



## Development of HOTS-Based Learning Media Mikka (Komik Fisika) on Dynamic Fluid Materials

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### Abstract

Komik Fisika, hereinafter referred to as Mikka, is a learning medium in the form of comics with physics material by integrating High Order Thinking Skills (HOTS) skills. Research and development of this product is carried out with a waterfall design. This study aims to describe the feasibility of Mikka in terms of validity and effectiveness. The validity of the media is seen from the results of the validation instrument which is assessed by two validators with three aspects of assessment, namely learning aspects, material aspects, and media aspects. While the effectiveness of the media in terms of the questionnaire responses to research subjects, namely 22 students of class XI SMA Assa'adah Sampurnan Bungah Gresik and N-gain learning outcomes. The response questionnaire used consisted of usefulness, convenience, and satisfaction. Based on data analysis, it was found that Mikka's learning media had a validity percentage of 87.2% and was categorized as valid. In the aspect of effectiveness, Mikka is said to be very effective in being used in the learning process with an effectiveness percentage of 90.1% in terms of the response questionnaire and has a value of 0.35 qualified in terms of the calculation of the N-gain value. Thus, it can be concluded that Mikka's HOTS-based learning media on dynamic fluid materials is suitable for use in learning.

**Keywords:** Physics Comics, HOTS, Mikka

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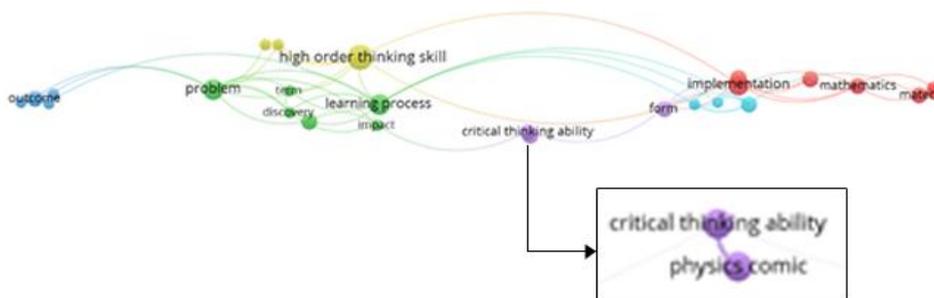
## INTRODUCTION

HOTS-based learning media implies better learning in the right skills, integrating, and connecting, connecting a concept in a scope that results in problem solving (Ariesta, 2018) (Saputra, 2016). HOTS skills are developed based on Bloom's Taxonomy at the process level of analyzing (analyzing), evaluating (evaluating), and creating (Setiawati, et al., 2019). From the third level of the process, students are required to know the skills of recalling information but more towards skills in being associated with different things, examining ideas and critically then processing and applying this information in problem solving. Cognitive competence by analyzing concepts, principles, laws, and applying metacognition to problem solving such as the nature of HOTS in learning physics in schools (Agustihana, 2018). In addition, it is very important for students to apply the knowledge gained during learning into real-life situations (Bagarukayo, et al., 2012). The application of knowledge into real-life situations is close to visualization in comics (Zurowati, et al., 2018).

Comics as learning media with their simple, clear, and easy-to-understand nature function as intermediaries in conveying learning by presenting the material and messages in it in an informative and educative manner (Waluyanto, 2006) (Rohani, 1997). Although they still use writing to show dialogue between characters and narration, the presentation of comics, which are mostly visual, makes it possible to provide a detailed picture of the object being studied. This advantage can be used in giving examples or analyzing objects/materials,

making it easier for readers to visualize objects/materials instead of using the narrative method, thus knowledge and HOTS-based learning can be done more easily.

In its development, research related to HOTS-based Physics Comics can be seen through bibliometric analysis using Vosviewer. The data used is Google Scholar RIS data from Publish or Perish with a range of the last 5 years (2018-2022). The search found 52 journals relevant to the keyword "HOTS Physics Comics". Research mapping is presented in the following figure:



**Figure 1.** HOTS Physics Comic Research Mapping from Vosviewer

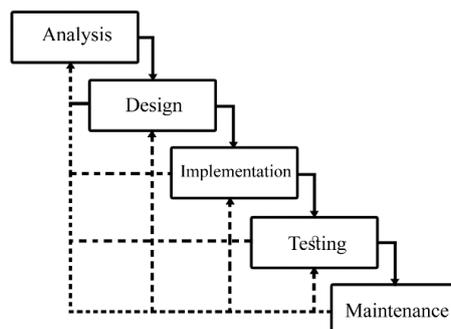
Based on the mapping obtained, the "physics comic" category has smaller nodes than the "High order thinking skills" category, which means that research on physics comics in the last 5 years has been less done than research on HOTS. In addition, the category of "high order thinking skills" is more related to many categories than "physics comic". The relationship with HOTS, physics comics are in a different cluster and far from the HOTS cluster, indicating that the relationship between the two is not very close, in fact both do not have a direct link. "physics comic" is only connected with the category of "critical thinking ability" which is one of the HOTS cognitive skills only. One example of research on "physics comics" and "critical thinking ability" is the research and development of comics conducted by Devi Retno Rosdiana and Abdul Kholiq (2021). The results obtained, comics are said to be able to improve students' critical thinking skills (Rosdiana & Kholiq, 2021).

Besides being able to improve critical thinking skills, comics that are close to the description of the application of knowledge in real-life situations (Bagarukayo, et al., 2012) have the potential to be further developed in training creative thinking skills. Thus, until the time of this bibliometric analysis, research on comic physics in relation to all HOTS cognitive skills (critical and creative) is an interesting novelty to be researched and developed. So that the difference between the physics comics developed in this study and the previous research lies in the skills developed. In this study, all HOTS cognitive skills were developed, namely critical thinking (analytical and evaluative) and creative thinking under the name Mikka (Komik Fisika).

Regarding the planning of Mikka's learning media development, 95% of the 22 students of class XI at SMA Assa'adah Sampurnan Bungah Gresik who are the subjects of this research consider the use of comics media in the learning process to be more enjoyable. In addition, 82% of students consider that digital media is more effective to use than print media so that the creation of digital Mikka learning media is able to become one of the interesting learning media and of course adapts to the digital era which is increasingly competing with various learning innovations. In the end, this research is intended to answer questions about the validity of Mikka's HOTS-based learning media on dynamic fluid materials and the effectiveness of the media. The validity of the media in terms of the results of the validity questionnaire while the effectiveness of the media in terms of the results of the student response questionnaire and the N-gain value.

## METHOD

The research method used is RnD (research and development). While the development design used is the Waterfall development model (waterfall). Waterfall design was first introduced by Herbert D. Benington (1956) and then presented visually by Dr. Winston W. Royce (1970) with 5 stages that are simplified and arranged systematically like a waterfall where each stage is carried out sequentially from top to bottom. The stages of the waterfall design consist of analysis (analysis), design (design), implementation (implementation), testing (testing), and maintenance (maintenance) (Benington, 1983) (Royce 1987) (Rahmaibu, et al., 2016). The waterfall model can be described as follows:



**Figure 2.** Simple Phase of Waterfall Research and Development Design by Herbert D. Benington

The results of the study in the form of the validity and effectiveness of the media were obtained at the testing stage. The validity of the media is done by testing the media to two validators using a validity sheet. The validity sheet used consists of three assessment aspects, namely learning aspects, material aspects, and media aspects. While the effectiveness test was carried out by giving questionnaires containing questionnaires about facts, opinions, perceptions and evaluations to 22 Assa'adah High School students who were research subjects. The response questionnaire used in the effectiveness test consisted of usefulness, convenience, and satisfaction. After the value of the validity and effectiveness of the media in terms of the responses of the research subjects is obtained, the percentage results can be calculated using the following formula (Arikunto, 2006) :

$$\text{Validity/effectiveness percentage} = \frac{\text{total score}}{\text{smax score}} \times 100\% \dots \quad (\text{equation 1})$$

Then the percentage obtained is matched with a Likert scale. The Likert scale is used to measure variables which are then translated into variable indicators in the form of questions or statements (Sugiyono, 2016). Media validity is carried out according to a Likert scale of 1-4 with a valid to invalid percentage qualification (Sudjana & Ahmad, 2001):

**Table 1.** Likert Scale 1-4 Media Validation

high percentage (%)	Validity qualification
80-100	Valid
60-79	Quite valid
40-59	less valid
0-39	Invalid

While the results of the percentage of the effectiveness of the media in terms of the responses of the research subjects were carried out by referring to the Likert scale 1- with the qualification of the percentage being very effective to very less effective (Riduwan, 2017).

**Table 2.** Likert Scale 1-5 Media Effectiveness

high percentage (%)	effective qualification
81-100	Very effective
61-80	Effective
41-60	Effective enough
21-40	Less effective
0-20	Very less effective

The effectiveness of learning media is also based on the N-gain value. The N-gain value in this study was used to measure how much the students' HOTS cognitive skills increased before the media was applied and after the media was applied to learning (Sundayana, 2014). The data used in the calculation of N-gain is the pretest and posttest value data from the one group pretest-posttest experiment at the testing stage by the research subject, namely 22 students of class 11 science at SMA Assa'adah Sampurnan Bungah Gresik. The questions given during the pretest and posttest are types of questions based on the level of thinking process of analyzing (C4), evaluating (C5), and creating (C6). According to Hake R.R (1999), the N-gain value is calculated using the formula (Hake, 1999):

$$\text{N-gain value} = \frac{\text{post test scores} - \text{pretest scores}}{100 - \text{score pretest}} \dots \quad (\text{equation 2})$$

Then the results of the N-gain value are then matched into the N-gain criteria table as follows:

**Table 3.** N-gain criteria

N-gain value	Qualification N-gain
$0,70 < \text{N-gain}$	High
$0,30 \leq \text{N-gain} < 0,70$	Medium
$\text{N-gain} < 0,30$	Low

## RESULTS AND DISCUSSION

The result of the product made in this research and development is in the form of learning media for physics comics integrated with HOTS with dynamic fluid content under the name Mikka (Komik Fisika). The product development stages are based on the Waterfall development model with the first stage in the form of analysis. At the analysis stage, the determination of indicators is enabled so that researchers can focus on achieving the competence of teaching materials/media (Hanum, 2017). The specified indicator is a reference that can direct the activities/visualization of learning in Mikka in accordance with HOTS skills. The indicators on Mikka's learning media are based on several categories of verbs according to the level of the process of analyzing (analyzing), evaluating (evaluating), and creating (creating) in Bloom's Taxonomy (Setiawati, et al., 2019), namely

**Table 4.** Indicators Developed in Mikka

Process level	Indicator
Analyzing (C4)	Distinguishing one concept from another Checking the problems that exist in an event or problem Formulate the equation/the right way to solve the problem
Evaluating (C5)	Organizing problems and solving Checking the problems that exist in an event or problem Planning a problem solving to a problem
Creating (C6)	Contribute a possible hypothesis to a problem Making the right choice in a problem solving Showing the design / problem solving for the problems that occur

From these indicators, Mikka was then formed through the design stage and implementation stage so that Mikka's finished form was produced in PDF (Portable Document Format)

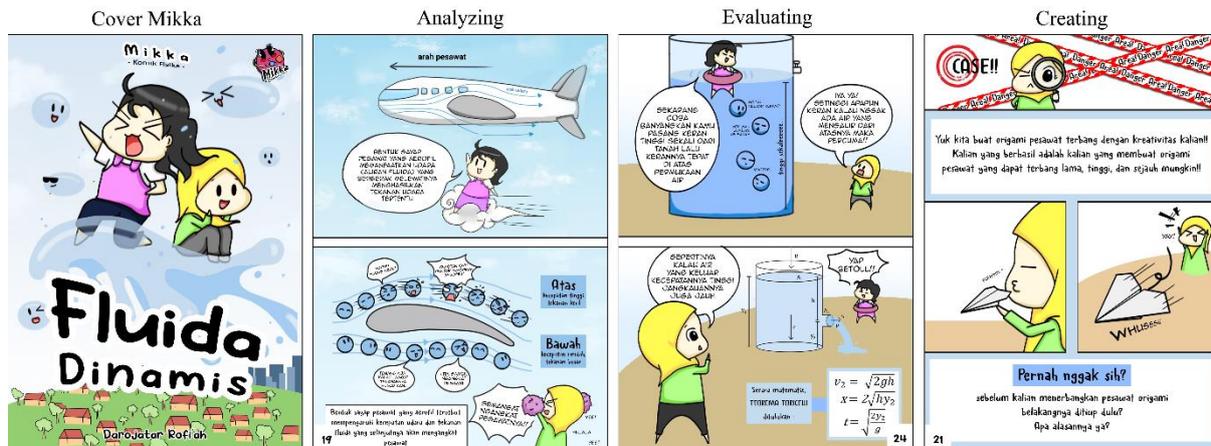


Figure 3 HOTS Skills in Mikka

Mikka's file is in PDF and then imported into the Flip PDF Professional application and then re-edited so that in visualization of its use Mikka looks like a book in digital form (FlipBook). The appearance of Mikka which has entered the final process and is ready to be used can be seen in the following image:



Figure 4. Mikka's product results

The result so Mikka is a file with EXE format. The selection of EXE as the final format of Mikka's learning media for researchers is expected to make it easier to package and distribute learning products/media in one well-compressed file. Meanwhile, students are expected to be able to become learning media that is easily accessible and used with laptops/computers without the need for supporting applications (Mawarni & Muhtadi, 2017) (Tompo, 2017).

The testing stage is the testing stage for the validator using a validity sheet with the aim of checking the product as a whole in order to minimize failures and errors. The validity sheet assessed by two validators has several assessment criteria which are grouped into 3 aspects and the data obtained in the following graph:

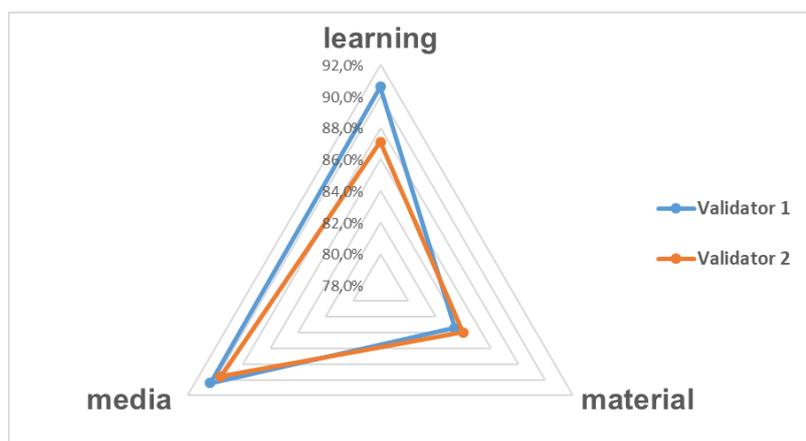


Figure 5 Mikka's Validity Graph of Two Validators

Each criterion in the aspect of validity assessment is assessed from a score of 1-5 positive statements with qualifications of 1 = not good, 2 = not good, 3 = quite good, 4 = good, and 5 = very good. Although each aspect is assessed by 2 validators In the Likert scale, the media validity is included in the valid category, the three aspects have different validity values. Both validators are more inclined to assess the media aspect with the highest validity and assess the material aspect with the lowest validity. Mikka with a high value of media aspect validity implies that Mikka has advantages in appearance, use, efficiency, and language. The low value of the validity of the material aspect becomes an evaluation for Mikka in improving the ease of learning the material, providing greater space for students to interpret ideas in real terms, and clarity of examples as a means of connecting HOTS skills development. From all aspects of the assessment, Mikka's HOTS-based learning media got a total validity percentage of 86.8%. This percentage falls into a Likert scale of 1-4 at 81%-100% which means that Mikka's overall learning media has valid qualifications.

In addition to conducting media validity, the testing phase is also carried out by providing products to users so that the effectiveness of Mikka's learning media can be taken from the data. The effectiveness test was carried out by giving a questionnaire containing a questionnaire about facts, opinions, perceptions and evaluations to 22 Assa'adah High School students. The following are the results of the effectiveness of the media by 22 students of SMA Assaadah class IPA 1 which are summarized in a graph:

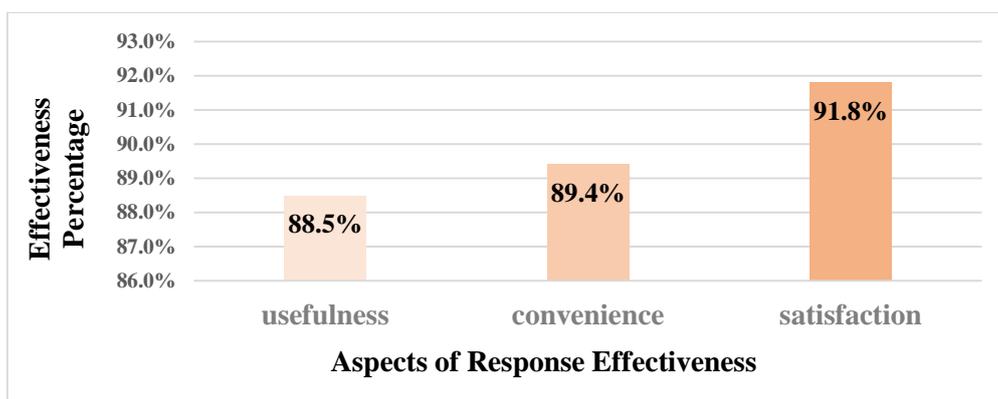


Figure 6. Effectiveness Response

Each criterion in the aspect of media effectiveness assessment is assessed from a scale of 1-4 with qualifications of 4 = strongly agree, 3 = agree, 2 = disagree, and 1 = strongly disagree. From the data obtained, the learning media can be analyzed for its effectiveness in terms of usefulness, convenience, and satisfaction. Although each aspect of effectiveness in the Likert scale has a very effective qualification, the three aspects have different levels of

effectiveness. The effectiveness with the highest percentage is found in the satisfaction aspect while the lowest effectiveness is in the usefulness aspect. In the aspect of satisfaction which has the highest percentage of effectiveness, Mikka excels in design, graphics and pleasant use. The low percentage value of the usability aspect becomes Mikka's evaluation in improving his presentation to train HOTS skills and providing space for students to evaluate. From all aspects of the assessment, Mikka's HOTS-based learning media has an effectiveness percentage of 90.1%. This percentage is included in the Likert scale of 1-5 at 80%-100% which means that overall Mikka (Physics Comics) is highly qualified to be used as a HOTS-based learning media.

Apart from being based on student responses, the effectiveness of the media is also based on the N-gain value. The N-gain test on 22 students of science class 1 SMA was conducted after it was known that the class was a normally distributed research subject with a significance value of less than 0.05. After the sample was declared to be normally distributed, the N-gain test was conducted to determine the effect that Mikka gave was a positive influence in the form of increasing students' cognitive learning outcomes, in this case the HOTS skills. The N-Gain test was carried out based on the pretest and posttest values using SPSS software, the data obtained were as follows:

**Table 5.** N-gain Test Calculation Results

pretest -	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2- tailed)	N-gain
				Lower	Upper				
posttest	-23.79	7.3845	1.5744	-27.0650	-20.5168	-15.1	21	0.000	0.35

The significance value (2-tailed) less than 0.05 is the rejection category of  $H_0$ , then the use of Mikka with a significance value of 0.000 in this study affects the cognitive learning outcomes of students. Calculation of N-gain obtained a value of 0.35, which means that the effect of the previous students' cognitive learning outcomes is a positive influence in the form of increasing HOTS skills with moderate qualifications (table 3). Descriptively, the improvement of students' HOTS skills at the level of the process of analyzing (C4), evaluating (C5), and creating (C6) can be analyzed through changes in the value of each type of question given during the pretest and posttest. Of the three types of questions, questions at the evaluation process level have a higher change in value than the others. This is because Mikka presents more evaluation skills through sample questions. Visualization of the material in Mikka also triggers the development of indicators of evaluation skills in the form of organizing problems and solutions, examining problems that exist in an event or problem, and planning problem solving for a problem (table 4). The results of the descriptive analysis are in accordance with research conducted by T.D Nanda which states that comics can train critical thinking in cognitive abilities of interpretation, analysis, evaluation, concluding, and explaining (Lesmono, et al., 2018). Compared to the indicators of evaluating and creating skills, in Mikka the indicators of evaluating skills dominate.

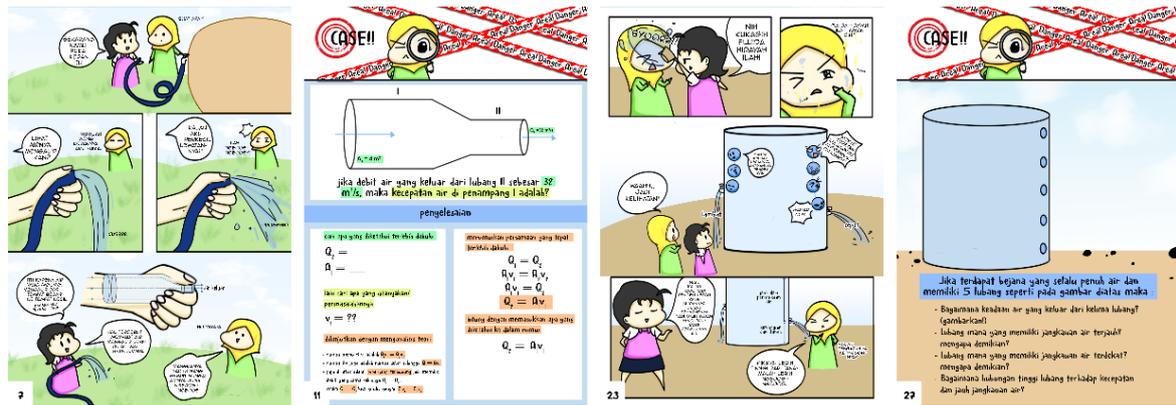


Figure 7 Evaluating Skills in Mikka

In contrast to the indicators of analyzing skills, indicators of creative skills are not presented in Mikka, resulting in changes in the value that occur in the types of questions in the pretest and posttest which have the lowest scores. The indicator of creative skill in question is contributing a possible hypothesis to a problem, making the right choice in solving a problem, and presenting the design/problem solving of the problems that occur (table 4). This is Mikka's evaluation at the last stage, namely the Maintenance stage.

Maintenance or maintenance stage is a stage that allows a researcher / product developer to evaluate the advantages and disadvantages of media. The advantages and disadvantages of the media are obtained through suggestions and opinions from 2 validators and 22 Assa'adah High School students. Overall, Mikka's media advantages lie in its fun, funny, interesting, and not boring appearance. The plot and visualization of the comics displayed in Mikka also provide an easy and clear understanding of studying physics in theory and its application in everyday life.

Mikka's media has a newness compared to other digital media, namely using a FlipBook display so that it triggers the enthusiasm to read to the end of the page. However, this novelty makes Mikka inflexible to use with smartphones because it can only be used with laptops/computers. The flexibility of using comics using a smartphone is found in the study of Instructional-Based Andro-Web Comics by A.D. Lesmono. The comics become alternative teaching materials for teachers using webtoon applications so that they can be used anywhere and anytime even though they need the internet to access them (Lesmono, et al., 2018). In this case Mikka in the form of a digital flipbook exe format has advantages in its practical use and can be accessed more easily without the internet and installing other applications (Mawarni & Muhtadi, 2017) (Aulia, et al., 2016). Apart from its advantages, Mikka's weakness lies in providing too many formulas with an unattractive presentation. Some of the explanations of Mikka's material are not understandable because they are too short. The Font Size in Mikka sometimes makes it difficult to read what is being conveyed.

In line with this research, using the same drawing style, research by A. Wahyuni in 2020 concluded that comics made as a physics learning medium for simple harmonic motion material are valid, practical, and have a potential impact on students' physics learning test results. (Wahyuni & Lia, 2020). In addition, research on comics by Mahya Zuhrowati in 2018 said that comics were interesting, easy to use, and effective in the learning process because their visual properties were very close to everyday life (Zuhrowati, et al., 2018). By using one of the HOTS cognitive skills, critical thinking, research by Devi Retno Rosdiana (2021) has shown that digital comics made are very feasible to be used as learning support media and help students think critically (Rosdiana & Kholiq, 2021).

**CONCLUSION**

Based on the research data that has been discussed previously, it can be proven that the HOTS-based Mikka learning media has valid and very effective qualifications in terms of the

response questionnaire and has a value of 0.35 with qualifications being reviewed from the N-gain calculation. In the end, Mikka's learning media was concluded to be suitable for use as a HOTS-based learning media with dominant evaluating cognitive skills.

## RECOMMENDATION

Suggestions for Mikka's learning media and improvement of future research to re-emphasize the explanation of the formula, rearrange Mikka's design/image so that it is not too crowded, add new characters and characters, add illustrations, simplify formulas, balance the HOTS competencies presented, and increase the variety of material provided by Mikka.

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