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THE DEVELOPMENT OF LEARNING MEDIA ON BUILDING THREE-DIMENSIONAL SHAPE USING E-COMIC

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ABSTRACT

The importance of the teacher's role in increasing students' interest and motivation in learning mathematics is that one of the steps taken is using interactive learning media in the form of E-Comic supported by the RME (Realistic Mathematics Education) learning approach. Using E-Comic in mathematics lessons can summarize the material and present it interestingly. This study aims to describe the development of learning media using E-Comic, students' responses to E-Comic on cylindrical geometry material, and the process of developing E-Comic. This study is an RnD (research and development) study using the ADDIE model with four stages, namely analysis, design, development, and implementation. The subjects of this study were 30 junior high school students and 3 validators as media experts and material experts. The object of this study is the learning media for cylindrical geometry using E-Comic with the RME approach with the help of the Canva application. The data collection tools used were validation sheets and student response questionnaires. The response questionnaire was closed and contained eight questions. The results of this study indicate an average validation of the E-Comic media of 80% with a very valid category. At the same time, the average student response results were 87% with a very practical category. From the results obtained, the E-Comic learning media with the RME approach is very valid and practical to use in the learning process and can increase students' interest and motivation to learn about the material on cylindrical spatial structures.

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INTRODUCTION

Education, as defined by Law Number 20 of 2003, refers to a deliberate and planned effort to foster a conducive learning environment and process. The purpose is to enable students to actively develop their potential in terms of religious and spiritual strength, self-control, personality, intelligence, noble character, and the necessary skills for the betterment of society, nation, and state. Given its transformative potential upon individuals, education holds significant importance and warrants attention (Hidayatullah et al., 2023). Similarly,

Triwiyanto (2022) defines the national education system as a collection of interconnected educational elements working towards national educational objectives. These elements encompass students, teaching staff, educational levels, types of education, curriculum, learning methods, educational evaluation, and more. Therefore, the progress of Indonesian education plays a pivotal role in successfully achieving national educational goals.

Teacher plays a crucial role in achieving learning goals by designing engaging lessons that enhance students' interest and motivation. This role is essential in facilitating the learning process and nurturing student potential. Mathematics education specifically focuses on developing rational and logical thinking to grasp concepts effectively (Rosmala, 2021). Furthermore, mathematics serves as the foundation of science, finding application as both a tool and a developmental resource in various scientific fields (Rahmata et al., 2020).

Teachers play a significant role in advancing mathematics education, particularly using effective learning approaches and instructional media. In this research, the Realistic Mathematics Education (RME) approach is employed. RME is a learner-centered approach that emphasizes the use of realistic contexts and student experiences as the foundation for learning. Realistic problems serve as valuable sources for the development of mathematical concepts and informal mathematical knowledge (Asih, 2019). According to the research findings by Puspitasari & Airlanda (2021), the implementation of the RME approach resulted in improved student learning outcomes. Cognitive learning outcomes increased from a minimum of 13.06% to 99.97%, with an average increase of 30.34%. Based on this success, implementing the RME approach for teaching tube shapes is worth considering.

In addition to adopting effective learning approaches, development in mathematics education also involves the creation of suitable learning media. Learning media serves as a platform for delivering messages and materials, acts as a learning resource, stimulates student motivation, and facilitates the attainment of meaningful learning outcomes (Hasan et al., 2021). Among the widely used learning media is interactive learning media, which combines various elements such as text, images, sound, animation, video, and interactivity into a single digital unit. This multimedia approach captivates students' interest and enhances their mastery of the subject matter (Dwiqi et al., 2020). One such interactive medium that encompasses these aspects is the electronic comic, or e-comic.

Originally derived from the French word "comique," meaning humorous, comics have traditionally entertained readers with funny characters (Aeni & Yusupa, 2018). In a similar vein, Angga, Sudarma, & Suartama (2020) attest that comics are known for their humorous content and the ability to amuse readers. However, comics have evolved beyond being purely entertaining; they can now serve as effective learning media while retaining their enjoyable and easy-to-comprehend qualities. Combining comics with technology has given rise to e-comics, which are picture-based stories accessible through electronic media. Each image carries meaning, and when combined, they form a comprehensive source of information (Muhaimin et al., 2023). Research conducted by Buchori & Murtianto (2017) supports the use of e-comic comics as an effective tool for learning mathematics, with better average learning outcomes compared to conventional classroom settings.

The objective of this study was to develop E-Comic learning media aimed at enhancing students' interest and motivation in learning mathematics, specifically on the topic of tube construction, based on student responses. A spatial shape refers to a three-dimensional structure that possesses volume and bounded sides (Topang et al., 2022). A cylinder, for instance, is a spatial shape defined by two congruent and parallel circular bases connected by a curved side. The height of the tube corresponds to the distance between the center points of

the base circles (Wulandari & Anugraheni, 2021). Tubes are commonly encountered in everyday life, such as in the form of condensed milk cans.

METHOD

The developed learning media is an interactive learning media, as E-Comic incorporates audio, text, images, videos, and captions to provide clear information. The research follows a research and development (R&D) approach, specifically utilizing the ADDIE model, which involves the stages of analysis, design, development, implementation, and evaluation. However, this research focused on the analysis, design, development, and implementation stages.

During the analysis stage, the research identified learning problems in schools and sought solutions. The design stage involved arranging the learning material, constructing a storyboard, and selecting the software for creating the E-Comic. The development stage encompassed the actual creation of the media, followed by validation and subsequent revisions. Finally, during the implementation stage, the learning media underwent a trial period with students to assess their response.

The research involved 30 junior high school students and 3 validators who served as experts in media and subject matter. The objective of the research was to develop learning media for tube room construction using E-Comic with the assistance of the Canva application.

To collect data, validation sheets and student response questionnaires were employed. The validation sheets were utilized to assess the soundness of both the material and the media. The validation results, represented in percentages, were then compared against the validity criteria outlined in Table 1.

Table 1. Validity Criteria for E-Comic Learning Media (Fridayanti et al., 2022)

No	Score	Validity Criteria
1	81% - 100%	Very Valid
2	61% - 80%	Valid
3	41% - 60%	Quite Valid
4	21% - 40%	Invalid
5	0% - 20%	Very Invalid

The student response questionnaire was used to collect students' feedback on the e-comic media used. The obtained data initially takes a qualitative form and is subsequently converted into quantitative data. Students were given the questionnaire after engaging with the learning process involving the e-comic media. The response percentages were then transformed into data using the criteria outlined in Table 2.

Table 2. Criteria for the Practicality of E-Comic Learning Media (Fridayanti et al., 2022)

No	Score	Practicality Criteria
1	81% - 100%	Very Practical
2	61% - 80%	Practical
3	41% - 60%	Quite Practical
4	21% - 40%	Not Practical
5	0% - 20%	Very Impractical

RESULTS AND DISCUSSION

Results

The research yielded E-Comic learning media for junior high school students, focusing on building tubes, developed using Canva software and employing the Realistic Mathematics Education (RME) learning approach. The development process of the E-Comic media for tube construction followed the ADDIE model, encompassing the stages of analysis, design, development, and implementation.

a. Analysis

The initial stage is analysis, which involves conducting a needs analysis to gather pertinent information addressing the learning problems. The goal is to ensure that students can easily comprehend the learning process. Currently, students have not fully grasped the concept of constructing the space of a cylinder. Their understanding is limited to memorizing the formulas for the cylinder's surface area and volume, indicating a lack of solid comprehension (Hamidah et al., 2021). This knowledge gap may arise from the diverse learning styles among students, as the teacher provides only one learning resource that does not cater to individual learning styles. Additionally, the teacher's instructional approach may not align with the students' preferred learning styles. In this research, the E-Comic media for teaching the construction of a cylinder adopts a Realistic Mathematics Education (RME) learning approach, tailored to accommodate three distinct learning styles: auditory, visual, and kinesthetic.

b. Design

The second stage involves designing the E-Comic learning media for students, specifically focusing on the material of tube construction based on the analysis conducted earlier. This stage encompasses the preparation of the material, creation of a storyboard, and selection of the software for developing the E-Comic. Storyboarding aids researchers in designing interactive E-Comic learning media, making it more effective and efficient. Moreover, storyboards serve as a valuable reference for the creation of other learning media (Novita et al., 2020). The content and material to be presented in the E-Comic are considered during the storyboard creation process, enabling a comprehensive portrayal of the media design in each part. The following is an E-Comic storyboard for a lesson on building space before combining it with the application.

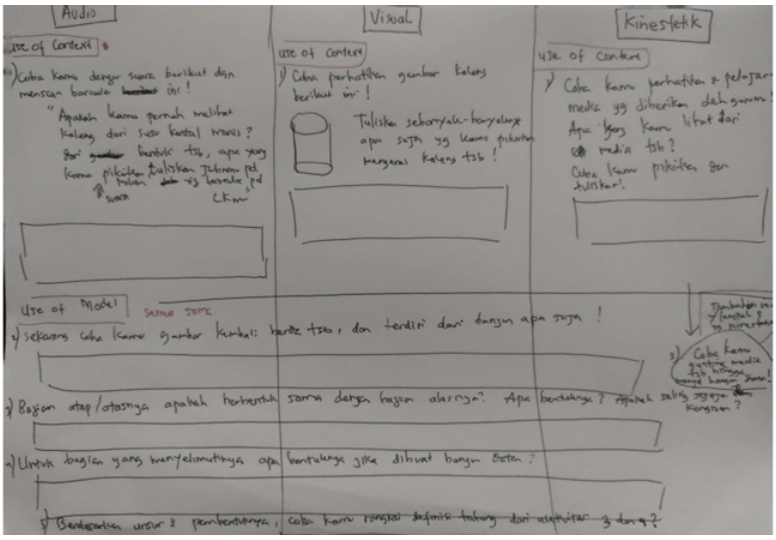

Figure 1. Storyboard E-Comic Build Space Tube

c. Development

The third stage, development, entails executing the creation of the E-Comic media based on the prepared designs, followed by validation and subsequent revisions. The previously designed storyboard is transformed into an E-Comic using Canva software. Once the E-Comic is completed, a validation test is conducted, involving experts in both the subject matter and the media. The outcomes of the validation assessment are detailed in Table 3 below.

Table 3. Validity Results of E-Comic Learning Media

Validator	Score
1	90%
2	80%
3	70%
Average	80%

Referring to Table 3 above, the average validation score of 80% categorizes the E-Comic media material for building tubes as "Highly Valid." Consequently, it is now ready for implementation with students.

d. Implementation

Referring to Table 3 above, the average validation score of 80% categorizes the E-Comic media material for building tubes as "Highly Valid." Consequently, it is now ready for implementation with students.

Table 4. Practical Results of E-Comic Learning Media

Student Code	Score	Student Code	Score
S1	92%	S16	90%
S2	92%	S17	87%
S3	90%	S18	85%
S4	90%	S19	85%
S5	92%	S20	87%
S6	87%	S21	85%
S7	92%	S22	80%
S8	90%	S23	85%
S9	87%	S24	77%
S10	92%	S25	90%
S11	90%	S26	87%
S12	94%	S27	85%
S13	92%	S28	90%
S14	90%	S29	90%
S15	69%	S30	64%
Average	87%		

Referring to Table 4, the average percentage of student responses reached 87%, categorizing the E-Comic media material on building tube rooms as "Highly Practical." The combined results of the validation and student responses indicate that the material is both highly valid and practical. As a result, the E-Comic learning media for building tubes can be employed in broader educational settings.

Discussions

This research employs the ADDIE model, which typically consists of five stages: analysis, design, development, implementation, and evaluation. However, in this study, only four stages were employed: analysis, design, development, and implementation. The objective is to

enhance students' interest and motivation in learning mathematics using E-Comic learning media with Canva software and the Realistic Mathematics Education (RME) approach. Canva is a user-friendly online graphic design tool accessible through web-based or mobile desktop devices (Wijaya et al., 2022). Learning media created using Canva can also improve students' mathematics learning outcomes, as in research by Fazriyah et al. (2023) there was an increase of 34.12, obtained from the results of the pre-test of the experimental class of 50.57 and the results of the post-test of the experimental class of 84.87.For this research, the premium version of Canva was utilized, offering additional elements compared to the free version.

In the initial stage of analysis, difficulties in understanding spatial shapes among students were identified through observations and literature studies. Awwalin (2021) identified factors contributing to this difficulty, including a lack of conceptual understanding and external factors. Additional research by Nuraida (2017) and Yusmin (2017) noted challenges faced by students in data organization, sorting, symbol usage, mathematical manipulation, procedural understanding, and drawing conclusions. Furthermore, Marasabessy, Hasanah, & Juandi (2021) highlighted common mistakes made by students when developing strategies, implementing them, or checking their work in tube building problems.

Based on this analysis, the researcher addressed the challenges by proposing the development of E-Comic learning media tailored to auditory, visual, and kinesthetic learning styles. The Realistic Mathematics Education (RME) approach was adopted for tube building material, known for its five key characteristics: contextual problem utilization, model incorporation, student contributions, interactivity, and integration with other topics (Fahrudin et al., 2018; Hutapea et al., 2020). Consequently, the solutions identified in the analysis stage served as the foundation for theme development in the subsequent stage.

In the subsequent stage of design, the E-Comic media is created by developing storyboards that align with the characteristics of Realistic Mathematics Education (RME) to facilitate the assembly of the storyline. A storyboard serves as a sequential sketch design based on the previously crafted story script (Wonggo et al., 2022). It consists of two primary components: organizing different scenes that convey a story and communicating the relevant information within each scene (Kunto & Ariani, 2021). For the tube building material, the E-Comic storyboard is depicted in Figure 1.

The storyboard in Figure 1 explains the E-Comic storyline according to the characteristics of Realistic Mathematics Education (RME) approach. The first characteristic involves the use of context, where students are encouraged to visually observe the provided tube-shaped objects in the E-Comic and share their ideas in the chat box. The second characteristic relates to utilizing models, where the teacher guides students to describe the objects based on the planar shapes they consist of. Intertwining, the third characteristic, entails the teacher's guidance for students to recognize the parallelism, congruence, or both between the lid and base of the tube. The final characteristic combines interactivity and student contribution. This aspect involves students working in groups to collectively construct a definition of a tube shape using previously learned elements. The created storyboard is then implemented in the subsequent stage. The third stage involves developing the E-Comic by implementing the storyboards using Canva software. The validation results for E-Comic as a module are categorized as very valid in line with the validation results of Fatmianeri et al. (2021) in research on developing differentiated instruction-based electronic modules which shows the category is very feasible. So, it can be drawn that learning mathematics with the help of electronic modules is suitable for application in learning. The resulting E-Comic has been adapted from the storyboard designed in the previous stage and has undergone refinements based on valuable input from validators.

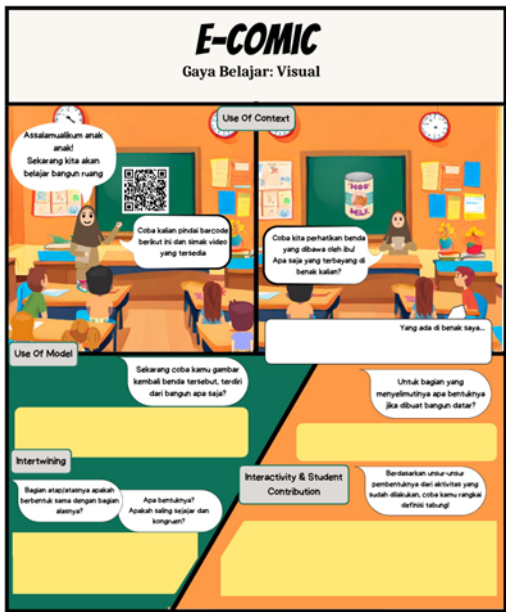

Figure 2. E-Comic Visual Learning Style

The visual learning style involves learning through direct observation (Labu, 2021). For students with a visual learning preference, interactive media like E-Comic can serve as an effective alternative since it incorporates text and visual elements (Damayanti et al., 2020). In this research, the E-Comic designed for visual learners embraces visually appealing characters and color themes to engage students' attention. Additionally, a QR-Code is included, directing students to relevant learning videos. QR-Codes are two-dimensional barcodes that can be scanned via barcode scanner applications or websites on mobile devices (Arianti et al., 2019). QR-Codes, as noted by Hadi & Yasi (2022), offer an efficient approach to store diverse information and data in a visually encoded format (Rahmadhani & Arum, 2022).

The use of colors in the E-Comic significantly influences students' learning motivation. Andriyani & Kusmariyatni (2019) found that students exhibit great enthusiasm when learning with colored comic media, perceiving it as novel, interesting, and even a blend of learning and play. The learning videos provided further support students in responding to statements and guided questions presented by the teacher within the E-Comic. For each characteristic of Realistic Mathematics Education (RME) associated with a visual learning style, the respective statements and guided questions are detailed in Table 5.

Table 5. Validity Results of E-Comic Learning Media

Characteristics of Realistic Mathematics Education (RME)	**Guided Statements and Questions**
Use Of Context	Try scanning the following barcode and watch the available video. Let's look at the objects that mother brought! What's on your mind?
Use Of Model	Now try to draw the object again, what shapes do it consist of?
Intertwining	Is the roof/top part the same shape as the base? What's the shape? Are they parallel and congruent? For the part that covers it, what would it look like if it were made flat?
Interactivity and Student Contribution	Based on the elements that form it from the activities that have been carried out, try to put together a definition of a tube!

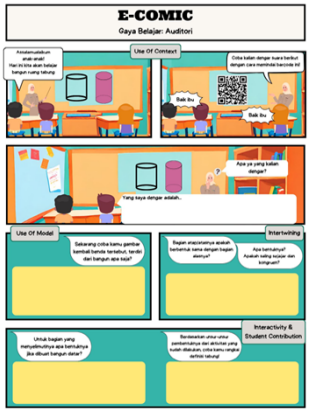

Figure 3. E-Comic Auditory Learning Style

The auditory learning style involves learning through listening and retaining information from discussions (Supit, Melianti, Lasut, & Tumbel, 2023). Students with auditory learning style tend to appreciate lectures, can absorb information effectively through verbal instructions, and have strong auditory memory (Radiusman & Simanjuntak, 2020). In this research, the E-Comic designed for auditory learners includes a QR-Code that provides audio explanations for learning. The statements and guided questions corresponding to each characteristic of Realistic Mathematics Education (RME) tailored to the auditory learning style are outlined in Table 6.

Table 6. Guided Statements and Questions Auditory Learning Style

Characteristics of Realistic Mathematics Education (RME)	**Guided Statements and Questions**
Use Of Context	Try listening to the following sound by scanning this barcode! What did you hear?
Use Of Model	Now try to draw the object again, what shapes do it consist of?
Intertwining	Is the roof/top part the same shape as the base? What's the shape? Are they parallel and congruent? For the part that covers it, what would it look like if it were made flat?
Interactivity and Student Contribution	Based on the elements that form it from the activities that have been carried out, try to put together a definition of a tube!

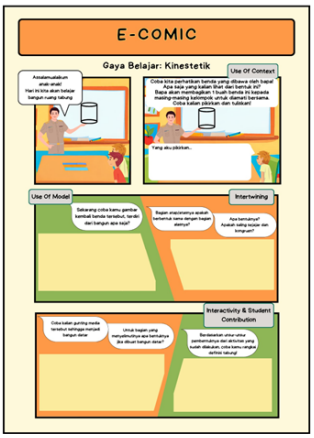

Figure 4. Kinesthetic Learning Style E-Comic

The kinesthetic learning style involves students focusing on movement-based learning, particularly through hands-on practice (Indah, 2023). Al-Hamzah & Awalludin (2021) outline

several characteristics of kinesthetic learners, including a preference for learning through physical manipulation and practice, being physically oriented and inclined towards movement, and a desire for engaging activities to stay occupied. In E-Comics designed for kinesthetic learners, students are provided with tube-shaped objects to observe and explore. The E-Comic guides students to observe these objects and subsequently presents guided questions to deepen their understanding of the elements of tube shapes. The statements and guided questions corresponding to each characteristic of Realistic Mathematics Education (RME) adapted for the kinesthetic learning style are presented in Table 7.

Table 7. Guided Statements and Questions Kinesthetic Learning Style

Characteristics of Realistic Mathematics Education (RME)	Guided Statements and Questions
Use Of Context	Let's try to be careful about the objects our father brings! What do you see from this shape? Father will distribute 1 of these objects to each group to observe together. Try to think and write it down!
Use Of Model	Now try to draw the object again, what shapes do it consist of?
Intertwining	Is the roof/top part the same shape as the base? What's the shape? Are they parallel and congruent? Try cutting the media so that it becomes a flat shape. For the part that covers it, what would it look like if it were made flat?
Interactivity and Student Contribution	Based on the elements that form it from the activities that have been carried out, try to put together a definition of a tube!

a. Implementation

In the implementation stage, the feasibility of the E-Comic media was assessed through trial sessions involving small groups of 30 students. The student responses were collected and analyzed based on several questions, as outlined in Table 8.

Table 8. Student Response Questions

No	Questions
1	I enjoy learning with the e-comic media used
2	Studying with e-comic media makes me feel bored
3	After learning to use e-comics, I like studying mathematics more
4	Whatever methods and media are used, I still don't like studying mathematics
5	My interest increased after learning mathematics using e-comics
6	I have no interest in studying mathematics because mathematics is very difficult
7	I always studied mathematics even though the teacher or parents didn't tell me to
8	Learning mathematics is fun and I always want to repeat it
9	I will study mathematics if there is a test
10	I always want to move forward to do the math problems given by the teacher

Based on the student responses, the average indicates a high level of practicality. Consequently, the E-Comic learning media for building tube rooms can be utilized extensively for learning purposes and can serve as a foundation for further research and development.

CONCLUSION

Based on the conducted analysis, it can be concluded that the use of e-comics as a learning media for teaching mathematics, specifically in the context of building tubes, is highly valid and practical. This conclusion is supported by the positive results obtained from validation tests and student responses. Considering the validation stage has been completed successfully, this e-comic learning media for tube building material can be widely implemented in educational settings. Furthermore, the practicality of this approach is evident through the significant increase in students' engagement and motivation to learn about tube construction.

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