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Utilizing e-comic media for differentiated learning: A realistic mathematics education approach to stimulate learning interest

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Abstract

The primary aim of this study is to ascertain the learning preferences of junior high school students and evaluate their interest in mathematics following instruction utilizing e-comic media grounded in realistic mathematics education within a framework of differentiated learning. Employing a mixed methods approach with an exploratory sequential design, the study targets junior high school students in the West Bandung region, with a cohort of 30 eighth-grade students selected as the sample. Questionnaires serve as the primary instruments to discern students' learning styles. Qualitative analysis involves scrutinizing these styles vis-à-vis their learning requisites. The ensuing analysis informs the customization of instructional media tailored to students' preferences, subsequently validated by experts. The study culminates in administering interest assessment questionnaires post-instruction. Findings and data analysis reveal three predominant learning tendencies among students: visual (37%), auditory (20%), and kinesthetic dominated (43%). The developed instructional media, validated and tested for efficacy, effectively caters to these learning styles. Application of this media demonstrates heightened interest in learning mathematics compared to traditional instructional methods.

Keywords: differentiated learning, e-comic, learning interest, realistic mathematics education

Introduction

In the contemporary landscape, various domains of human existence are undergoing rapid evolution, notably within the realm of education (Joan, 2015). Educational paradigms are shifting, with learning resources becoming increasingly accessible to students not solely from

traditional sources like teachers and textbooks, but also from the vast expanse of the internet and electronic media. Consequently, there is a pressing need for learning materials to adapt and keep pace with these advancements. However, the current state of mathematics education falls short of meeting these expectations. Challenges abound, including a dearth of engaging teaching resources and limited accessibility facilitated by technology (Nasution & Saragih, 2017).

The onset of the pandemic has precipitated a heightened demand for diverse digital educational resources. Regrettably, this demand has not been met with commensurate responsiveness (UNICEF, 2021). The prevailing modes of instruction are widely perceived as inadequate, contributing to a waning interest in mathematics among students and consequently, a palpable downturn in their academic performance (Azmidar et al., 2017; Yeh et al., 2019). The current educational milieu necessitates educators to innovate and imbue their teaching methodologies with creativity to foster engaging and enjoyable learning experiences. However, this lack of preparedness has exacerbated students' circumstances, leading to a progressive decline in learning outcomes a phenomenon commonly referred to as learning loss (Pascotini et al., 2023).

Various educational tools are available for teaching mathematics, among which comics stand out. Comics, characterized by sequential images depicting narratives, serve as a comprehensive storytelling medium (Rasiman & Pramasdyahsari, 2014). In the realm of technology-based mathematics instruction, comics take on the form of Math E-Comics. These digital resources feature structured narratives and problems, presented through a series of images. Electronically accessible, Math E-Comics offer an engaging and enjoyable learning experience, potentially boosting students' interest in mathematics (Harisman et al., 2023; Hidayah & Fathimatuzzahra, 2019).

Math E-Comics prove to be captivating educational tools due to their ability to imbue narratives with vivid imagery, thus making the content come alive for students. Consequently, this medium fosters an enjoyable learning experience, potentially heightening students' interest in mathematics, as demonstrated by research conducted by Batubara et al. (2021). Notably, the narratives within Math E-Comics are tailored to contexts closely aligned with students' everyday lives, adhering to the principles of the Realistic Mathematics Education approach (Fitriani et al., 2018). Beyond contextual relevance, the storylines in Math E-Comics are crafted to enable students to construct models and actively engage in problem-solving, thereby further enhancing their interest and interaction with mathematical concepts.

The findings from surveys conducted by the OECD and TIMSS, as documented by Dasaprawira et al. (2019), reveal a prevalent issue: a significant portion of Indonesian students exhibit low levels of numeracy proficiency. Yet, numeracy skills are indispensable for navigating daily life. This deficiency in numeracy proficiency correlates closely with students' diminished interest in mathematics, a trend corroborated by Rodhi's research in 2021. Importantly, this lack of interest has far-reaching implications, impacting not only students' learning outcomes but also their numeracy abilities, as highlighted by Yeh et al. (2019). Given

these challenges, concerted efforts are imperative to cultivate and sustain students' enthusiasm for mathematics education.

In Indonesia, contemporary educational paradigms increasingly advocate for differentiated learning methodologies, prioritizing the accommodation of diverse student needs. As educators, our responsibility lies in adeptly navigating this landscape to unlock the full potential of every student, with the ultimate goal of cultivating a pervasive interest in learning. Against this backdrop, it becomes imperative to deliberate upon and implement pedagogical strategies that resonate effectively with students' individualities. Consequently, teachers are compelled to undertake meticulous assessments of students' learning proclivities, predicated upon their distinct learning styles. Through this process of meticulous mapping, educators can glean insights into the unique educational requirements of each student, thus laying the foundation for tailored differentiated learning initiatives.

The primary objective of this research endeavor is two-fold: firstly, to elucidate the spectrum of student learning styles, meticulously delineating their corresponding educational needs; secondly, to ascertain the efficacy of e-comic media, underpinned by realistic mathematics education principles, within a differentiated learning framework, specifically in fostering students' interest in mathematics at the junior high school level. By juxtaposing the outcomes of students exposed to this innovative pedagogical approach with those adhering to conventional instructional methods, this study aims to provide empirical insights into the efficacy and viability of employing technology-enhanced differentiated learning strategies in mathematics education. Through rigorous analysis and interpretation of these findings, educators can glean invaluable insights into the optimization of pedagogical methodologies, thereby enhancing student engagement and academic outcomes within the realm of mathematics education.

Methods

The research methodology adopted for this study is a mixed methods approach, which integrates qualitative and quantitative techniques to comprehensively address the research objectives. A suite of questionnaires serves as the primary instruments employed in data collection, aligning with the nuanced nature of the research problem. Initially, the investigation focuses on conducting a nuanced analysis of students' learning styles, utilizing a questionnaire-based approach. Subsequently, the qualitative data gleaned from this phase are meticulously analyzed to elucidate nuanced insights into students' learning preferences. Concurrently, to gauge students' interest levels, another questionnaire is administered. The quantitative data derived from this phase are subjected to inferential statistical analyses to discern patterns and trends.

This research adopts an Exploratory Sequential design, which represents a systematic progression from qualitative inquiry to quantitative investigation. The initial phase involves the collection and qualitative analysis of data, thereby laying the foundation for subsequent quantitative exploration. This sequential design facilitates a holistic understanding of the research phenomenon by enabling researchers to delve deeper into the intricacies of students'

learning styles and interests. By synthesizing qualitative insights with quantitative findings, this methodological framework enhances the robustness and comprehensiveness of the research outcomes. Noteworthy contributions to the literature regarding the application of the Exploratory Sequential design are underscored by Akram et al. (2021) and Buchholtz (2019), affirming its efficacy in elucidating complex research inquiries presented in Figure 1.

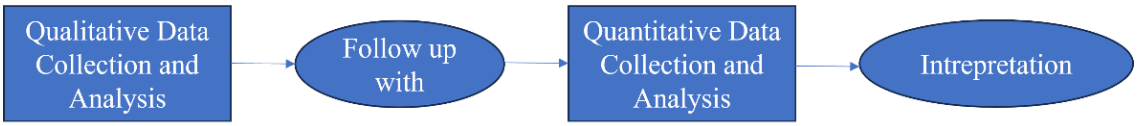

Figure 1. Exploratory sequential design

The research progresses through a systematic sequence of stages to methodically address the research objectives. Initially, the research endeavor commences with the identification and formulation of the research problem, setting the foundational framework for subsequent inquiry. Following this, the theoretical underpinnings relevant to the research domain are delineated, providing a conceptual scaffold for the investigative endeavors.

Subsequently, qualitative data are systematically collected and analyzed to elucidate nuanced insights into students' learning styles. This phase involves administering questionnaires to the research participants and meticulously analyzing the qualitative data gleaned from their responses. The ensuing phase entails a rigorous follow-up on the initial qualitative data analysis, validating the findings obtained.

Concurrently, hypotheses pertinent to the research inquiry are formulated, serving as pivotal conjectures to be empirically tested. The subsequent phase involves the systematic testing of these hypotheses, employing quantitative research methods. In this regard, quantitative data are collected through the administration of questionnaires tailored to ascertain students' learning interests.

The collected quantitative data are subjected to comprehensive statistical analyses to discern patterns, relationships, and trends. The culmination of the research endeavor involves synthesizing the qualitative and quantitative findings to formulate cogent conclusions and actionable recommendations. Throughout this iterative process, meticulous attention is accorded to ensure methodological rigor and the attainment of research objectives.

The data processing procedure involves the qualitative analysis of gathered data, specifically employing qualitative descriptive analysis to discern and categorize students' learning styles. This analytical approach facilitates the identification of distinct patterns and preferences among students, delineating whether they exhibit a propensity towards visual, auditory, or kinesthetic learning modalities. The outcomes of this analysis serve as the foundational basis for subsequent instructional interventions tailored to accommodate students' individual learning needs.

Subsequently, the research endeavors to design Math E-Comic media grounded in realistic mathematics education principles within a differentiated learning framework. This media design process is underpinned by a rigorous validation protocol, involving scrutiny by

IT media experts, language specialists, and learning experts. The validation process adheres to predefined criteria, ensuring the integrity, effectiveness, and suitability of the designed instructional media for facilitating meaningful learning experiences summarize in Table 1. The collaborative input and expertise of these diverse stakeholders collectively contribute to enhancing the validity and efficacy of the instructional materials developed (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

In the final stage, the research transitions into quantitative data processing to ascertain the comparative efficacy of utilizing e-comics based on realistic mathematics education within a differentiated learning framework versus conventional instructional methods. The quantitative analysis entails the transformation of questionnaire data collected previously utilizing the Successive Interval Method (MSI). This method facilitates the systematic quantification and comparison of data, enabling researchers to discern meaningful insights and draw robust conclusions regarding the effectiveness of the instructional interventions employed.

By employing the MSI, the research endeavors to systematically analyze and interpret the quantitative data gleaned from the administered questionnaires. This methodological approach facilitates the delineation of distinct patterns and trends, enabling researchers to discern whether students exposed to e-comic-based learning interventions exhibit differential learning outcomes compared to their counterparts engaged in traditional instructional methodologies. Through rigorous statistical analyses, the research aims to elucidate nuanced insights into the comparative effectiveness of the instructional interventions under scrutiny, thereby informing evidence-based pedagogical decision-making processes.

Results and Discussion

The primary objective of this research is two-fold. Firstly, it aims to scrutinize students' learning styles through comprehensive assessments of their individual learning needs. Through meticulous inquiry, the research endeavors to delineate the diverse array of learning modalities exhibited by junior high school students, thereby providing valuable insights into their cognitive predispositions and preferences. Secondly, the research aims to investigate the mathematics learning interest among junior high school students who are exposed to e-comic media grounded in realistic mathematics education within a differentiated learning framework. By comparing the outcomes of this cohort with those undergoing conventional teaching

methodologies, the research seeks to ascertain whether the former cohort demonstrates superior levels of engagement and interest in mathematics learning. Through robust empirical analysis, the research endeavors to contribute to the ongoing discourse on optimizing instructional approaches to foster enhanced interest and proficiency in mathematics among junior high school students.

Learning Style

In pursuit of the first research objective, a preliminary investigation was conducted in collaboration with Guidance and Counseling teachers to explore diverse learning styles, drawing insights from Bobby De Porter's theory. This theory delineates three primary learning modalities: visual, auditory, and kinesthetic (Evalina & Aritonang, 2023; Wiguna et al., 2020). Through the administration of a structured questionnaire, students' learning preferences were systematically assessed, providing valuable insights into their individual learning styles. Subsequent analysis of the acquired data unveiled the presence of three discernible types of learning styles among the student cohort.

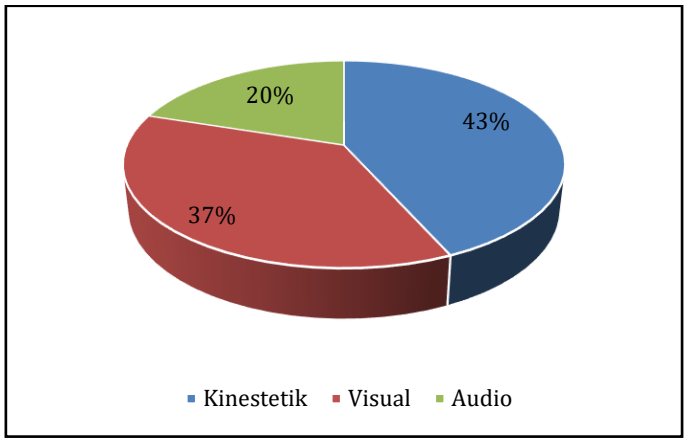

Figure 2. Students' learning styles

Based on the data presented in Figure 2, an analysis of the learning styles exhibited by eighth-grade students at a Junior High School in West Bandung Regency, comprising a sample size of 30 students, reveals noteworthy trends. Notably, students demonstrate a predilection towards visual learning, accounting for 37% of the cohort, followed by kinesthetic learning at 43%, with auditory learning registering at 20%. These findings underscore a notable deviation from a heavy reliance on auditory methods for learning or information assimilation, instead highlighting a prevalent inclination towards kinesthetic and visual learning modalities.

The profile of students' learning styles within the school exhibits considerable diversity, with kinesthetic learning emerging as the predominant modality, followed by visual and auditory learning, respectively. This diversity underscores the imperative for schools and educators to adopt strategies conducive to accommodating varied learning styles. Differentiated learning emerges as a pivotal concept in addressing this diversity, with its emphasis on tailoring instructional approaches to individual students' readiness, interests, and learning profiles

(Rohaeti et al., 2023). Contrasting with traditional classroom models, differentiated learning recognizes and integrates the multitude of intelligences, thereby fostering a learning environment that resonates with the diverse needs of students (Halimah et al., 2023). By aligning instructional strategies with students' interests, there exists a compelling opportunity to cultivate heightened engagement and interest in mathematics learning, with the attendant expectation of commensurate improvements in learning outcomes. These findings corroborate and extend prior research conducted by Wiguna et al. (2020), thus underscoring the consistency and relevance of the current research outcomes.

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

Based on the outcomes of the descriptive statistical data processing, a comprehensive understanding of students' learning styles has been attained, with visual learning comprising 37% of the student cohort, auditory learning at 20%, and the prevailing modality being kinesthetic learning at 43%. Leveraging these insights, the subsequent pedagogical intervention will adopt a differentiated learning approach, strategically tailored to accommodate the diverse learning modalities exhibited by the students. Central to this approach is the design and implementation of an e-comic instructional medium grounded in the principles of realistic mathematics education.

By capitalizing on the predominant kinesthetic learning modality identified among the student cohort, the e-comic will be meticulously crafted to engender immersive and interactive learning experiences. Through sequential narratives and problem-solving scenarios embedded within the e-comic, students will be afforded opportunities to actively engage with mathematical concepts in a dynamic and experiential manner. Moreover, the integration of realistic mathematics education principles ensures that the instructional content remains contextualized and relevant to students' lived experiences, thereby enhancing its efficacy in facilitating meaningful learning outcomes. By embracing differentiated learning strategies and leveraging innovative instructional mediums such as e-comics, the research endeavors to foster a learning environment that resonates with the diverse needs and preferences of students, ultimately striving towards the cultivation of enhanced interest and proficiency in mathematics.

The e-comic medium is thoughtfully crafted into three distinct designs, each meticulously tailored to cater to the diverse learning styles exhibited by students. Within the storyline of the comic, instructional directives are seamlessly woven to align with the tenets of the realistic mathematics education approach, thereby ensuring the preservation of meaningfulness in conceptual construction and the problem-solving process. The e-comic is ingeniously presented in electronic format, taking the form of a dynamic flipbook. Furthermore, to enhance its visual appeal and captivate student interest, the e-comic is augmented with cutting-edge Augmented Reality (AR) technology, as evidenced by research conducted by Prihandiri & Siswati (2022).

Through the fusion of AR technology and the e-comic medium, an immersive and engaging learning experience is envisioned, one that transcends traditional instructional methodologies. By leveraging interactive elements and visually stimulating content, the e-

comic endeavors to capture students' interest and foster active participation in the learning process. As an exemplar, consider the following depiction of an e-comic tailored specifically for students with an auditory learning style illustrated in Figure 3.

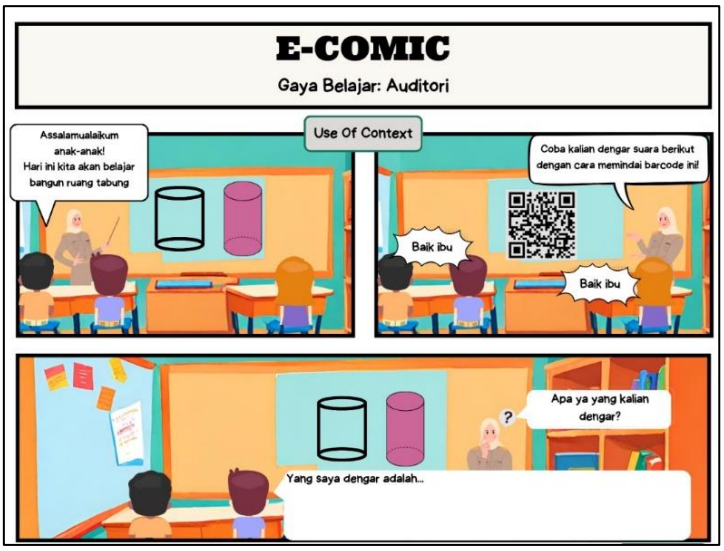

Figure 3. E-Comic for auditory learning style part 1

In crafting the e-comic tailored to the auditory learning style, the design commences with an innovative audio feature, inviting students to immerse themselves in the auditory depiction of everyday contexts. Recognizing that students with auditory learning preferences often optimize their auditory senses to absorb and comprehend information, this strategic approach capitalizes on their preferred modality of learning. Through the integration of soundscapes and audio narratives, the e-comic introduces students to a realm of non-formal mathematics embedded within the storyline. This auditory stimulus serves as a potent catalyst for engaging students in mathematical exploration and conceptualization, laying a foundation for meaningful learning experiences within the e-comic narrative.

Figure 4. E-Comic for auditory learning style part 2

Figure 4 illustrates the subsequent segment of the e-comic, where students are guided to engage in a dynamic process of spatial reconstruction based on the auditory narration provided earlier. This phase of the e-comic represents a pivotal stage wherein students are prompted to translate auditory information into visual representations, thereby fostering mathematical modeling and spatial reasoning skills. Through this hands-on activity, students are encouraged to manipulate spatial structures, thereby consolidating their understanding of mathematical concepts in a tangible and experiential manner. Subsequently, the e-comic facilitates a seamless transition towards more abstract conceptualization, eliciting student participation through thought-provoking questions and interactive elements. This iterative approach not only nurtures students' visual learning preferences but also cultivates critical thinking skills and mathematical proficiency.

Moving forward, the e-comic design for the visual learning style harnesses the innate predisposition of visual learners towards graphical representations and imagery. Central to this design is the integration of vibrant visuals and illustrative graphics, serving as visual stimuli to captivate students' attention and facilitate comprehension. Through visually immersive narratives and dynamic illustrations, the e-comic endeavors to evoke a sense of engagement and curiosity, thereby fostering an enriching learning experience. As an exemplar, consider the following depiction outlining the e-comic media design tailored specifically for students with a visual learning style as shown in Figure 5.

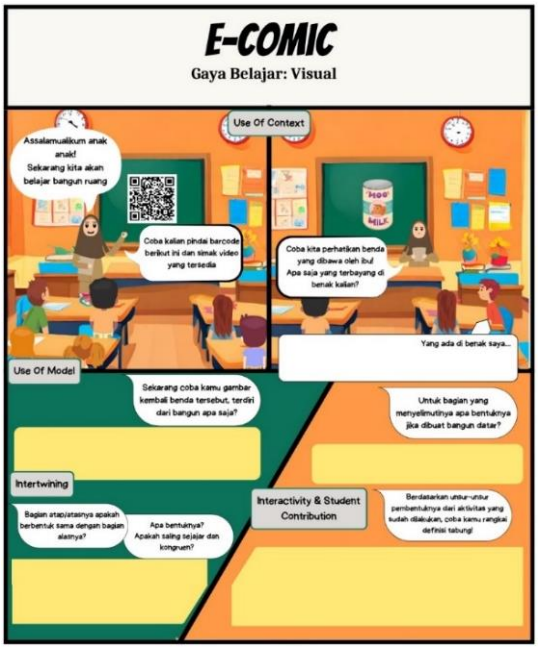

Figure 5. E-Comic for visual learning

In catering to the visual learning style, the e-comic media is ingeniously structured to commence with the presentation of captivating videos and images. Accessible through scanning a provided barcode, these multimedia elements serve as dynamic visual stimuli intended to resonate with students' visual learning preferences. Leveraging the inherent engagement elicited

by visual content, the conveyed videos and images depict contextual situations drawn from daily life, thereby setting the stage for students to explore and apply mathematical concepts within familiar contexts (Halimah et al., 2023).

Similar to the e-comic design tailored for auditory learners, the subsequent segment of the e-comic prompts students to engage in spatial reconstruction exercises following the viewing of video content. This hands-on activity facilitates a process of mathematical modeling, enabling students to manipulate spatial structures and conceptualize abstract mathematical concepts in a tangible manner. Moreover, this phase of the e-comic fosters critical thinking and problem-solving skills through the incorporation of stimulating questions, encouraging active student participation and interactivity (Figure 6). Next, consider the e-comic media design tailored specifically for students with a kinesthetic learning style, which leverages tactile and experiential learning modalities to facilitate meaningful mathematical engagement.

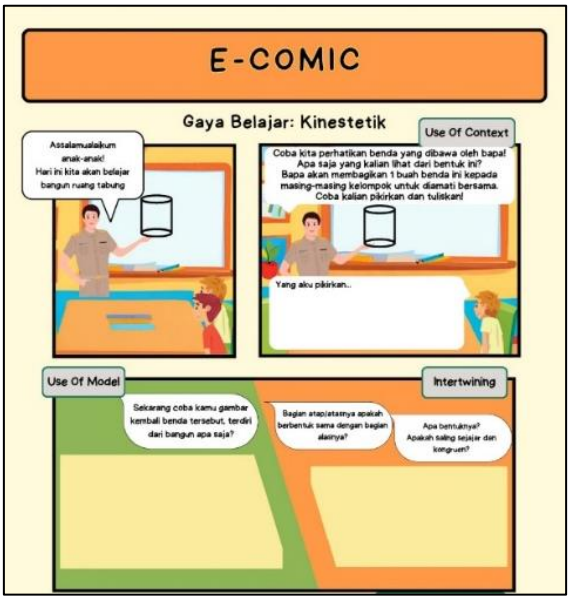

Figure 6. E-Comic for kinesthetic learning style part 1

Aligned with the kinesthetic learning style, characterized by a propensity for physical movement and tactile engagement in the learning process, the e-comic media design adopts a hands-on approach to foster mathematical understanding. Students are guided to interact directly with tangible media provided within the e-comic, facilitating experiential learning and kinesthetic exploration of mathematical concepts. This tactile manipulation serves as a dynamic catalyst for active engagement and comprehension, allowing students to internalize mathematical principles through physical interaction and manipulation of concrete objects.

Analogous to preceding learning style designs, the manipulation of tangible media within the e-comic constitutes a form of horizontal mathematics, representing an initial step towards vertical mathematization. This tactile engagement lays the groundwork for subsequent phases of mathematical abstraction and conceptualization, paving the way for deeper exploration and understanding of mathematical principles. By integrating kinesthetic learning modalities into

the e-comic design, students are afforded opportunities to synthesize physical movement with mathematical concepts, thereby fostering a holistic and experiential approach to mathematical learning. The ensuing depiction outlines the process of vertical mathematization within the e-comic media design tailored specifically for students with a kinesthetic learning style, elucidating the progression towards more abstract mathematical concepts and problem-solving strategies.

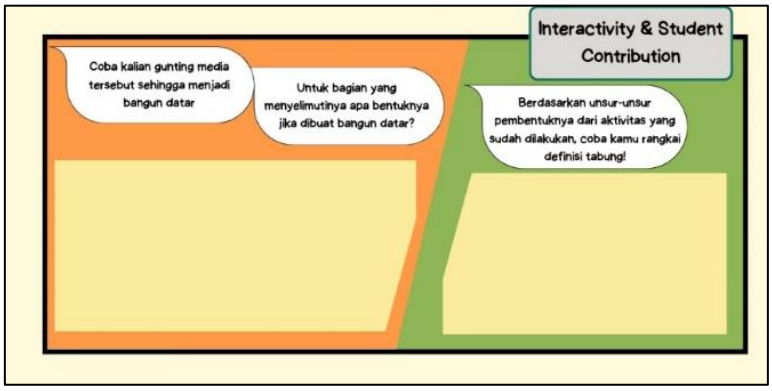

Figure 7. E-Comic for kinesthetic learning style part 2

The process delineated in Figure 7 embodies a crucial phase within the e-comic design, aimed at guiding students towards the formulation of more abstract mathematical concepts through the integration of stimulating questions, student contributions, and interactive elements. Through these iterative stages, the comprehension of mathematics is anticipated to deepen, while concurrently stimulating other cognitive abilities, as corroborated by previous research findings (Laurens et al., 2018; Lestari & Surya, 2017). Furthermore, beyond these cognitive dimensions, the primary objective of enhancing student interest is expected to be markedly augmented.

Evident disparities in the e-comic media are discernible, particularly in the initial stages. During the preliminary phase, contextualization is adeptly introduced to students through various stimulus methods tailored to their specific learning styles. For visual learners, the context is conveyed through dynamic video presentations, compelling students to focus on visual displays. Conversely, auditory learners are provided with context through auditory delivery, affording them the opportunity for repeated listening to optimize auditory processing. Meanwhile, kinesthetic learners are immersed in context through the tangible manipulation of real objects, engaging in direct hand-on activities to facilitate the recognition of initial concepts. These tailored approaches aim to effectively scaffold students' understanding of mathematical concepts while harnessing their preferred learning modalities, thereby fostering meaningful engagement and comprehension.

The e-comic media, meticulously structured to cater to diverse learning styles, has undergone rigorous validation by three esteemed validators: an IT media expert, a language expert, and a learning expert. The validation process culminated in the synthesis of results, as summarized in the Table 2. With an average feasibility score of 80%, as per the criteria

delineated in the feasibility table, the e-comic media is deemed Very Feasible, warranting utilization without the need for revisions. This validation outcome underscores the efficacy and suitability of the e-comic media in facilitating meaningful learning experiences tailored to students' individual learning needs.

Furthermore, the findings gleaned from data processing attest to the compelling interest elicited by this instructional medium, aligning seamlessly with prior research endeavors (Prihandiri & Siswati, 2022). This corroborates the efficacy and relevance of the e-comic media in engendering heightened engagement and interest in the learning process. As such, the validation outcomes and research findings collectively affirm the utility and effectiveness of the e-comic media as a potent instructional tool for fostering enhanced learning outcomes and student engagement.

Table 2. Result of media validations

Validator	Score	Percentage (%)
V1	9	90
V2	8	80
V3	7	70
Average		80

(Note: V = Validator)

Based on the comprehensive calculations conducted presented in Table 2, the interpretation unequivocally suggests that the created media attains the classification of "Very Feasible." This designation signifies that the media is exceptionally viable and efficacious, warranting immediate utilization without necessitating any revisions or amendments. This resounding validation underscores the meticulous craftsmanship and efficacy of the media design, affirming its suitability for facilitating meaningful learning experiences tailored to diverse student needs. As such, educators can confidently deploy the media in instructional settings, confident in its capacity to engender enhanced engagement and learning outcomes without the need for further modifications.

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

Following the qualitative data collection and analysis phase, the subsequent step entailed implementing learning activities through a series of sessions utilizing the e-comic media based on realistic mathematics education within a differentiated learning framework. These sessions were meticulously orchestrated to cater to the diverse learning needs of the students, fostering active engagement and comprehension.

During the culmination of the learning sessions, students were tasked with completing a questionnaire pertaining to their respective interests in mathematics learning. The questionnaire was administered to two distinct groups of students: those immersed in learning experiences facilitated by the e-comic media grounded in realistic mathematics education within a

differentiated learning context, and those undergoing conventional instruction without the utilization of such media. The comparative analysis of questionnaire results from both groups offered invaluable insights into students' evolving interest in mathematics learning.

Prior to subjecting the collected data to inferential statistical analysis for independent two-sample testing, a crucial preprocessing step was undertaken. Both sets of data were systematically transformed into interval scales employing the Successive Interval Method (MSI). This data conversion process entailed meticulous tabulation and transformation facilitated by specialized Excel software pre-programmed to expedite and streamline the conversion process. The ensuing processed data outcomes serve as foundational pillars for robust statistical analysis, enabling the delineation of meaningful insights into the comparative impact of instructional interventions on students' interest in mathematics learning.

Table 3. Successive detail for questionnaire in experimental class

Col	Likert value	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, a discernible pattern of data conversion is observed, wherein categorical values are systematically transformed into numerical equivalents. Specifically, instances categorized as '2' are converted to the numerical value '1', indicative of a standardized representation. Similarly, the categorical designation '3' is correspondingly transformed to '2.491', while '4' undergoes conversion to '4.057'. This meticulous conversion process ensures the alignment of data points on a uniform interval scale, thereby facilitating accurate and meaningful statistical analysis to glean insights into the comparative efficacy of instructional interventions on students' interest in mathematics learning.

Table 4. Successive detail for questionnaire in control class

Col	Likert value	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 elucidated. Notably, instances categorized as '2' are converted into the numerical value '1', representing a standardized representation within the interval scale framework. Similarly, categorical designations denoted as '3' undergo conversion to '2.636', ensuring consistency and uniformity in data representation. Following the meticulous conversion of ordinal questionnaire data into interval data, the subsequent step entails processing it utilizing the SPSS software for statistical analysis.

The statistical test employed is a two-sample independent test, a robust analytical tool designed to discern potential differences between two distinct groups. A pivotal prerequisite

for conducting this test involves performing a normality test to ascertain the distributional characteristics of the data. Presented below are the outcomes of the data processing, delineating the results derived from the normality test, which serve as foundational insights guiding subsequent inferential statistical analyses.

Table 5. Descriptive Analysis

	Class			Statistic	Std. Error
Learning Interest	Experiment	Mean		52,6771	,72594
		95% Confidence Interval for Mean	Lower Bound	51,1924	
			Upper Bound	54,1618	
		5% Trimmed Mean		53,1783	
		Median		53,8080	
		Variance		15,810	
		Std. Deviation		3,97615	
		Minimum		39,16	
		Maximum		56,16	
	Control	Mean		31,3600	,58699
		95% Confidence Interval for Mean	Lower Bound	30,1595	
			Upper Bound	32,5605	
		5% Trimmed Mean		31,6933	
		Median		32,1780	
		Variance		10,337	
		Std. Deviation		3,21509	
		Minimum		21,54	
		Maximum		34,63	

Based on Table 5, the computed averages for the two distinct classes have been derived, revealing a notable disparity in variance, with the experimental class exhibiting a larger variance compared to the control class. Notably, the significance values obtained for both classes fall below the conventional threshold of 0.05, indicating a departure from normal distribution within the dataset. Given this deviation from normality, subsequent data processing endeavors will employ the Mann-Whitney U test, a non-parametric statistical method robust to deviations from normality. The hypothesis formulated for the Mann-Whitney U test is as follows:

H_o: 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.

H_a: 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.

These hypotheses serve as the foundation for conducting rigorous statistical analysis aimed at discerning potential differences in students' interest in mathematics learning between

the experimental and control groups. Through meticulous hypothesis testing utilizing the Mann-Whitney U test, meaningful insights into the efficacy of instructional interventions can be gleaned, thereby informing evidence-based decision-making in educational practice.

Table 6. Normality test

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

Table 6 and Table 7 show the results of the data processing for the questionnaire from both classes.

Table 7. 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

Experimental Result, Their Interpretation, and The Experimental Conclusions

Based on the results obtained from the conducted tests, a significance value of 0.000 was attained, indicating statistical significance at the conventional alpha level of 0.05. Given that the significance value is less than 0.05, the null hypothesis (H_o) is rejected. In other words, there is sufficient evidence to conclude that students' interest in learning mathematics, when utilizing e-comic media based on realistic mathematics education within a differentiated learning framework, is significantly higher compared to students undergoing regular learning methods.

This compelling finding underscores the efficacy of incorporating innovative instructional approaches, such as e-comic media grounded in realistic mathematics education, to enhance student engagement and interest in mathematics learning. By leveraging technology-enhanced learning modalities and differentiated instructional strategies, educators can cultivate a dynamic and stimulating learning environment conducive to fostering students' intrinsic motivation and enthusiasm for mathematics education. Consequently, these findings hold profound implications for pedagogical practices aimed at optimizing learning outcomes and promoting lifelong engagement with mathematics among students.

The utilization of e-comics grounded in realistic mathematics education within a differentiated learning framework offers several distinct advantages over traditional teaching methods, contributing to enhanced student interest and engagement in mathematics learning. These advantages include:

1. Attractive Visualization
   E-comics leverage visually appealing formats, combining text, images, and graphics to present mathematical concepts in an engaging and comprehensible manner. This visual richness caters to the preferences of students who respond positively to visual stimuli, facilitating a deeper understanding of mathematical concepts.
2. Interactivity
   E-comics can incorporate interactive elements that empower students to actively participate in the learning process. Through features such as clickable passages for further explanations or interactive math simulations, students are encouraged to explore and engage with mathematical concepts actively, reinforcing their comprehension and retention.
3. Narrative-Based Learning
   E-comics often employ narratives or storytelling to elucidate complex mathematical concepts, embedding them within relatable contexts. By weaving mathematical principles into narratives, e-comics create a compelling and relevant learning experience, fostering student engagement and facilitating a deeper connection with the subject matter.
4. Accessibility
   E-comics offer unparalleled flexibility and accessibility, being accessible across various electronic devices such as laptops, tablets, or smartphones. This ubiquitous accessibility empowers students to engage in mathematics learning anytime and anywhere, aligning with their individual learning preferences and schedules.

By capitalizing on these factors, e-comics based on realistic mathematics education in differentiated learning environments can effectively cultivate heightened student interest and enthusiasm for mathematics learning. Through visually engaging content, interactive features, narrative-based learning approaches, and enhanced accessibility, e-comics pave the way for a more effective and enjoyable learning experience, ultimately fostering greater student achievement and mastery of mathematical concepts.

The research findings underscore the imperative of developing learning media and materials tailored to students' diverse learning styles, yielding a plethora of favorable outcomes, chief among them being the augmentation of students' interest in learning. This resonates with previous research endeavors, as evidenced by studies conducted by Özerem & Akkoyunlu (2015), Pascotini et al. (2023), and Schulze & Bosman (2018). Building upon these seminal findings, further research endeavors could explore the multifaceted benefits of such tailored learning approaches.

Beyond the enhancement of interest, research suggests that personalized learning modalities have the potential to bolster students' understanding and critical thinking skills, as elucidated by studies conducted by Purwanto et al. (2020) and Risnawati et al. (2018). These

findings underscore the transformative potential of adaptive learning methodologies in nurturing well-rounded and intellectually adept learners.

Moving forward, future research endeavors could delve deeper into the nuanced impacts of personalized learning approaches on various facets of student development, including academic achievement, problem-solving abilities, and metacognitive skills. By elucidating the multifaceted benefits of tailored learning interventions, such research endeavors could inform evidence-based pedagogical practices aimed at optimizing learning outcomes and fostering holistic student growth.

Conclusion

Several compelling conclusions can be drawn based on the comprehensive research findings and meticulous data analysis conducted. Firstly, students' learning styles exhibit three predominant tendencies: visual, auditory, and kinesthetic. The data scrutinization reveals that these tendencies manifest with varying prevalence, with visual learning comprising 37%, auditory learning at 20%, and a predominant kinesthetic inclination at 43%. Consequently, the instructional media design has been meticulously tailored to accommodate these diverse learning needs, ensuring inclusivity and efficacy across all three learning styles while maintaining the validity of the created materials.

Furthermore, the implementation of this tailored instructional media yields promising outcomes, as evidenced by the analysis of students' learning interest subsequent to utilizing e-comic media grounded in realistic mathematics education within a differentiated learning framework. The results underscore a notable enhancement in students' interest in learning mathematics compared to their counterparts undergoing conventional instruction, highlighting the efficacy and potential of innovative pedagogical approaches in fostering heightened engagement and enthusiasm for learning.

However, it is essential to acknowledge the limitations inherent in this research endeavor. Specifically, the utilized media may not fully facilitate students' exploration of their understanding through drawing or illustrating geometric forms, suggesting avenues for further refinement and development in future studies. Additionally, while the current research focuses on the augmentation of student interest, future investigations could delve into broader outcomes, including mathematical abilities and proficiency in algebraic material, to provide a more comprehensive understanding of the impacts of differentiated instructional interventions on student learning outcomes.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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