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The Implementations of E-Comic Media Based on Realistic Mathematics Education in Differentiated Learning on Middle School Students' Learning Interests

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ABSTRACT

The primary objective of this research is to scrutinize students' learning styles, develop e-comic media based on realistic mathematics education for differentiated learning, and assess the interest in learning mathematics among junior high school students. The research employs a mixed-method approach with an Exploratory Sequential design, focusing on VIII grade students in a junior high school located in West Bandung. Two questionnaires were utilized as instruments to identify students' learning styles and learning interests. Qualitative data processing involved an analysis of students' learning styles based on their learning needs. The outcomes of this analysis informed the creation of media aligned with students' learning styles, validated by experts. The research concludes with the distribution of a questionnaire on learning interest to students using the developed media and those using regular learning methods. The research findings and data analysis lead to several conclusions. Notably, student learning styles encompass three tendencies: visual learning (37%), auditory learning (20%), and predominantly kinesthetic learning (43%). The developed learning media has been tailored to meet these learning needs, effectively accommodating all three learning styles and demonstrating validation. The implementation of this media resulted in a more favorable interest in learning mathematics compared to students using traditional learning methods.

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A. INTRODUCTION

Currently, there are many areas in human life that are experiencing rapid development, including education (Joan, 2015). In the world of education, learning resources can be accessed by students not only from teachers or textbooks, but also from the internet or electronic media. Therefore, learning media must be able to keep pace with these developments. However, the real conditions hardly meet expectations, current mathematics learning cannot facilitate the conditions, there are limited interesting media and teaching materials but can be accessed easily through technology (Irwan Padli Nasution & Hasan Saragih, 2017).

The pandemic situation triggered an increase in the need for various digital media for the education sector, unfortunately the condition was not responded well (UNICEF, 2021), where the learning carried out was considered inadequate, resulting in a decline in students' interest in learning mathematics and of course had a direct impact on their learning outcomes (Azmidar et al., 2017; Yeh et al., 2019). The conditions at that time meant that teachers were

required to innovate and be creative in creating interesting and enjoyable learning, but unpreparedness meant that this had an impact on students' declining condition, and resulting a learning loss (Pascotini et al., 2023).

There are various learning media that can be used in learning mathematics, one of which is comics. Comics are a series of images that contain the entire series of stories (Rasiman. & Pramasdyahsari, 2014). Comics in technology-based mathematics learning can also be called as Math E-Comic. The media can be used to help increase students' interest in learning mathematics. This media is a medium for conveying messages in the form of a series of images containing stories and mathematical context problems in which there are concepts arranged in a structured and easy to understand manner which are presented electronically so that even difficult mathematics lessons will feel easy, fun and easily accessible (Harisman et al., 2023; Hidayah & Fathimatuzzahra, 2019).

Math e-comic is an interesting media, because Math e-comic contains a series of images that can bring the content of the story to life. Therefore, this media is a fun mathematics learning media for students so that students' interest in learning can increase. The content of the story in Math e-Comic is adapted to a context that is closely connected to students' life, and Math e-comic is a real context in learning using the Realistic Mathematics Education approach (Fitriani et al., 2018). Apart from using context, the storyline in Math e-Comic is designed so that students can create models and also direct students to continue to be able to contribute and be interactive in solving mathematical problems, through this of course student interest will increase.

The results of the OECD and TIMSS surveys (Dasaprawira et al., 2019) state that the majority of Indonesian students have low abilities in terms of numeracy. Whereas these abilities are very important for students to master, because students will numeracy skills in everyday life applications. The low ability is closely related to students' low interest in studying mathematics. In general, their low interest in learning is closely related to student learning outcomes (Yeh et al., 2019), including numeracy abilities). Based on these problems, efforts should be made to increase students' interest in learning mathematics.

Currently, education in Indonesia is oriented towards independent learning, one of the core aspects of learning is related to differentiated learning. As teachers, we must be able to facilitate student diversity, with the hope that we can help develop their potential to the maximum which can ultimately increase students' interest. Based on this situations, it is necessary to consider appropriate actions that are acceptable to students. Teachers need to think about how to implement differentiated learning in the classroom, such as mapping learning needs based on learning styles. Next, the teacher plans differentiated learning based on the mapping results, where several RME-based Math e-Comic media will be designed that suit their learning needs.

The objective of this research is to examine: 1) Student learning styles based on learning needs; 2) Development of e-comic media design based on realistic mathematics education in differentiated learning based on the results of learning style mapping; 3) Students' Interest in learning mathematics for junior high school students whose learning uses e-comic media based on realistic mathematics education in differentiated learning compared to those who use regular learning method.

B. METHODS

The method used to answer the research questions in this study is Mix Method research design. This method was chosen according to its characteristics because the research questions to be answered include processes and outcomes that involve combining qualitative research and quantitative research.

This research is a mix method research with an Exploratory Sequential design. This design is used because the researcher will start the research by collecting qualitative data and then continue with collecting quantitative data to answer the hypothesis quantitatively. The following is an Exploratory Sequential design (Akram et al., 2021; Buchholtz, 2019).

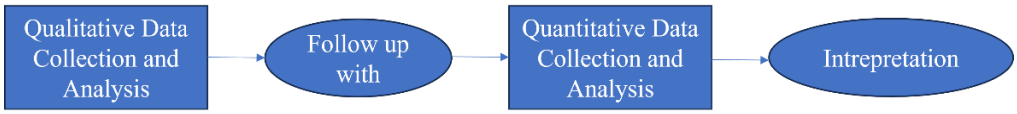

Figure 1. Exlporatory Sequential Design

In general, the research stages are as follows: 1) Determining the problem and formulating the problem, 2) Determining the theoretical basis, 3) Data collection and analysis, 4) Determining the hypothesis, 5) Testing the hypothesis through quantitative stages, 6) Determining the population and sample, 7) Collect data, 8) Analyze Data, 9) Prepare Conclusions and Suggestions.

The population in this study were all junior high school students in West Bandung with a sample of class VIII students at one of the junior high schools in West Bandung. The instruments used in this research were a questionnaire to determine students' learning styles and a questionnaire to determine learning interests.

The data processing process carried out is by processing qualitative data by analyzing students' learning styles based in on students learning needs, whether they tend to be more visual, auditory or kinesthetic. The results of the analysis are used to follow up on creating media according to their learning style.

Then proceed with the design of e-comic media development based on realistic mathematics education in differentiated learning. The media that is designed is of course first checked for validity by IT media experts, language experts, learning experts, along with the validity criteria (Rohaeti et al., 2023),

Table 1. Feasibility Criteria

No	Percentage	Criteria	Description
1	$80\% < V \leq 100\%$	Very Feasible	No Revision Required
2	$60\% < V \leq 79\%$	Feasible	No Revision Required
3	$40\% < V \leq 59\%$	Fair	Revision Required
4	$0\% < V \leq 39\%$	Not Feasible	Major Revision Required

The final stage is quantitative data processing to find out the comparison between those who use e-comics based on realistic mathematics education in differentiated learning and those who use regular learning method. The questionnaire data obtained previously is converted using the Successive Interval Method (MSI) (Mondiana et al., 2018).

C. RESULT AND DISCUSSION

This research is aimed to examine: 1) Student learning styles based on learning needs assessments; 2) The design of e-comic media based on realistic mathematics education in differentiated learning based on the mapping of learning styles; 3) The problem-solving ability and mathematics learning interest of junior high school students whose utilizes e-comic media based on realistic mathematics education in differentiated learning, compared to those undergoing conventional teaching, demonstrate superior outcomes.

1. Learning Style

In pursuit of the first research objective, an initial investigation was carried out in collaboration with Guidance and Counseling teachers to explore various learning styles

adapted from Bobby De Potter's theory. This theory identifies three predominant learning tendencies: visual, auditory, and kinesthetic (Evalina & Aritonang, 2023; Wiguna et al., 2020). Students were administered a questionnaire, the results of which would indicate their respective learning styles. The analysis of the obtained data revealed the existence of three distinct types of learning styles

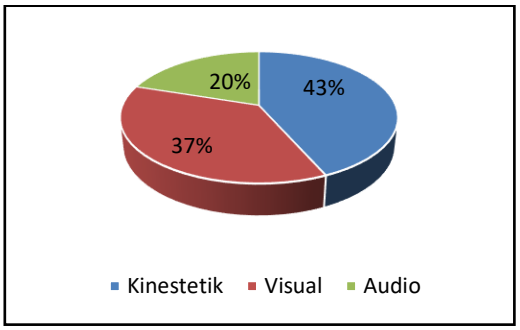

Figure 2. Students' Learning Styles

Based on Figure 2, data regarding the learning styles of eighth-grade students at SMP Negeri in one of the schools in West Bandung Regency, with a sample size of 30 students, indicate that students exhibit a tendency towards visual learning at 37%, auditory learning at 20%, and predominantly kinesthetic learning at 43%. From these results, it is evident that students do not heavily rely on auditory methods for learning or information assimilation; instead, they demonstrate a more dominant inclination towards kinesthetic and visual learning.

The profile of students' learning styles in the school is quite diverse. When ranked in descending order of prevalence, the sequential learning styles are kinesthetic, visual, and auditory. This diverse array of learning styles underscores the necessity and challenge that schools and, in particular, teachers must accommodate. The concept of differentiated learning is crucial in addressing this diversity. Through differentiated learning, teachers become more attuned to the individual differences among students (Rohaeti et al., 2023). The distinction between a traditional classroom and a differentiated one lies in the latter's recognition of multiple intelligences, as learning is based on the readiness, interests, and learning profiles of students (Halimah et al., 2023). By providing tailored approaches aligned with students' interests, it is expected to cultivate a heightened interest in learning mathematics, with the anticipation that improved interest will correspondingly yield enhanced learning outcomes. The results of this research are in line with research conducted by Wiguna et al., (2020)

2. The Design Of E-Comic Media Based on Realistic Mathematics Education for Differentiated Learning

Based on the results of descriptive statistical data processing, information regarding students' learning styles was obtained, with visual learning at 37%, auditory learning at 20%, and the predominant kinesthetic learning at 43%. Building upon these findings, a differentiated learning approach will be implemented through the design of an e-comic based on realistic mathematics education.

The e-comic encompasses three distinct designs, each tailored to accommodate the learning style of students. The instructions embedded within the comic storyline align with the characteristics of the realistic mathematics education approach, ensuring that the meaningfulness in constructing concepts and the problem-solving process is effectively maintained. The designed comic can be presented in electronic format as a

flipbook. Apart from being designed in a flipbook format, this media is also supported by Augmented Reality technology so that it looks more attractive, in line with research conducted by Prihandiri & Siswati (2022). Through this E-comic medium, it is anticipated that learning will become more engaging, capturing students' interest and proving effective in the learning process. The following is an example of an e-comic for the auditory learning style.

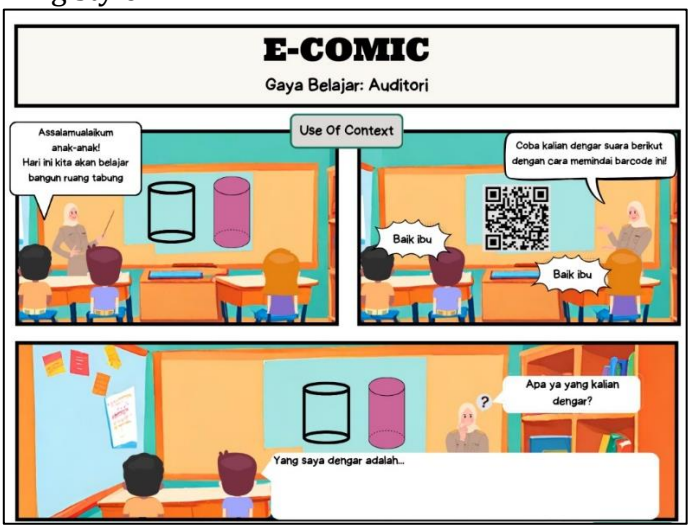

Figure 3. E-Comic for Auditory Learning Style Part 1

For the auditory learning style design, the e-comic media design begins with an audio facility, directing students to listen to the illustration of everyday contexts through sound. This approach is adopted as students typically maximize their auditory senses to receive and assimilate information. This initial stimulus serves as a form of non-formal mathematics within the storyline.

Figure 4. E-Comic for Auditory Learning Style Part 2

Figure 4 above represents the subsequent part of the e-comic, where students are directed to redraw the spatial structures that were previously conveyed through the earlier audio narration. This process constitutes a mathematical modeling phase, subsequently guiding students towards the formation of more abstract concepts through stimulating questions, encouraging student contributions and interactivity. The following is the e-comic media design for the visual learning style.

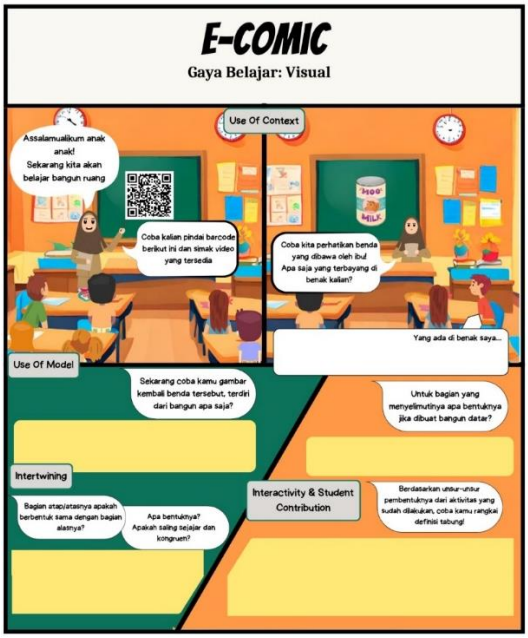

Figure 5. E-Comic for Visual Learning

For the visual learning style design, the e-comic media begins with the presentation of videos and images. The video content can be accessed by scanning the provided barcode. Students with this learning style tend to be more engaged with visual stimuli. The conveyed videos and images depict contextual situations provided at the outset as stimuli to delve into more abstract concepts. The presented context relates to daily life and requires solutions using mathematics (Halimah et al., 2023). Similar to the e-comic media used for the auditory learning style, after providing the initial stimulus, students are then directed to redraw the spatial structures previously presented following the viewing of the video content. This process constitutes a mathematical modeling phase, subsequently guiding students towards the formation of more abstract concepts through stimulating questions, encouraging student contributions and interactivity. Below is the e-comic media design for the kinesthetic learning style.

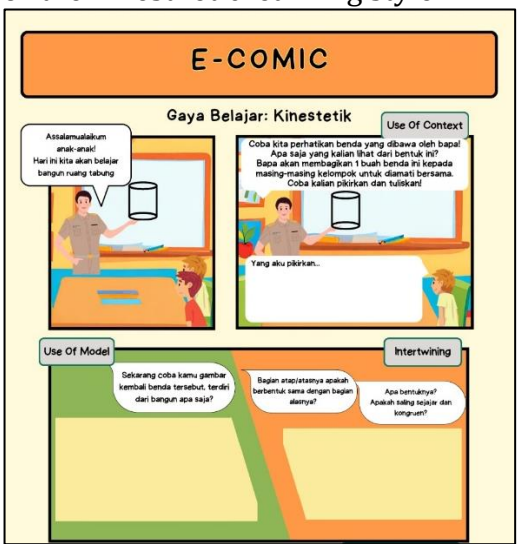

Figure 6. E-Comic for Khinestetic Learning Style Part 1

For the kinaesthetic learning style, students tend to leverage body movements in the learning process or in understanding something. Thus, the e-comic media design is crafted to direct students to directly handle and manipulate tangible media provided.

Similar to the previous styles, the media manipulation involved is a form of horizontal mathematics, representing an initial step towards vertical mathematics. The following outlines the process of its vertical mathematization

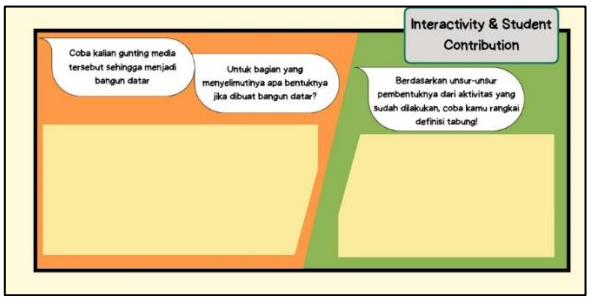

Figure 7. E-Comic for Khinestetic Learning Style Part 2

The process depicted in Figure 7 represents a mathematical modeling phase, subsequently guiding students towards the formation of more abstract concepts through stimulating questions, encouraging student contributions, and fostering interactivity. Through these stages, the understanding of mathematics is expected to improve, and other cognitive abilities are likely to be stimulated, aligning with previous research findings (Laurens et al., 2018; Lestari & Surya, 2017). Beyond these aspects, the primary target of interest is expected to increase.

The e-comic media, as structured, has undergone validation by three validators, including an IT media expert, a language expert, and a learning expert. The results of the validation are then summarized in the table below. The average feasibility score is 80%, according to the criteria in the feasibility table, indicating that the results are considered Very Feasible (can be used without revisions). From the results of data processing, it can be shown that this media is very interesting to use and this is in line with previous research (Prihandiri & Siswati, 2022).

Tabel 2. Result of Media Validations

Validator	Skor	Persentase (%)
V1	9	90
V2	8	80
V3	7	70
Avarage		80

(Note: V = Validator)

Based on the calculations conducted, the interpretation is that the created media is deemed Very Feasible. Consequently, the media can be utilized directly without the need for revisions.

3. The Interest in Learning Mathematics Among Junior High School Students Whose Instruction Utilizes E-Comic Media Based on Realistic Mathematics Education in Differentiated Learning

Upon the collection and analysis of qualitative data, the subsequent step involved a follow-up in the form of learning activities. Learning sessions were conducted over several meetings by implementing e-comic media based on realistic mathematics education in differentiated learning.

During the final meeting, students were given a questionnaire regarding their learning interests. The questionnaire was distributed to two groups of students: those

engaged in learning using e-comic media based on realistic mathematics education in differentiated learning, and those in a regular learning environment without the use of such media. The questionnaire results from both groups would provide a comparison of students' interest in mathematics learning.

Before processing the data using inferential statistics for independent two-sample testing, both sets of data were first converted into interval scales using the Successive Interval Method (MSI). The data conversion involved tabulating and transforming the data using an Excel software program that was pre-programmed to assist in the conversion process. The processed data results are as follows,

Table 3. Succesive Detail for Questionnaire in Experimental Class

Col	Category	Freq	Prop	Cum	Density	Z	Scale
1.000	2.000	7.000	0.016	0.016	0.039	-2.156	1.000
	3.000	143.000	0.318	0.333	0.364	-0.431	2.491
	4.000	300.000	0.667	1.000	0.000		4.057

In Table 3, it is evident that there is data conversion taking place. For instances where the category is 2, it is transformed into the numerical value 1. Similarly, the category 3 is converted to 2.491, and the category 4 is changed to 4.057.

Table 4. Succesive Detail for Questionnaire in Control Class

Col	Category	Freq	Prop	Cum	Density	Z	Scale
1.000	2.000	150.000	0.333	0.333	0.364	-0.431	1.000
	3.000	300.000	0.667	1.000	0.000		2.636

In Table 4, the data conversion for the control class is presented. It is observed that the category 2 is transformed into the numerical value 1, and for category 3, it becomes 2.636. After the ordinal questionnaire data has been converted into interval data, the next step involves processing it using the SPSS software. The statistical test utilized is a two-sample independent test. The essential prerequisite for conducting this test is to first perform a normality test. Below are the results of the data processing.

Table 5. Normality Test

Tests of Normality

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Questioner of Learning Interest	Eks	.246	30	.000	.750	30	.000
	Control	.200	30	.004	.829	30	.000

Based on Table 5, the significance values for both classes are below 0.05. Therefore, it can be concluded that both classes do not have a normal distribution. Since the results are not normal, the subsequent data processing will utilize the Mann-Whitney U test. The hypotheses for this test are as follows:

Ho : The interest in learning mathematics for students whose instruction utilizes e-comic media based on realistic mathematics education in differentiated learning is equal to the interest of students in regular instruction.

Ha : The interest in learning mathematics for students whose instruction utilizes e-comic media based on realistic mathematics education in differentiated learning is better than that of students in regular instruction.

Below are the results of the data processing for the questionnaire from both classes,

Table 6. Mann-Whitney U Data Test of Learning Interest

	Questioner of Learning Interest
Mann-Whitney U	.000
Wilcoxon W	465.000
Z	-6.692
Asymp. Sig. (2-tailed)	.000

Based on the results obtained from the conducted tests, a two-tailed significance value of 0.000 was obtained, which is also the same for the one-tailed significance value. This indicates that the generated significance value is <0.05. Given the obtained data, Ho is rejected, or in other words, the interest in learning mathematics among students whose instruction utilizes e-comic media based on realistic mathematics education in differentiated learning is better than that of students in regular instruction. The results suggest the need to develop instructional media or other materials tailored to students' learning styles. Consequently, many positive outcomes can be achieved, one of which is an increase in students' learning interest. This aligns with previous research findings (Özerem & Akkoyunlu, 2015; Pascotini et al., 2023; Schulze & Bosman, 2018). Based on other research, apart from increasing interest, learning like this can also increase understanding and critical thinking skills (Purwanto et al., 2020; Risnawati et al., 2018) and this is further research that can be carried out.

D. CONCLUSION AND SUGGESTIONS

Based on the research findings and data analysis conducted, several conclusions can be drawn. Among them is that students' learning styles consist of three predominant tendencies: visual, auditory, and kinesthetic. The data processing reveals that the students' learning tendencies are visual at 37%, auditory at 20%, and predominantly kinesthetic at 43%. Based on this, the design of the instructional media has been tailored to their learning needs, facilitating all three learning styles, and ensuring the validity of the created media. Through the implementation of this media, the analysis of students' learning interest after using e-comic media based on realistic mathematics education in differentiated learning indicates superior results compared to students in regular instruction.

Suggestions for future researchers are that they can design for mathematics topics related to algebra, so that responding or answering the e-comic is easier

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