhancing students' mathematical literacy compared to the use of conventional media. Therefore, this research center on the development of an interactive E-Module based on AI Comic to improve the mathematical literacy abilities of fourth grade elementary school students.

METHODS

This study employed a research and development (R&D) approach. Generally, research and development (R&D) is a systematic process aimed at producing a specific product through stages of design, testing, and revision to achieve the desired level of quality and standard (Okpatrioka, 2025). The R&D research approach and methods were used to design, develop, revise, and assess the viability and effectiveness of an interactive AI Comic based e-module in improving the mathematical literacy skills of fourth grade elementary school students. The ADDIE development model was used in this study because ADDIE is one of the most used instructional design models in research and consists of five stages: Analyze, Design, Development, Implementation, and Evaluation.

Data in this study were collected using three main instruments: tests (pretest and post-test), interviews, and documentation. The collected data will then be analyzed using two approaches: quantitative and qualitative. The feasibility assessment of the interactive E-module involved experts, and validation was conducted to gather feedback, suggestions, and improvements for the developed E-module. A Likert scale was used for the validation assessment. This scale is divided into four rating levels for each criterion. The total scores collected

are then classified into category ranges based on the Likert scale. The feasibility levels in this assessment instrument are categorized into several criteria, namely:

Table 2.1 Feasibility Scale

Achievement level (%)	Category	Description
76-100	Highly Feasible	Valid
56-75	Acceptable	Fairly Valid
40-55	Less Acceptable	Not Very Valid
0-39	Not Acceptable	invalid

The data obtained from the students' pretest and posttest results were subsequently evaluated using the N-Gain formula.

RESULTS AND DISCUSSION

An interactive e-module based comic utilizing Artificial Intelligence (AI) was designed aimed at enhancing students' mathematical literacy, particularly in the subject of plane geometry. The ADDIE model was used in the development process as a systematic and structured approach. This model consists of five sequential stages:

Analysis

This investigation aimed to identify prevailing issues in schools, specifically within fourth-grade elementary classrooms. Observational findings suggest that classroom instruction predominantly employs traditional approaches, but the integration of digital learning presents opportunities for enhancement. Following the conducted needs assessment, the creation of interactive e-module based comic ai on mathematics specifically on plane figures is deemed the suitable approach to resolve these concerns.

Design

In the design phase of this AI-based interactive Comic E-Module, the researchers developed a flowchart of the interactive E-Module components and a pre-visualization for Comic AI, which consists of four main components: cover, AI comics, content, and summary.

1. Cover

The front cover of this Interactive E-Module features a clear and eye-catching main title: "PLANE FIGURES." The cover design is visually appealing to capture

students' attention the moment they see it and is tailored to the characteristics of elementary school students.

2. Contextual Learning with AI Comics

This instructional material consists of four subtopics: triangles, quadrilaterals, composition, and decomposition. Each subtopic begins with a contextual problem related to math literacy. In addition, there is an interactive video on each comic panel.

3. Content of the Interactive E-Modules

The second section constitutes the core of this Interactive E-Module, organized systematically and structurally to help users easily follow the learning flow. The components included in the content section of the e-module are as follows: preface, table of contents, user guide, interactive game, flat shapes material, and assessment.

4. Conclusion section

The conclusion of this Interactive E-Module consists of three important components that round out the module's content: the bibliography, the author's profile, and the back cover.



Figure 1. Front and back covers



Develop

During the media development phase, the researcher began designing the layout and comic panels using the

At this stage, the



Figure 2. Content in the E-Module

Canva application.

researcher carefully

designed the visual structure, including panel composition, story flow, and visuals that would make it easier for readers to follow the narrative. The researcher considered principles of visual communication design, such as balance, contrast, and readability, when designing the comic panels. The initial prototype of this module was designed to introduce mathematical concepts related to regular two-dimensional shapes, using images and interactive elements that can stimulate student engagement in learning. The images are not merely decorative but serve as visual aids to make the material on two-dimensional shapes easier to understand. In the comic section, use illustrations depicting children's daily lives that correspond to the geometric shapes of triangles and quadrilaterals. In addition, rewrite the comic dialogue to make it shorter but still understandable to students. In the composition subtopic, simplify the examples of arrangements involving several geometric shapes.

The comic's appearance is not only aesthetically appealing but also functional as a learning medium for students. The illustrations in the comic are not merely supporting images but visual representations that make the concepts of plane figures more concrete and contextual for students to improve their mathematical literacy. Real-life situations that closely relate to students' daily lives integrate geometric shapes, such as triangles and quadrilaterals.

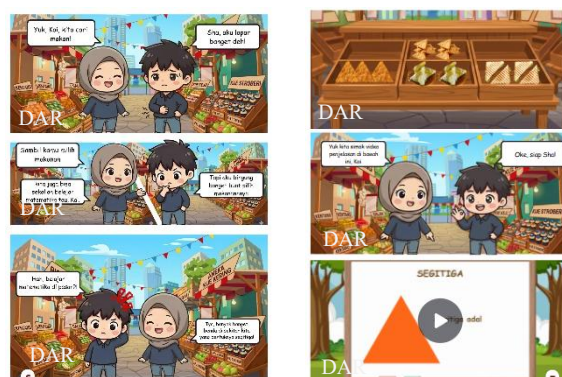


Figure 3. AI comic features

The design of the e-module has been completed, and the final product will be converted to the Heyzine platform. Once converted to the Heyzine platform, the e-module can be accessed digitally, making it more interactive and attractive for students to read in addition, contents of the e-module also include lesson presentations, instructional videos, fun games, and assessment. The product that has been designed and developed is then validated by subject matter and media experts. This validation involves filling out a questionnaire on the material's relevance and media clarity, as well as suggestions and improvement feedback.

The following is a summary of the validation assessments of the interactive e-module by material and media experts

Table 1 Material Expert Scores

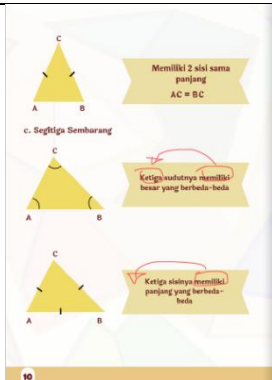
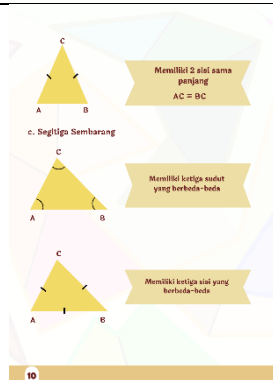
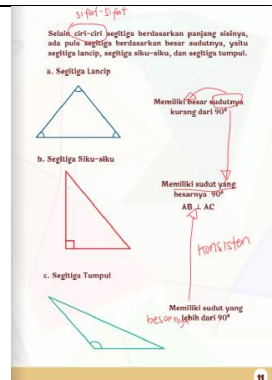
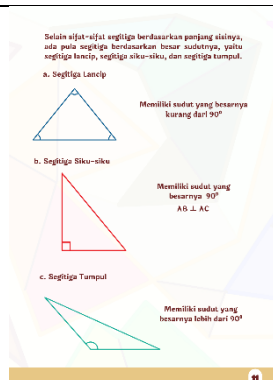
Aspect	Score	Maximum Score	Percentage	Category
Content Suitability	11	12	91,67%	Highly Feasible
Language	12	16	75%	
Score Total	23	28	82,14%	

Based on Table 2, the results obtained from subject matter experts yielded an overall percentage of 82.14%. According to the established feasibility criteria, thus percentage is categorized under the "Highly Feasible" category. Therefore, the interactive e-module can be used with revisions in accordance with the recommendations provided by material experts.

Table 2. Media Expert Scores

Aspect	Score	Maximum Score	Percentage	Category
Design	19	20	95%	Highly Feasible
Language	11	12	91,67%	
Presentation Overall	11	12	91,67%	

Based on the table of validation results obtained from media experts, the overall percentage is 93.18%. Based on the existing feasibility criteria, this percentage is classified under the “Highly feasible” category. During the evaluation phase, the e-module that was developed received feedback from experts. Subject matter and media experts commented that the e-module was already good but that there were a few improvements to be made, as follows:

	Suggested corrections	Revised version
Matter Expert	 Inconsistent text	 The text has been made consistent
	 Replace the word “characteristics” with ‘properties’ and make the spelling consistent, such as “right-angled triangle.”	 The word “characteristic” was changed to “properties” to make the text more consistent.

Media Expert	 There is only a front cover	 Add a back cover just like the front cover
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Implementation

After the interactive E-Module was deemed suitable by the validators, the next step was to implement it in the target schools or research schools. Implementation involved conducting pretest and posttest in two different groups. The small group trial (Small Group Try-out) consisted of 10 students, while the large group trial (Field Try-out / Large Group Try-out) involved 22 students. Before the questionnaire is distributed, students will take the pretest to assess their mathematical literacy, then try out the developed product-the interactive E-Module-followed by the posttest and finally fill out the questionnaire. After conducting these two-stage assessments on the students, the next step is to analyze to determine the suitability of the interactive E-Module. The analysis of student questionnaire responses used the Guttman scale.

Table 3. Students' Responds Result

Pilot Test	Score (%)
Small Group Try-out	96%
Field Try-out / Large Group Try-out	90%
Total	186%
Overall Average	92%

According to table 3, the pilot test was conducted in two groups results showed a percentage of 96% for the small group and 90% for the large group. The results indicate that the AI Comic-based E-Module has fulfilled the criteria for student utilization.

An N-Gain analysis was conducted to evaluate the enhancement of students' mathematical literacy skills before and after the adoption of the Comic-Based Interactive E-Module.

The objective was to assess the degree of enhancement by contrasting the pretest and posttest scores. The following are the results of the N-Gain calculations for students' literacy skills.

Table 4. N-Gain Score

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain Score	32	.25	1.00	.6555	.22240
N-Gain Percent					
Valid N (listwise)	32	25.00	100.00	65.5499	22.23950
	32				

The N-Gain test findings indicate that the improvement in students' mathematical literacy following the intervention is classified as moderate, with an average N-Gain score of 0.65, which lies within the range of g 0.3. The implementation of this Interactive E-Module is highly beneficial in enhancing students' reading skills.

Table 5. Paired Sample T Test

	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1: Pretest-Posstest	25.62500	11.20124	1.98012	29.66348	21.58652	-12.941	31	<.000

Table 6. Effect Size

Test	Mean	N	Std Deviation	Effect Size	Category
pretest	58,5938	32	16,37240	0,67790	Medium
posttest	84,2188	32	10,86496		

Based on the paired samples t-test that was conducted, a significance value of < 0.001 ($p < 0.05$) was obtained. This result indicates that there is a significant difference between the pretest and posttest scores. Since the significance value is < 0.05 , H_0 is rejected, meaning there is a significant difference between the pretest and posttest scores. In other words, the

treatment/intervention administered was effective in significantly improving the scores. Furthermore, to determine the magnitude of the treatment's effect on the students, the results of the analysis showed a effect size 0,67790, indicating that the difference between the pre-test and posttest scores had a medium effect, as it was well under the threshold of 0.8.

The process of studying this instructional material involves understanding contextual problems through AI comics, whose stories are based on everyday life. In addition, there are interactive videos within the AI comics that help students fully grasp the material. The next section of this teaching material covers the properties of triangles and quadrilaterals in detail, followed by an interactive game in which students are asked to answer questions based on the material. At the end of the teaching material, there is an assessment of the entire material to measure students' understanding and mastery. The AI-integrated comic developed in this study does not merely present material in the form of images or as a digital comic. Instead, it is equipped with features designed to make the mathematics learning process enjoyable. Specifically, it includes explanatory videos that visually and auditorily explain concepts after students have read the comic's storyline. Assis et al., (2026) states that comics are not merely a form of entertainment, but a medium that integrates text and visuals. The combination of text and visuals makes it easier for students to understand mathematical concepts. These explanatory videos provide in-depth reinforcement of plane geometry concepts because they include real-world examples of geometric shapes, enabling students to learn more deeply, engage in self-directed learning, increase their active participation in learning, and support the improvement of their mathematical literacy.

Evaluation

After conducting pilot tests on small and large groups, the next step was to conduct interviews with fourth-grade homeroom teachers. The interviews aimed to gather feedback and evaluate the products that had undergone pilot testing. The interview results revealed that students were still in the adaptation phase regarding their use of digital learning media. In addition, students' literacy skills still need to be further developed, particularly in comprehensive understanding of the information presented in narrative-based questions, so that they can solve the problems more effectively. The homeroom teacher asserts that the Interactive E-Module facilitates pupils' comprehension of geometric forms and enhances their

mathematical literacy skills. This E-Module is deemed effective in enhancing student engagement and motivation throughout the learning process. In accordance with these interview findings, students indicated that the Interactive E-Module enhanced their mathematical literacy skills and rendered the learning of mathematics more interesting and engaging.

In addition to evaluating the product, the homeroom teacher also provided several suggestions and recommendations to serve as input for the further development of the E-Module. The evaluation quiz should incorporate not just multiple-choice questions but also fill-in-the-blank questions and essays to measure students' understanding more fully. Additionally, it was suggested that the content of the E-Module encompass discussions on calculating the area and perimeter of two-dimensional forms, rather than concentrating just on a single issue. The evaluation results suggest that the Interactive E-Module can effectively facilitate the learning of mathematical information, specifically with planar figures. Not only does it support the learning process, but this E-Module can also help improve students' literacy skills. The feedback received can be used as a basis for refining the product to better align with classroom learning needs.

DISCUSSION

This AI-based comic interactive E-Module was chosen as a solution to improve mathematical literacy and make learning more interactive and enjoyable. Research related to interactive E-Modules conducted by (Prayitno, 2025) indicates that the use of E-Modules can help students better understand mathematical material, foster active engagement in learning, and assist students in understanding the material, increase their engagement in learning, and make the learning process more enjoyable and interactive. Furthermore, research on digital comics conducted by (Sumantri & Sekar, 2021) found that the images in digital comics can spark students' interest and enthusiasm for learning.

The development process employed the Canva program to facilitate the production of the E-Module, specifically in designing the layout and comic panels. Besides Canva, ChatGPT contributed as a tool to the development of the comic scripts. The design and development of the E-Module utilized reference materials such as teacher's guides, student workbooks, official educational websites, and instructional videos. The content of this E-Module includes

plane geometry, AI comics and videos, fun games, instructional videos, and assessment quizzes. The content in this e-module combines text, images, and video, in line with the theory proposed by Richard Mayer (Mayer, 2024), which states that students can learn more effectively using a combination of images, video, and text than by learning using text alone. This theory is also grounded in Paivio's dual-coding theory and the theory of cognitive processing in multimedia learning, which state that students have two separate systems for processing learning information: the verbal system, which processes audio narration, and the visual system, which processes animations or images. The use of these e-modules is highly appropriate as learning materials for students to prevent boredom, as they incorporate various types of media such as text, images, audio, and video. This principle must be linked to how students actively develop their mathematical knowledge, rather than merely passively receiving information. This is in line with Piaget's views. According to Piaget, constructivism focuses on students learning independently to develop their understanding through direct experience. With this approach, learning is no longer teacher-centered; rather, students must actively construct their own knowledge, rather than merely passively receiving information (Iswara & Usman, 2025). The use of this e-module supports this process because it is designed as a platform for self-directed learning, allowing students to read and study material on plane figures and receive feedback through assessment exercises. Thus, this e-module is expected to help students improve their mathematical literacy, because according to the OECD (OECD, 2023), Mathematical literacy is a person's ability to formulate, employ, and interpret mathematics in various real-life contexts. Mathematical literacy emphasizes not only computational skills but also the ability to reason, solve problems, and communicate mathematical ideas in everyday life.

The developed E-Module was evaluated for suitability by experts in their respective fields including subject matter experts and media experts and received a "Highly Feasible" category. Survey results collected from students through small- and large-scale pilot tests on the use of these interactive E-Modules indicate that the E-Modules enhance their understanding and make the classroom learning process more interactive and enjoyable for them, while also making the taught material easier to grasp. In line with research by (Hasibuan & Amir, 2026) indicates that educational media can positively affect students, allowing a more enter-

taining and comprehensible learning experience by enhancing its significance. Learning materials delivered via e-modules are more engaging due to diverse designs that correspond with students' interests, and the inclusion of interactive features can augment student participation in the classroom.

The use of e-modules helps teachers make their teaching materials more varied and engaging for students, as the e-modules cover the entire scope of the lesson, including text, images, and videos (Suputra et al., 2023). The use of e-modules in classroom learning makes students more enthusiastic and less likely to become bored because the e-module content is supplemented with fun games or educational activities and interactive quizzes that engage them, thereby creating a pleasant learning atmosphere. Derunansyah et al., (2024) who state that e-modules have an impact on student participation particularly active student participation in the learning process and can reduce boredom. The inclusion of AI-generated comics in the e-module content provides an innovative and engaging learning experience, conveying abstract concepts of plane figures in an accessible-to-understand manner with visually appealing elements. The combination of interactive elements in this e-module supports students in learning in their own ways; in addition to the visualizations of elements within the e-module, there are also instructional videos on plane figures. In addition, Sömen & Aktaş, (2026) also stated that digital comics can effectively illustrate abstract concepts in the material; by presenting these concepts through storylines and visually engaging designs, digital comics provide students with an enjoyable learning experience that can enhance their mathematical literacy. The use of scenarios related to students' daily lives allows them to connect the material to their personal experiences, thereby fostering meaningful learning.

Consequently, it can be inferred that this e-module based comic AI is highly effective and significantly enhances students' mathematical literacy skills. Compared to conventional media, the use of e-modules in learning can make the learning experience more enjoyable and active for students. These e-modules also offer students convenient and flexible access whenever and wherever they need them, as they are supported by internet-connected devices, making learning with these e-modules practical, efficient, and effective. With a stable internet connection, students can access and use e-modules and the content they contain. A

stable internet connection is essential for accessing these interactive e-modules (Marsitin & Sesanti, 2023).

CONCLUSION

The AI-based comic interactive e-module, developed using the ADDIE model, was found to be feasible and effective in improving fourth-grade students' mathematical literacy on plane figures. Content and media validation showed "highly feasible" results, and both small and large group trials indicated positive student responses. Pre-test and post-test analysis using n-gain showed a "moderate" improvement, confirming the module's effectiveness in enhancing students' literacy skills. Overall, the e-module proved to be an effective, practical, and innovative learning tool with a positive impact on both students and teachers.

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