

Enhancing Studens' Understanding Of Annuities In The Digital Era Trough Educational E-Comics

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Abstract

This study aims to determine the effectiveness of mathematics learning media using e-comics in improving students' conceptual understanding of mathematics on the topic of annuities. This research is a development study employing the ADDIE model and utilizing two data collection techniques: (1) questionnaires and (2) tests. The subjects of this study were eleventh-grade students of the Health Analyst Vocational High School (SMK Analis Kesehatan) DITKESAD. The results of the study show that validation conducted by two experts, namely a media expert and a material expert, obtained an average overall percentage of 88% from the media expert—categorized as *very feasible*, and 78% from the material expert—categorized as *feasible*. The effectiveness of the media was tested through small group trials and field . The N-gain calculation indicated an improvement in learning outcomes, with an average N-gain of 0.49 in the small group trial and 0.45 in the field trial, both of which fall into the *medium* category. The t-test results showed a significant difference between the pre-test and post-test scores, with a significance value of $0.00 < 0.05$.

Keywords: Development of learning media, e-comic, mathematical concept understanding.

1 INTRODUCTION

Mathematics plays a crucial role in developing students' logical, analytical, and creative thinking skills. Through mathematics learning, students are not only taught to calculate but also trained to think systematically and solve problems based on rational reasoning. Effective mathematics instruction helps students construct meaningful knowledge and apply it in various real-life contexts (Medianti et al., 2022). Therefore, mathematics learning in schools requires appropriate strategies and learning media that can foster curiosity, interest, and a deeper understanding of mathematical concepts.

Among the various competencies in mathematics, conceptual understanding is the most fundamental and essential aspect. It enables students to connect abstract ideas, think systematically, and solve problems meaningfully. Students with strong conceptual understanding are better able to explain relationships between concepts, apply formulas appropriately, and use their knowledge in new situations. According to Nur Imani (2021), students' conceptual understanding of mathematics can be observed through their ability to define concepts verbally and in writing, identify examples and non-examples, use models and symbols to represent ideas, and recognize various meanings and interpretations of a concept. Thus, conceptual understanding is not limited to procedural skills or memorization of formulas, but it also reflects the ability to construct meaning and establish connections among mathematical concepts.

However, based on the researcher's observations during teaching practice (PPL) at SMK Analis Kesehatan DITKESAD, many students still experience difficulties in understanding mathematical concepts. Most of them perceive mathematics as abstract, rigid,

monotonous, and associated with complicated formulas. Such perceptions lead to low learning motivation and limited student engagement during the learning process (Rahmawati & Kusumah, 2021). The lack of conceptual understanding can be caused by several factors, including the use of less engaging teaching methods, limited learning media, and insufficient efforts by teachers to connect mathematical content with students' real-life contexts (Hidayati & Firmansyah, 2020).

One of the mathematical topics that requires a high level of conceptual understanding is annuity. This topic deals with financial concepts such as interest, present value, and future value, which are abstract and complex in nature. Many students find it difficult to understand this material, especially when the teaching approach focuses only on formulas and calculations without meaningful conceptual explanation (Siregar & Pratiwi, 2023). A similar situation is found among students at SMK Analis Kesehatan DITKESAD, where many struggle to comprehend the relationship between annuity concepts and their practical applications in health analysis, such as financial management in laboratories or investment planning for medical equipment.

To overcome these challenges, innovation in the learning process is required—particularly through the use of innovative learning media that can make mathematics more engaging and effective. Learning media serve as tools to help teachers explain abstract materials, enhance students' motivation, and facilitate understanding of complex concepts (Arsyad, 2020). Well-designed learning media can also foster students' interest and encourage independent or collaborative learning. One promising learning medium is the e-comic (electronic comic). E-comics are digital comics that combine text, images, and narratives to present learning materials in an engaging and easy-to-understand way. According to Fahmudita and Zatiyalen (2024), e-comics function as effective visual communication tools that integrate entertainment with educational messages, thereby increasing students' interest and participation in the learning process. Through engaging visual storytelling, e-comics can help students understand mathematical concepts more contextually, interactively, and enjoyably.

Based on the description above, this study aims to examine the effectiveness of e-comic learning media in improving students' conceptual understanding of mathematics, particularly in the topic of annuity. Therefore, the research is entitled "Enhancing Students' Conceptual Understanding of Annuities in the Digital Era through Educational E-Comics."

2 RESEACRH METHODS

The type of research used in this study is developmental research (*Research and Development* or *R&D*). The product developed in this research is a learning medium in the form of an e-comic, designed to improve students' conceptual understanding of mathematics on the topic of annuities. Research and Development (R&D) is a research method used to develop and validate educational products that can be effectively implemented in the learning process. According to Borg and Gall (2003), R&D aims to bridge the gap between theory and practice by creating innovative learning tools that have been empirically tested for their effectiveness. In the field of education, R&D allows researchers to design, develop, and evaluate instructional materials systematically to ensure they meet learners' needs and improve learning outcomes.

There are several development models that can be used as a reference in R&D studies, one of which is the ADDIE model. According to Dick, Carey, and Carey (2015), the ADDIE model is a systematic instructional design framework that consists of five main stages: Analysis, Design, Development, Implementation, and Evaluation.

2.1 Analysis

Pada In the analysis stage, the researcher conducts a thorough identification of both learning needs and instructional materials. This stage aims to determine what is required to develop an effective and relevant learning product—such as an appropriate model, method, or learning material—that can address the problems identified in the learning process. The analysis is carried out to identify students' learning difficulties, the characteristics of the learners, the learning objectives, and the context in which the learning will take place. In addition, this stage involves examining the suitability and feasibility of developing the product to ensure that it aligns with curriculum standards and students' cognitive levels.

Through this process, the researcher can obtain a clear understanding of the needs and requirements for developing an e-comic learning medium that can effectively enhance students' conceptual understanding of mathematics, particularly on the topic of annuities.

2.2 Design

In the design stage, the researcher focuses on developing the initial prototype of the learning product to be created. This stage aims to plan and organize the structure of the learning media so that it meets standards of usability, effectiveness, and alignment with the learning objectives of the annuity topic. The design phase involves selecting appropriate instructional strategies, determining the media format, and outlining the content to ensure that the learning experience effectively supports the intended outcomes. The researcher begins by determining the design concept of the e-comic learning media, which includes decisions about the layout, storyline, character design, visual style, and integration of mathematical content. The process ensures that the media is not only visually engaging but also pedagogically appropriate and comprehensible for students. As stated by Smaldino et al. (2019), learning media design should focus on visual communication, message clarity, and alignment with learners' characteristics to optimize understanding.

Furthermore, the researcher collects and analyzes information from a variety of reference sources, including previous research, existing learning materials, and relevant theoretical frameworks, to strengthen the design foundation. This step is crucial to ensure that the developed product is innovative, evidence-based, and grounded in established educational design principles (Dick, Carey, & Carey, 2015).

The outcome of this stage is a detailed blueprint or initial design plan that serves as the foundation for the development stage, where the e-comic learning media will be produced, validated, and refined before implementation.

2.3 Development

The development stage is the process in which all components and resources required to support the creation of the product are prepared and produced. At this stage, the researcher develops the learning media based on the results of the previous design phase. The process begins by reviewing previous studies and existing examples of e-comic learning media that serve as references and benchmarks for the development of the new product. The development stage in Research and Development (R&D) involves transforming design specifications into tangible products that can later be tested and evaluated for their effectiveness.

After the e-comic learning media is developed, the next step is validation by experts to ensure the product's quality, feasibility, and appropriateness for educational use. The validation process is conducted by two experts: a subject matter expert and a media expert. The subject matter expert assesses the accuracy, relevance, and clarity of the mathematical content, while the media expert evaluates the visual design, interactivity, and overall usability of the e-comic. As emphasized by Sugiyono (2019), expert validation is an essential step in determining whether a product is feasible for implementation before it is tested on students.

The product data analysis in this stage is carried out using the results obtained from expert validation. The analysis employs a Likert scale to quantify the validators' assessments of each aspect of the product, such as content quality, media design, and technical functionality. The use of Likert scale analysis allows the researcher to identify strengths and weaknesses of the developed product and make necessary revisions before proceeding to the implementation phase (Riduwan, 2018).

Through this systematic development and validation process, the e-comic learning media is expected to meet the established criteria of effectiveness, feasibility, and attractiveness for use in mathematics learning, particularly in teaching the annuity concept.

Table 1. Criteria for Likert Scale Assessment

No	Statement	
	Response	Score
1	Strongly Agree	5
2	Agree	4
3	Undecided	3
4	Disagree	2
5	Strongly Disagree	1

The data analysis used in this study is descriptive data analysis, which is carried out by converting qualitative data into quantitative data. The interval data are analyzed by calculating the average score based on the ratings provided by the validators for each item. Based on the predetermined scoring criteria, the obtained data are then converted into percentages using the following formula:

$$P = \frac{f}{N} \times 100\%$$

Description:

P = percentage value

f = score obtained

N = total number of samples

After the percentage is determined, it can then be used to identify whether the product is feasible or not based on the criteria described in the following table.

Table 2. Product Assessment Criteria

Category	Percentage
Very Feasible	81,25% < score ≤ 100%
Feasible	60% < score ≤ 81,25%
Fairly Feasible	43,75% < score ≤ 62,5%
Less Feasible	25% < score ≤ 43,75%
Not Feasible	score < 25%

2.4 Impelementation

After the e-comic learning media was declared valid through expert validation, the product was then tested in the actual learning process. This implementation stage aims to obtain empirical data and feedback regarding the practicality and effectiveness of the developed e-comic as a learning medium. According to Sugiyono (2019), the implementation phase in development research is intended to determine the product's functionality and identify its impact on the learning outcomes of students in real classroom settings.

The trial was conducted with Grade XI students at SMK Analis Kesehatan DITKESAD, focusing on the topic of annuities. During this stage, the e-comic learning media was integrated into classroom activities to observe students' engagement, understanding, and responses toward the material. The implementation process also aimed to assess the feasibility and effectiveness of the e-comic in enhancing students' conceptual understanding of mathematics.

To measure the effectiveness of the e-comic, a learning achievement test was administered after the learning session. The test results provided quantitative data that reflected students' improvement in understanding mathematical concepts after using the media. According to Gall, Gall, and Borg (2007), such testing is a crucial step to determine whether the developed product can effectively achieve the intended learning objectives. The data obtained from the student test results were then analyzed and interpreted in the evaluation stage to identify the strengths and weaknesses of the developed e-comic. This process ensures that the final product not only meets validation standards but also demonstrates practical benefits in improving students' conceptual understanding and learning outcomes in mathematics.

2.5 Evaluation

The final stage of this development process is the evaluation of the e-comic learning media on the annuity material for Grade XI students at SMK Analis Kesehatan DITKESAD. Evaluation serves as a process to determine whether the developed product can be effectively and appropriately used in the learning environment. According to Dick, Carey, and Carey (2015), evaluation is an essential phase in the ADDIE model that aims to measure the effectiveness, efficiency, and quality of a learning product based on feedback and performance outcomes.

In this study, evaluation plays a crucial role in improving the e-comic learning media to ensure that it meets both pedagogical and technical standards. The evaluation process involves two main components: expert evaluation and product testing evaluation. The expert evaluation is conducted by a team of specialists—subject matter experts and media design experts—who assess the accuracy of the content, visual quality, and usability of the product. Meanwhile, the evaluation of validation and trial results focuses on analyzing data obtained from the product implementation phase, including students' learning outcomes and responses.

As stated by Tessmer (1993), continuous evaluation in educational product development helps identify weaknesses and areas for improvement, ensuring that the final version of the product is optimized for classroom use. Through this evaluation stage, the researcher can determine the overall feasibility, validity, and effectiveness of the e-comic learning media as a tool to enhance students' conceptual understanding of mathematics.

3 RESULT AND DISCUSSION

The results of this study provide important implications, both theoretical and practical. Theoretically, this research offers empirical evidence that digital comic-based learning media have the potential to serve as effective instructional tools in mathematics education. This supports previous studies showing that visual and interactive learning media can help students better understand abstract mathematical concepts and improve engagement (Putri & Zulkardi, 2020; Fitriani et al., 2021).

Practically, the developed e-comic can serve as a reference for teachers to diversify their teaching methods and for students as an engaging and flexible learning resource. The validation by material experts yielded a score of 47, equivalent to 81%, categorizing the material as *feasible*. Meanwhile, the validation by media experts obtained a score of 57 or 88%, categorizing the media as *highly feasible* for classroom application. These findings are consistent with previous research suggesting that digital comics are effective learning

tools because of their ability to simplify complex content and sustain students' attention (Anas & Suryani, 2022).

During the implementation stage, to determine the extent of improvement in students' conceptual understanding after using the media, the N-gain score was calculated. In the small group trial, the average N-gain between the pre-test and post-test was 0.49, indicating a *moderate improvement*. Similarly, in the field trial, the average N-gain was 0.45, which also indicates *moderate improvement*. These findings demonstrate a significant increase in students' mathematical understanding after using the e-comic, aligning with research that highlights the positive impact of digital learning tools on students' learning outcomes (Sari & Nugraha, 2022; Mulyani et al., 2021).

To further verify the effectiveness, a Paired Sample T-test was conducted to examine the significance of differences between pre-test and post-test scores. The results of both the small group and field trials showed a two-tailed significance value of $0.00 < 0.05$, indicating a statistically significant difference between pre-test and post-test scores. This result supports the conclusion that the use of e-comic media significantly enhances students' mathematical conceptual understanding. Similar conclusions were drawn by Setiawan et al. (2022) and Lestari & Rahma (2021), who found that interactive comic-based learning media contribute to students' better comprehension and motivation in mathematics learning.

Overall, based on the N-gain and t-test analyses, it can be concluded that the use of e-comic learning media on annuity material is significantly effective in improving students' understanding of mathematical concepts.

4 CONCLUSION

Based on the results of the research on the development of e-comic learning media to enhance students' conceptual understanding of mathematics in the topic of annuities, it can be concluded that the development process followed the ADDIE model, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation. The validation results from both material and media experts showed that the e-comic was feasible for classroom use.

The developed e-comic presents annuity material in a contextual and visual format, supported by practice questions at the end of each story. It can be accessed via various devices such as smartphones and laptops, making it flexible and user-friendly. The trial results indicated that the media is effective in improving students' conceptual understanding of mathematics. This finding supports previous studies showing that digital comic-based learning can enhance students' engagement and understanding of mathematical concepts (Putri & Zulkardi, 2020; Fitriani et al., 2021).

5 REFERENCES

- Anas, M., & Suryani, D. (2022). *Digital comics as a learning media to improve students' mathematical communication skills*. *Journal of Mathematics Education Innovation*, 9(1), 45–55.
- Arsyad, A. (2020). *Learning Media*. Jakarta: RajaGrafindo Persada.
- Fahmudita, N., & Zatiyalen, M. (2024). *The Use of E-Comic Media to Increase Students' Learning Interest in the Digital Era*. *Journal of Innovative Mathematics Education*, 8(2), 112–120.
- Dick, W., Carey, L., & Carey, J. O. (2015). *The Systematic Design of Instruction*. Boston: Pearson Education.

- Fitriani, N., Kurniawati, D., & Rahmat, A. (2021). *Development of e-comic learning media to improve mathematical problem-solving skills. Indonesian Journal of Educational Technology*, 5(2), 112–121.
- Fitriani, N., Kurniawati, D., & Rahmat, A. (2021). *Development of e-comic learning media to improve mathematical problem-solving skills. Indonesian Journal of Educational Technology*, 5(2), 112–121.
- Lestari, S., & Rahma, A. (2021). *The effect of digital comic learning media on students' conceptual understanding in mathematics. International Journal of Instructional Media and Learning*, 10(3), 56–65.
- Medianti, D., Suryani, T., & Ramadhan, R. (2022). *Pembelajaran Matematika untuk Mengembangkan Kemampuan Berpikir dan Pemahaman Konsep Siswa. Jurnal Pendidikan Matematika dan Sains*, 10(2), 45–56.
- Mulyani, S., Pratiwi, D., & Utami, E. (2021). *E-learning and digital media in mathematics: The role of visualization in conceptual understanding. Journal of Educational Research and Practice*, 11(4), 78–89.
- Nur Imani, B. (2021). *Pengaruh Pendekatan Open-Ended terhadap Kemampuan Pemahaman Konsep Matematis Siswa. Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(2), 1623–1633.
- Putri, R. I. I., & Zulkardi, Z. (2020). *Designing digital comics for mathematics learning in the digital era. Journal on Mathematics Education*, 11(1), 93–106.
- Rahmawati, A., & Kusumah, Y. S. (2021). *Analisis Kesulitan Siswa dalam Memahami Konsep Matematika di Sekolah Menengah Kejuruan. Jurnal Penelitian Pendidikan*, 28(3), 233–242.
- Riduwan. (2018). *Skala Pengukuran Variabel-variabel Penelitian*. Bandung: Alfabeta.
- Sari, M., & Nugraha, F. (2022). *The effectiveness of e-comic media to improve students' mathematical understanding and learning interest. Jurnal Pendidikan Matematika Indonesia*, 7(1), 12–22.
- Setiawan, D., Aini, N., & Wulandari, R. (2022). *Developing interactive e-comics for mathematics learning: A study of feasibility and effectiveness. International Journal of Emerging Educational Technologies*, 2(4), 33–44.
- Smaldino, S. E., Lowther, D. L., & Russell, J. D. (2019). *Instructional Technology and Media for Learning* (12th ed.). Boston: Pearson.
- Sugiyono. (2019). *Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.
- Tessmer, M. (1993). *Planning and Conducting Formative Evaluations: Improving the Quality of Education and Training*. London: Kogan Page.
- Hidayati, N., & Firmansyah, D. (2020). *Faktor-Faktor yang Mempengaruhi Pemahaman Konsep Matematis Siswa. Jurnal Cendekia: Jurnal Pendidikan Matematika*, 4(1), 98–107.