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Development of Electronic Comic Based on Realistic Mathematics Learning to Improve Students' Concept Comprehension Ability

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Abstract: This research is motivated by the low student concept comprehension ability caused by the teacher-centered learning process and the absence of additional media used during the learning process. The purpose of this research is to develop an electronic comic based on Realistic Mathematics Learning with valid, practical, and effective criteria in improving the ability to understand concepts. This research uses the ADDIE development model: analysis, design, development, implementation and evaluation. The data collection techniques used are observation, interviews, questionnaires, and tests. Instruments for data collection include electronic comic validity questionnaire sheets, practicality questionnaires from teachers and students, concept comprehension ability tests, and student response questionnaires. The research findings show that electronic comics based on realistic mathematics learning developed on social arithmetic materials are suitable for use as a learning medium that can improve students' concept comprehension ability because they have been declared valid, practical, and effective. This is based on the results of the validation from media expert 4.5 (very valid) and 4.41 (very valid) from the material expert, the results of the practicality questionnaire from the teacher of 90% (very practical), and the results of the practicality questionnaire from students of 80.18% (very practical), the results of the test of students' conceptual comprehension ability, including (1) the completeness of classical concept comprehension of 87.18%; (2) the achievement of each indicator of concept comprehension of 97.20%, 97.20%, 74.35%, and 69.23%; (3) increased conceptual comprehension ability with N-Gain by 0.73; and (4) positive response from students of 90.25%.

Keywords: concept comprehension ability; development research; electronic comics; realistic mathematics learning.

INTRODUCTION

The concept comprehension ability is one of the abilities to be achieved when learning mathematics. Mathematics learning outcomes are explained by the Educational Standards, Curriculum, and Assessment Agency, where concept comprehension is the first goal mentioned. This shows how crucial concept comprehension abilities are. Concept comprehension is a bridge between levels of knowledge in mathematics that is constructed continuously. This means that knowledge of a topic is a continuation of the previous topic (Ansari, 2015). It is like the foundation of a building: to build the next floor, the foundation of the building must be strong. Effective concept comprehension can help students to simplify, summarize, group information, and relate between concepts (Radiusman, 2020).

Formulated indicators of concept comprehension ability, namely (1) restating a concept; (2) categorizing topics based on certain characteristics according to their concepts; (3) providing examples and non-examples of concepts; (4) presenting concepts in various forms of mathematical representation; (5) elaborating the requirements for the need or sufficiency of a concept; (6) choosing a specific procedure; and (7) applying a concept or algorithm for solving a problem (BNSP, 2016). According to (Agustina, 2016), indicators of the ability to understand mathematical concepts include (1) restating a concept; (2) setting an example and not an example; (3) apply concepts to problem-solving. Next, (Umam & Zulkarnaen, 2022) revealed several indicators of the ability to understand mathematical concepts, which include (1) restating a concept; (2) presenting concepts into mathematical representations; (3) applying the concept of algorithms in problem solving.

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Indonesian students are placed 68th out of 81 nations in the 2022 Program for International Student Assessment (PISA) survey, which was released in December 2023. Furthermore, according to the Organization for Economic Cooperation and Development (OECD), pupils' aptitudes are divided into six categories. Just 0.17% of pupils are in the middle to upper levels of mathematics (levels 4, 5, and 6) (Lumbantobing, 2024).

One of the causes of the low achievement of students' mathematics learning outcomes is the lack of concept comprehension ability. Lack of comprehension of concepts learned in elementary school can lead to fundamental miscomprehension at the next level (Akhidah, Zuliana, & Ermawati, 2023). This statement is supported by the findings of diagnostic tests that show that students' ability to comprehend concepts is relatively low with the following details: (1) In the indicator "restating a concept", out of 39 students, 12.8% are at a good level, 17.9% are at an adequate level, and 69.2% are at a low level; (2) In the indicators "classify objects according to certain properties according to their concept" and "give examples and not examples", out of 39 students, 30.8% were at an adequate level, and 69.2% were at a low level; (3) In the indicator "using, utilizing, and choosing certain procedures or operations", out of 39 students, 5.12% were at a good level, 38.5% were at an adequate level and 56.5% were in the low category; (4) In the indicator "applying concepts or algorithms to problem solving", out of 39 students, 10.3% were at a good level, 25.7% were at an adequate level and 46.1% were at a low level.

After observing the learning process in the classroom, it can be seen that one of the factors causing students' low concept comprehension ability is the learning process that is still focused on the teacher. This process makes the teacher the sender of messages or information while the student receives directly from the teacher. If it continues, learning will be less effective for students (Siregar et al., 2023). In addition to the learning method, the learning process that occurs in the classroom relies solely on teaching materials from packaged books provided by the school. Teachers have not used additional media that are able to help students understand the subject matter. In fact, learning media has an important role because it can help teachers in conveying messages so that students understand the concept of the material being studied. Students need media that they can see, hear, and read for effective learning. The media used is not only pegged to package books or student handbooks but also more varied media (Ismawanto, 2014).

Learning media can be packaged in various forms, including e-comics. Electronic comics are digital comics that can be accessed and read through gadgets. Electronic comics can be used as an effective source of learning media because they can present information in visual form that is attractive and simple to digest. Based on studies from several previous studies, namely the research of (Kusumadewi, Gunartha & Ariawan, 2022; Sakinah & Hendriana, 2022), it was concluded that electronic comics in general can transfer knowledge directly through the delivery by characters in the story, story narratives, and material explanations decorated with character images. Therefore, in the development of electronic comics, there needs to be a learning approach that invites students to construct the concept of knowledge; in this case, it can start with the use of real context depicted through characters in electronic comic stories.

The material will be easier to understand if the learning approach found in students' daily lives is used so as to help students understand the concepts learned. Therefore, it is important for teachers to choose a learning approach that relates the material to daily life. A realistic approach uses the real context of students' daily lives to learn mathematics. Previous research conducted by (Juliawan et al., 2022) states that the use of realistic mathematics learning has a positive impact on concept comprehension ability. This advantage is due to the fact that realistic mathematics learning offers pupils unique competencies, such as locating and comprehending the idea of learning materials more thoroughly. Students find it easier to

solve contextual difficulties when they have this comprehension (Juliawan et al, 2022). The orientation of PMR is a daily experience (Yuniawati, Palupi & Fiangga, 2024). The Freudental view states that mathematics must be associated with real life and a human activity (Gravemeijer, 2012). Packaging mathematics as a process of guided rediscovery will take students through the same process as the discovery of mathematical concepts in the first place. The real context depicted in PMR is linked to activities that students can imagine.

The development of mathematical electronic comics has been developed in previous research with various approaches, improvement goals, and materials contained in electronic comics. One of them is research by (Arum, Suryaningtyas & Soemantri, 2022) who use digital comics as a learning medium. Research findings show that comics are considered effective and have a favorable and significant influence on student learning outcomes. Furthermore, there is research by (Cahyono et al., 2023), where the research is oriented to develop comic media for MTs/junior high school students in geometry materials. The research findings were obtained that comics developed using the ADDIE development stage have met the criteria of being very valid, practical, and effective in increasing students' motivation and creative thinking skills. However, in the development of this product, the criteria for comic effectiveness were obtained only through the N-Gain analysis of the test results given to students without analyzing the achievement of learning indicators and measured ability indicators (Cahyono et al., 2023). Based on previous research, the difference with this research is in the material contained in the comic, namely social arithmetic. Additionally, the analysis of the effectiveness of the developed comics differs because it utilizes the Nieven effectiveness reference, which evaluates both the improvement in students' abilities and their responses to learning.

In this research, an electronic comic based on Realistic Mathematics Learning was developed to improve the ability of Grade VII students to understand concepts in social arithmetic materials that meet the criteria of validity, practicality, and effectiveness. .

METHODS

This study's research and development approach makes use of the five stages of the ADDIE model: analysis, design, development, implementation, and evaluation (Branch, 2020). The research subjects were 39 students in grades VII–3 at a private junior high school in Medan City, and an electronic comic based on realistic mathematics learning acted as the research object. Analysis is the first stage of the ADDIE model. At this stage, we define the field conditions to guide the creation of electronic comic media. This stage involves the analysis of four key elements: needs, students, curriculum, and materials. The second stage is designed, which is the process of designing electronic comic media along with research instruments according to the outcome analysis. The electronic comic's design process begins with designing the comic framework, designing the comic script, designing each part of the comic, and finally realizing the comic in electronic form.

The next stage is development where validation of electronic comic and research instruments that have been designed in the previous stage is carried out to produce products that are suitable for use. After the electronic comic and research instruments are declared valid, it will enter the implementation stage where trials are carried out in learning activities to assess the practicality and effectiveness of the products that have been made. Finally, the evaluation stage is carried out at all stages to see the shortcomings and improvements that need to be made to improve the development of electronic comic.

Data collection techniques used in this research are observation, interview, questionnaire, and test. Observations are carried out at the analysis stage to observe the learning process carried out in the classroom so that the cause of the problems that occur in the field can be identified. The researcher conducted interviews with the students to gather more in-depth information regarding their ability to understand concepts. The questionnaire was used by researchers during the development and implementation stages to obtain an assessment related to the validity and practicality of the electronic comic they developed. Meanwhile, the test is used to assess the level of students' ability to understand concepts both in diagnosis and before and after learning using electronic comics to determine the effectiveness of the electronic comic media.

The instrument in this research is used to measure the validity, practicality and effectiveness of the development of electronic comics based on Realistic Mathematics Learning to improve students' ability to understand concepts. The instruments used can be seen as shown in table 1.

Table 1. Research Instruments

Variable	Data Source	Method	Research Instruments
Validity of Electronic Comics Based on Realistic Mathematics Learning	1. Material Expert 2. Media Expert	Questionnaire	1. Material Expert Validity Questionnaire 2. Media Expert Validity Questionnaire
Practicality of Electronic Comics Based on Realistic Mathematics Learning	1. Teacher 2. Student	Questionnaire	1. Teacher's Practical Questionnaire 2. Student's Practical Questionnaire
The Effectiveness of Electronic Comics Based on Realistic Mathematics Learning to Improve Students' Concept Comprehension Ability	Students	Test	1. Concept Comprehension Ability Test – *Pretest* – *Posttest* 2. Student Response Questionnaire

There are two types of data analysis used in this study: qualitative and quantitative. Qualitative data was obtained from observations, interviews and suggestions/inputs on the validation process. Qualitative data analysis techniques are in the form of descripting, descripting, and summarizing the occurrence of the phenomenon being studied. Furthermore, quantifiable information was gathered from the outcomes of assessments of concept comprehension ability, practicality, validity, and student response. The following is a description of quantitative data analysis methods.

- Analysis of the Validity of Electronic Comic and Research Instruments

The validity analysis was obtained from the validity questionnaire of media experts and material experts. Validity analysis is carried out by calculating the average validity score using the formula:

$$V = \frac{\sum v}{N} \quad \text{.....(1)}$$

with, V = average validity score, $\sum v$ = total score obtained, and N = amount of data/questions

After obtaining an average validity score, the validity description is interpreted based on the provisions in table 2.

Table 2. Validity Interpretation

Interval (V)	Classification
$4{,}0 < V \leq 5{,}0$	Very valid
$3{,}0 < V \leq 4{,}0$	Valid
$2{,}0 < V \leq 3{,}0$	Quite Valid
$1{,}0 < V \leq 2{,}0$	Invalid
$0{,}0 < V \leq 1{,}0$	Very invalid

- Analysis of the Practicality of Electronic Comic

The practicality analysis was obtained from the practicality questionnaire from teachers and students. Practicality analysis is carried out by calculating the percentage of practicality using the formula:

$$P = \frac{\sum score\ per\ item}{Maximum\ score} \times 100\% \quad \text{.....(2)}$$

After getting the percentage of practicality, the description of the practicality is interpreted based on the provisions in table 3.

Table 3. Practical Interpretation

Interval	Classification
$80\% < V \leq 100\%$	Very practical
$60\% < V \leq 80\%$	Practical
$40\% < V \leq 60\%$	Quite practical
$20\% < V \leq 40\%$	Impractical
$0\% < V \leq 20\%$	Very impractical

- Analysis of the Effectiveness of Electronic Comic

The effectiveness of the electronic comic is seen based on the results of the test of students' concept comprehension ability, namely during *the pre-test* and *post-test*. The effectiveness analysis is seen based on: (1) completeness of classical concept comprehension which means that at least 85% of students get a minimum KKM score of 75 (Trianto, 2017), (2) achievement of each concept comprehension indicator which means that at least 65% of students get a score of at least 75% of each indicator formulated (Hasratuddin, 2018), (3) Improvement of concept comprehension ability, (3) positive student response to electronic comic media. The analysis of improving the concept comprehension ability was obtained based on N-Gain analysis using the formula:

$$g = \frac{S_{posttest} - S_{pretest}}{S_{maks} - S_{pretest}} \times 100\% \quad \text{.....(3)}$$

with g = N-Gain factor, $S_{posttest}$ = Posttest score. $S_{pretest}$ = Pretest score, and S_{maks} = maximum score. After getting an N-Gain score, the description of the improvement in concept comprehension ability can be interpreted based on the provisions in table 4.

Table 4. N-Gain Interpretation

Interval (g)	Classification
$g \geq 0{,}7$	Tall
$0{,}3 < g < 0{,}7$	Enough
$g \leq 0{,}3$	Low

(Kurniawan & Hidayah, 2021)

Meanwhile, student responses were analyzed using a Guttman scale questionnaire with an alternative solution of "Yes" and "No". The "Yes" solution scores 1 and the "No" solution scores 0. Furthermore, the percentage of student responses is calculated using the formula:

$$PSR = \frac{\sum score}{maximal\ score} \times 100\% \quad \text{.....(4)}$$

After getting the percentage of student responses, the description of the student's response is interpreted based on the provisions in table 5.

Table 5. Interpretation of Student Responses

Interval (PSR)	Classification
$81\% \leq PRS \leq 100\%$	Positive
$0\% \leq PRS < 75\%$	Negative

RESULTS AND DISCUSSION

The results found from the research process are described as follows:

- Analysis Stage

The findings at the analysis stage are in the form of needs analysis, student analysis, curriculum analysis, and material analysis. The findings of the needs analysis indicate that students' concept comprehension ability is still low with the identification of problems, namely the monotonous learning process due to the lack of variation in methods and only using a teacher-centered approach. In addition, it was also obtained that classroom learning only relies on package books from schools without additional media that can help students in learning. The package books used mostly contain summaries, examples of questions and discussions, as well as practice questions. That way, it will tend to make students just memorize concepts without knowing the process from the beginning of the concept. Therefore, it is necessary to develop media that can activate students in learning and help students to understand mathematical concepts.

Student analysis is carried out by looking at the cognitive development of students in the classroom. This analysis is carried out to assist researchers in determining the right methods and media for students to appropriate their cognitive development stages. Reviewed based on the average age of grade VII students aged 12-13 years, grade VII students are in the initial formal operational stage. Piaget argued that the hallmark of this stage is the abandonment of the ability to think abstractly, reason logically, and draw conclusions from existing information. Even though students are already at the initial formal operational stage based on their age, it is still possible that grade VII junior high school students have not entered that stage. Considering the findings of the analysis of students' needs and analysis, the chosen solution is an electronic comic media based on realistic mathematics learning oriented towards improving students' concept comprehension skills.

Additionally, the curriculum and materials are analyzed to ensure that the creation of electronic comic complies with the requirements of the Independent Curriculum and chooses content appropriate for electronic comic. The results of the curriculum analysis were obtained that electronic comic media was in accordance with the demands of the Merdeka curriculum where learning must be able to activate students and be fun. Meanwhile, based on the material analysis, the material chosen for the developed media is social arithmetic.

- Design Stage

The researcher design electronic comic and research instruments throught this stage. The process of designing electronic comic media starts from designing an electronic comic

framework and designing a story script. Then it is continued with the process of designing each part of the comic framework such as the cover, instructions for use, learning objectives, table of contents, character introduction, comic story, practice questions, and finally the developer profile. Overall, the process of designing e-comic uses the help of Canva and Flip PDF Professional apps. Figure 1 illustrates how the comic that has been designed looks.

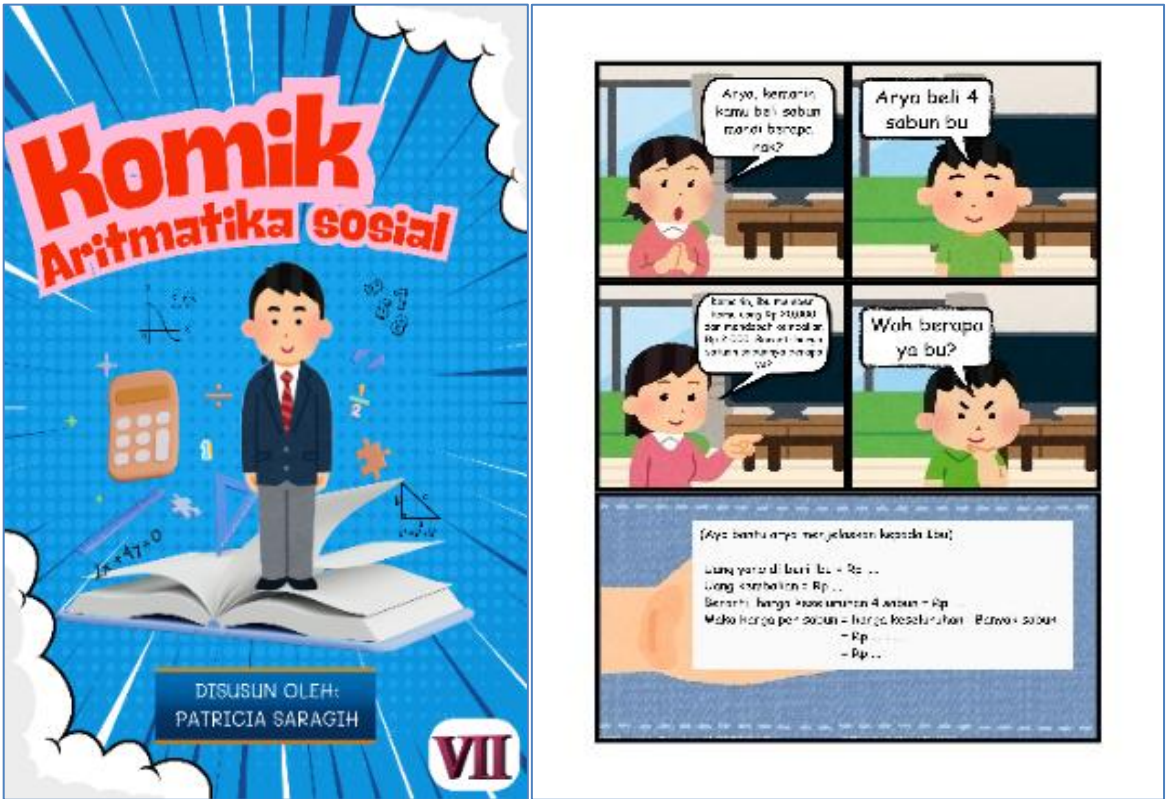

Figure 1. Electronic *Comic Media* Design Results

If the design of the comic has been completed, the next step is to design a research instrument which includes: teaching modules, concept comprehension ability test instruments, validity questionnaires for material experts and media experts, practicality questionnaires from teachers and students, and student response questionnaires. Before use, all instrument designs will go through a validation process first.

- Development Stage

There are two activities in the *development stage*, namely the process of validating electronic comic media and all research instruments as well as readability tests. The purpose of the validation process is to provide a usable product. The result of validation from electronic comic media and research instruments are listed in table 6.

Table 6. Result of Validation

No	Questionnaire	Validation Average (V)	Classification
1	Material Expert	4,5	Highly Valid
2	Media Expert	4,41	Highly Valid
3	Practicality Questionnaire from Teachers	4,33	Highly Valid
4	Practicality Questionnaire from Students	4,33	Highly Valid
5	Student Response Questionnaire	4,6	Highly Valid

No	Questionnaire	Validation Average (V)	Classification
6	Initial Concept Comprehension Ability Test (*Pretest*)	3,62	Valid
7	Final Concept Comprehension Ability Test (*Posttest*)	3,62	Valid
8	Teaching Module	4,35	Highly Valid

Based on table 6, it was found that the electronic comic developed was suitable for use as a mathematics learning medium because it met the validity criteria with an average validation of 4.5 from material expert and 4.41 from media experts. The validity classification of the electronic comic developed is very valid. In addition, it was found that all research instruments and learning tools are also suitable for use as data collection tools in this research.

The classification very valid showing that electronic comic: (1) Based on the content component, It is empirically consistent with the ideas and notions that are applicable in the scientific domain and with the advancement of science. so that it can be scientifically accounted for in terms of science and does not cause misconceptions to readers. (2) Based on the linguistic component, it is in accordance with the rules of the Indonesian language, consistent in the writing of symbols, and unambiguous (double meaning). (3) Based on the format component, it is appropriate in terms of design, layout, and suitability between sections so that the message or information expressed can be conveyed well and give a more attractive impression. (4) Based on the terms of the construct component, it has been presented with a systematic Realistic Mathematics Learning that raises situations that are close to students and is designed to increase students' concept comprehension ability. Even when the instruments and electronic comic have satisfied the validity requirements, the validators offer feedback and ideas for improvement to make the final product better. Table 7 contains the validators' feedback.

Table 7. Validators' Feedback

No	Questionnaire	Feedback for Improvement
1	Material Expert	It is enough for one problem to be given a model *of* solving, for the next problem provide student activities to help the main character with a few solution instructions, then the next problem again without solution instructions.
2	Media Member	❖ Page number generation and table of contents addition ❖ Complete the comic identity on the cover
3	Practicality Questionnaire from Teachers	No revisions
4	Practicality Questionnaire from Students	Question items changed in the student's point of view
5	Student Response Questionnaire	No repair
6	Initial Concept Comprehension Ability Test (*Pretest*)	No repair

No	Questionnaire	Feedback for Improvement
7	Final Concept Comprehension Ability Test (*Posttest*)	No repair
8	Teaching Module	Adjustment of student activities with electronic comic media

The results of the improvement of the validators' feedback on electronic comic are listed in table 8.

Table 8. Electronic Comic Media Repair

Feedback for Improvement	Before Repair	Improvement Results
Create a page number		
Leave the answers blank so that there is a student activity but give a few clues to completion		

Feedback for Improvement	Before Repair	Improvement Results
Blank answers without any completion instructions		

After the electronic comic is repaired according to the suggestions of the validators, the next readability test is carried out. The purpose of this readability test was to see the suitability of the language used in electronic comic media with the level of students being tested. This trial was carried out by asking students to read comics and test questions. If there are instructions or questions that are not understood by students, they are asked to provide suggestions and inputs for the improvement of electronic comic media and test questions. Based on the findings of the readability test, it was stated that students were able to clearly understand the instructions for use and the purpose of each activity displayed in electronic comic media and test questions.

- Implementation Stage

The practicality and efficacy of employing electronic comics for learning will be evaluated at this stage, which is often referred to as a field trial. During the implementation stage, the researcher plays the role of an educator. The findings produced at the stage of field trials are practicality data and data on students' concept comprehension ability. The findings of practicality from teachers and students are presented in table 9.

Table 9. Findings of Practicality

No	Practicality Questionnaire	Percentage of Practicality	Classification
1	From the Teacher	90%	Very Practical
2	From Students	80,18%	Very Practical

Table 9 shows that, according to teacher and student assessments, the electronic comic based on realistic mathematics learning generated has a very practical level of 90% and 80%, respectively. This level of practicality shows how well the created product works in the field and may be applied in accordance with the designer's vision (Nieeven & Folmer, 2013).

The classification is very practical in electronic comic based on realistic mathematics learning that has been developed showing that: (1) students' concept comprehension ability can be stimullated through the use of an electronic comic as a learning media. This is in accordance with the opinion of (Sola et al., 2022), she claims that one of the useful advantages of incorporating educational media into the teaching and learning process is that it enhances and facilitates learning outcomes by providing clarity in the way messages and

information are presented. (2) The expanded electronic comic media is easy to use by teachers and students during the learning process. The reasons why the electronic comic media developed are easy to use, including: (a) can be accessed online from a link and can be used repeatedly; (b) the use of simple comics so that it does not cause misperception between researchers and users; (c) storylines that are easy to understand because they use stories that are close to students' lives. (3) By using electronic comic, the learning process time is more efficient. Efficient in this case refers to the suitability with the learning hours. This is consistent with the viewpoint of (Irawan & Hakim, 2021) who states that the time required in the process of using developed learning media should be fast, short and precise. The effectiveness of learning time will give teachers the chance to be more adaptable in how they oversee the learning process, allowing it to function more smoothly and successfully.

Meanwhile, the findings of the test of students' concept comprehension ability showed that in the *pretest* classical completeness had not been achieved while in the *posttest* it had been achieved. The percentage of completeness of conceptual understanding is classically presented in table 10.

Table 10. Classical Completeness Percentage

Description	*Pretest*		*Posttest*	
	Number of Students	Percentage	Number of Students	Percentage
Conclusion	1	2,56%	34	87,18%
Incomplete	38	97,44%	5	12,82%
Sum	39	100%	39	100%

The analysis of effectiveness is also seen from the achievement of each indicator formulated. Based on the findings of the analysis, it was obtained that at the time of the pretest, there was no indicator of concept comprehension that could be achieved by students. Meanwhile, the posttest showed that each indicator of concept understanding had been achieved according to the criteria. The percentage of achievement of the indicators formulated is presented in figure 2.

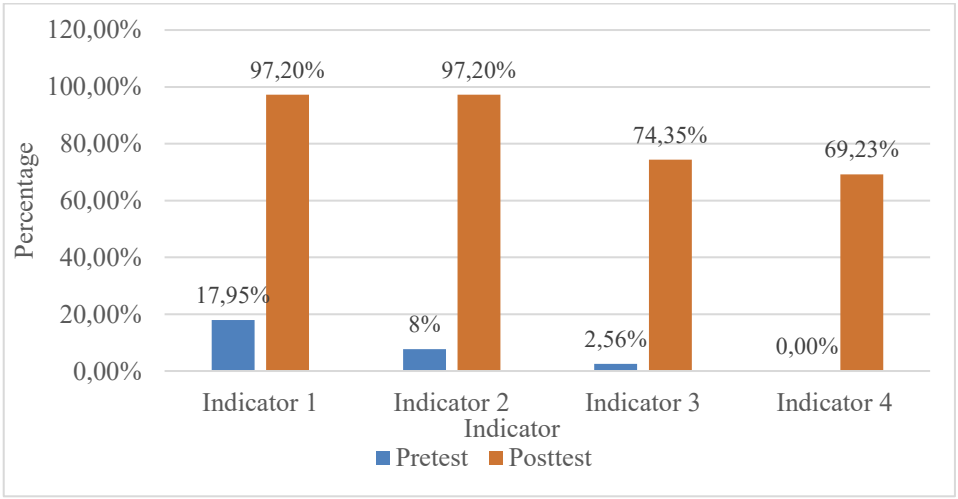

Figure 2. Percentage Achievement Chart of Concept Comprehension Indicators

Based on the percentage of completeness of classical concept understanding in table 10 and the percentage of achievement of concept comprehension indicators in figure 2, it shows that there is an increase in students' concept comprehension ability. The increase can

be seen based on each indicator and overall. From the point of view of improving each indicator, it was found that the increase in indicator 1 was 79.25%, in indicator 2 increased by 89.51%, in indicator 3 increased by 71.79%, and in the indicator 4 increased by 69.23%. Meanwhile, the overall improvement can be seen from the N-Gain analysis in table 11.

Table 11. N-Gain Analysis

Category	*Pretest*	*Posttest*
Average Score	37,56	82,88
Overall N-Gain	0,73	
N-Gain Classification	Tall	

In addition, the effectiveness of electronic comic media is also reviewed from students' responses to electronic comic media. Electronic comic media is said to be effective if students give a positive response. The results of the student response questionnaire obtained a percentage of student responses of 90.25% with a positive classification.

It is possible to draw the conclusion that electronic comics based on actual mathematics learning are helpful in enhancing students' concept comprehension ability based on the results of the concept comprehension ability test, which have satisfied all effectiveness requirements. This is consistent with the viewpoint of (Slavin, 2006), that the determination of the level of learning effectiveness depends on the mastery of certain abilities called the completeness of certain abilities and the achievement of a certain level of mastery or the achievement of certain indicators.

- Evaluation Stage

The evaluation stage is conducted at every stage of this research with the help of lecturers. The evaluation of PMR-based electronic comic media was carried out formatively. Formative evaluation is carried out in the middle of the development process. Formative evaluation is a type that focuses on improving product development. Evaluation at the *analysis stage* is carried out by the supervisor to help find solutions to the problem. This evaluation was carried out on the selection of the type of media, the mathematical approach used, and the selection of material to be published. Evaluation at the *design* stage is also carried out by the supervisor, where the supervisor will evaluate the electronic comic media and instruments that have been made and ensure their completeness.

Evaluation at the *development* stage is obtained from 3 experts as validators, where the validators will provide comments/suggestions for improvements to the developed media and instruments. Following an analysis of the practicality and efficacy of electronic comic media, the researcher conducted the evaluation at the implementation stage. To increase the usefulness and efficacy of electronic comics, an improvement assessment will be conducted if the practicality and effectiveness analysis results fall short of the requirements. There is no need for additional assessment because the results of the practicality and efficacy of the created electronic comic satisfy the success criteria. In this sense, ADDIE's development phase is over.

Previous research, namely research by (Afifah & Dewi, 2020) who developed e-comic to improve students' concepts comprehension ability obtained validity with a score of 4.3, practicality with a score of 4.5 and effectiveness with a percentage of 90%. In addition, research by (Yuniati et al., 2024) who developed a Mathematics *e-Comic* Based on a Realistic Mathematical Approach on One-Variable Linear Equation Material obtained a validation result of 91.15%, practicality of 82.5% and an N-Gain analysis of 0.7 with a very high category. These two studies support the results of the research conducted that the developed

realistic mathematics learning-based electronic comic media is effective in improving students' concept comprehension skills.

CONCLUSION

The electronic comic based on realistic mathematics learning developed is of high quality because it satisfies 3 development requirements of validity, practicality, and effectiveness. The validity of electronic comic media based on realistic mathematics learning is based on the results of the validation questionnaire of material experts of 4.5 and media experts of 4.41. Based on the validation results, the validity of the electronic comic based on realistic mathematics learning developed is in the category of very valid. Meanwhile, the practicality of electronic comics based on realistic mathematics learning is determined by a 90% score from the teacher's practicality questionnaire and an 80.18% score from the students' practicality questionnaire. Based on this practicality assessment, the practicality of the electronic comic based on realistic mathematics learning developed is in the category of very practical. The level of effectiveness of the electronic comic developed is seen from (1) the completeness of the classical concept understanding, (2) the achievement of each of the formulated concept understanding indicators, (3) the improvement of concept comprehension skills, and (4) positive student response to electronic comic media. Based on the results of the study, it was concluded that electronic comic media is effective in improving students' concept comprehension ability because it has met the criteria, namely (1) completeness of classical concept comprehension by 87.18%, (2) achievement of each concept comprehension indicator by 97.20%, 97.20%, 74.35%, and 69.23%, (3) improvement of concept comprehension ability with N-Gain by 0.73, and (4) positive response from students by 90.25%.

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