THE DEVELOPMENT OF E-BOOK USING FLIP PDF PRO THROUGH MISSOURI MATHEMATICS PROJECT MODEL TO IMPROVE METACOGNITION ABILITIES AND MATHEMATICAL SELF-EFFICACY OF DHARMA PANCASILA MEDAN HIGH SCHOOL STUDENTS

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Abstract

The aim of this research is to develop e-book learning media using flip pdf pro through the Missouri Mathematics Project (MMP) learning model which was developed to improve metacognitive abilities and mathematical self-efficacy of SMA Dharma Pancasila Medan students in a valid, practical and effective way. This type of research is the ADDIE (Analysis, Design, Development, Implementation and Evaluation) development model with a modification of Tessmer formative evaluation. The subjects in this research consisted of 2 classes, each consisting of 27 class 10th SMA Dharma Pancasila Medan students. The results of the research found that the e-book learning media using flip pdf pro through the MMP learning model which was developed to improve students' mathematical metacognition and self-efficacy skills was valid, practical and effective. The increase in metacognitive ability can be seen from the N-gain value increasing from trial I of 0.65 (Medium) to trial II of 0.74 (High). The increase in students' mathematical self-efficacy increased from trial I of 0.36 (Medium) to trial II of 0.45 (Medium).

Keywords: ADDIE, E-book, Metacognition, Missouri Mathematics Project, Self-Efficacy

Abstrak

Tujuan dari penelitian ini adalah mengembangkan media pembelajaran *e-book* menggunakan *flip pdf pro* melalui model pembelajaran *missouri mathematics project* (MMP) yang dikembangkan untuk meningkatkan kemampuan metakognisi dan *self-efficacy* matematis siswa SMA Dharma Pancasila Medan yang valid, paraktis, dan efektif. Jenis penelitian ini adalah model pengembangan ADDIE (*Analysis*, *Design, Development, Implementation,* dan *Evaluation*) dengan modifikasi evaluasi formatif Tessmer. Subjek dalam penelitian ini terdiri dari 2 kelas yang masing-masing berjumlah 27 orang siswa kelas X SMA Dharma Pancasila Medan. Hasil penelitian mendapatkan bahwa media pembelajaran e-*book* menggunakan *flip pdf pro* melalui model pembelajaran MMP yang dikembangkan untuk meningkatkan kemampuan metakognisi dan *self-efficacy* matematis siswa yang dikembangkan adalah valid, praktis dan efektif. Peningkatan kemampuan metakognisi dilihat dari nilai *N-gain* meningkat dari uji coba I sebesar 0.65 (Sedang) ke uji coba II sebesar 0.74 (Tinggi). Peningkatan *self-efficacy* matematis siswa meningkat dari uji coba I sebesar 0.36 (Sedang) ke uji coba II sebesar 0.45 (Sedang).

Kata kunci: ADDIE, E-book, Metakognisi, Missouri Mathematics Project, Self-Efficacy
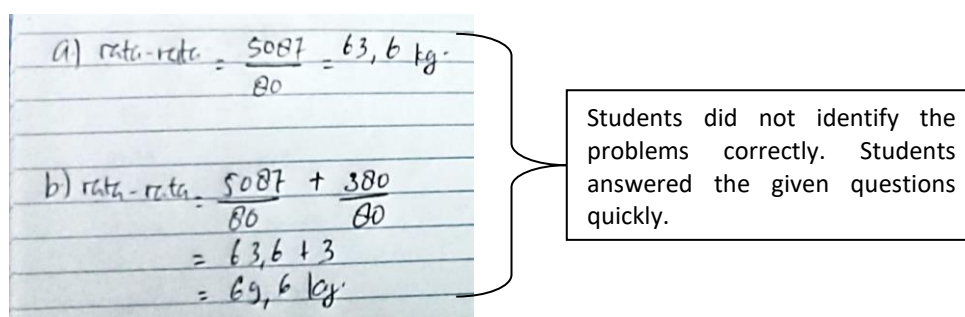
INTRODUCTION

Education can be interpreted as a process or activity that changes someone's behavior. Apart from that, education is also expected to help prepare someone to face the changes that will occur. One subject that must be taught in education is mathematics. Mathematics is a universal science and is the basis for the progress of modern science and technology (Hasratuddin, 2015). From elementary school through high school and on through college, all students should learn mathematics because it is a means of explicit logical thinking, a means

of solving everyday problems, and a means of fostering creativity (Abdurrahman, 2011). However in reality there are still many students who do not like or avoid mathematics subjects. This is because many students find it difficult when working on the mathematics problems given. Referring to the views of Wulandari (2020) that mathematics is a subject that some people fear because of the use of many formulas and mathematics is a subject that prioritizes the process of thinking to learn something logically and systematically.

One of the mathematical abilities that every student must have is metacognition. Metacognition is the ability to monitor and control one's understanding of thought processes. Metacognition is defined as what one thinks about. According to Flavell (1976), metacognition includes metacognitive knowledge and metacognitive experience or rules. According to Papaleontiou (2008) metacognition is awareness of different ways of thinking and the ability to develop in-depth practical knowledge in order to function more effectively. Metacognition skills include the ability to recognize and correct errors in students understanding while identifying and using effective learning strategies in the context of mathematics. Students with good cognitive skills in this subject can monitor and reflect on their understanding of mathematical material to make improvements and changes.

Metacognition is basically related to two aspects of thinking, namely the knowledge a person has about their thoughts (cognition self-awareness), and a person's ability to control their conscience and regulate their cognitive processes (Cognition self-regulation) (Bruning., et al, 1995). Schoenfeld (1987) also put forward several explanations of metacognition in mathematics learning: (a) Beliefs and intuitions. What mathematical ideas prepare you for a job in mathematics and how do these ideas shape the way you do mathematics; (b) Your knowledge of mental processes, how accurately do you express your thoughts?; (c) Self-awareness or self-regulation, how well do you track what needs to be done (e.g. anxiety) and how well do you use input from observations to direct what actions to take?. According to the findings of Suryaningtyas & Setyaningrum (2020), almost all students have low metacognitive skills and still do not utilize them. According to the findings of Zakiah (2020), the level of metacognitive skills of students is still low. This is because teachers are still monotonous in the classroom and do not use a variety of teaching methods in the teaching and learning process. Teachers provide material directly in class and give practice assignments and homework.

Researchers provide metacognitive ability questions to see how students solve problems given in statistics material based on indicators of metacognitive ability according to Schraw (1998), namely: 1) Planning is choosing the right strategy and providing ways to influence the outcome. Examples include: assessing step assignment or sequencing strategies and timing before reading; 2) Monitoring refers to an individuals awareness of behavior and its consequences. For example you have the ability to go inside while studying. 3) Evaluation refers to evaluating learning outcomes and validity. One of the answers given by students is as follows.

Figure 1. The result of one students answer

According to the answers students did not understand the question properly and did not write what they know and the issues raised in the question. Moreover students often fail to choose the correct strategy while answering the question and immediately write the answer to the question without taking any steps to solve the problem. This means that students do not remember their previous knowledge. According to the results of the solution the student did not answer the question with the expected good or correct answer.

Mathematics self-efficacy is also an important factor for successful mathematics learning. Mathematics self-efficacy is believed to affect an individuals ability to perform mathematical tasks. Students who have high self-efficacy in mathematics have strong motivation to solve mathematical problems and will not give up when faced with a problem. According to Zimmerman (2000), self-efficacy increases students motivation to learn through self-regulation which is the process of goal-setting, self-monitoring, self-evaluation, and application strategies. Several factors influence self-efficacy, including age, gender, experience and level of education. Self-efficacy refers to one's perception or evaluation of one's ability to organize and carry out tasks to demonstrate the skills necessary to achieve certain goals. According to Bandura (1998) the characteristics of an individual's self-efficacy

are based on four sources: 1) successful experiences; 2) other people's experiences. 3) Social perspective. 4) Physical and emotional state. By developing these four sources you can influence a person's self-efficacy. Mukhid (2009) self-efficacy is an important element underlying human behavior and states that what people think believe and feel influences their behavior. Zalkosky (2009) asserts that self-efficacy refers to the perception or evaluation of an individuals ability to achieve specific goals. People with high levels of self-efficacy are confident that they can complete tasks and find the right answers to achieve goals and are people who do not give up easily when solving complex problems.

The Missouri Mathematics Project (MMP) is a learning model that can improve students' metacognition abilities and mathematical self-efficacy. The MMP model is a program designed to help teachers effectively use exercises so that students achieve extraordinary improvements. Another opinion according to Tasci (2015) states that the MMP learning model is a core design approach for schools that encourages children to learn about their environment in an experimental and hands-on way. This is demonstrated by the provision of worksheets for math projects that include questions about applied math exercises for students to complete. Good and Grows (1979), suggested that MMP focuses on how teacher activities influence student outcomes and follows the process-product paradigm. With project assignments, students are expected to be able to develop metacognitive abilities and gain experience in solving various mathematical problems.

The use of the MMP model in the teaching and learning process can improve students' metacognitive abilities and mathematics self-efficacy. This is supported by Sani., et al (2020) research with the conclusion that the MMP model has better metacognition abilities than students treated with other learning models. Suri., et al (2023) research results concluded that the MMP learning model was effective and could increase students' mathematical self-efficacy. The main characteristic of the MMP model is in controlled practice, which in this case is related to metacognitive abilities which are seen based on metacognitive ability indicators, namely: 1) Planning, students can determine what is known about given problems and questions and identify appropriate strategies to solve the given problems; 2) Monitoring, where students can realize that the work steps are correct according to the strategy that has been determined, and understand the concept of the problem given; 3) Evaluation, where students can think about and express/write down the methods used to check the correctness

of the results, and students can check whether what was done to check the correctness of the results is correct.

Flip PDF Professional is software that can create mathematics learning media in the form of e-books to help the learning process in class. According to Hanikah., et al, (2022), e-books are computer programming books that use illustrations and animations to present complex content to make the content easier to understand increase learning motivation and ultimately improve student learning outcomes. Meanwhile, Yusminar (2014), E-books are basically traditional printed books but in the form of electronic versions that can be used in computer programs and other computing devices. The role of the e-book with flip pdf pro which was developed to improve metacognition skills is the presence of project assignment sheets. This project assignment sheet can help students improve metacognitive abilities based on the relationship between the MMP learning model and existing indicators of metacognitive abilities. When working on a project assignment sheet, the teacher is also involved in it by monitoring and controlling every activity carried out by students in solving existing problems. Using the MMP Model in e-book development also has its own advantages. The MMP model encourages students to be actively involved in mathematics learning through a project-based approach. This model requires students to use mathematical concepts in the real world and think critically and collaboratively. This helps students strengthen their cognitive thinking correct mistakes and develop confidence in math tasks.

METHODS

This type of research uses the Research and Development (R&D) model. This research uses the ADDIE development model using the Tessmer formative evaluation method. This research focuses on developing e-books using Flip PDF Pro through the Missouri Mathematics Project (MMP) model to improve students' metacognitive abilities and mathematical self-efficacy. The subjects in this research are class statistical material. The instruments of this research are lesson plan, student worksheets, metacognition ability tests and mathematical self-efficacy questionnaires. As for instrument validation, there were 4 validators, namely 3 mathematics lecturer at Medan State University and 1 mathematics study teacher. Data analysis techniques are carried out through the use of learning media validity, learning

practicality and learning media effectiveness. The results of the validation assessment by experts will be analyzed based on Yahya., et al (2020) as follows.

$$K = \frac{\sum_{i=1}^{N} R_i}{N} X \ 100\%$$

The validation percentage results are grouped by score interpretation criteria as follows.

Table 1. Feasibility Interpretation Criteria

Category	Interpretation Criteria
81% ≤ K ≤ 100%	Very Feasible
61% ≤ K < 81%	Eligible
41% ≤ K < 61%	Adequate
21% ≤ K < 41%	Not Eligible
0% ≤ K < 21%	Very Infeasible

Practicality was obtained from the results of observing the implementation of learning using e-books which were developed according to Sinaga (2007).

$$\bar{O} = \frac{\sum_{j=1}^{m} P_j}{m}$$

The results obtained are categorized according to Sinaga (2007) as follows.

Table 2. The Level of Learning Implementation Criteria

Learning Implementation Level	Implementation Criteria
$1 \leq \bar{O} < 2$	Not implemented
$2 \leq \bar{O} < 3$	Not well implemented
$3 \leq \bar{O} < 4$	Well done
$\bar{O} = 4$	Very Well done

The e-book being developed is said to be practical if the minimum learning implementation average is in the 'Well Done' category, namely in the range $(3 \leq \bar{O} < 4)$. Effectiveness analysis is carried out by measuring student learning completeness. The value of students' knowledge and skills can be obtained using the following formula.

$$SKM = \frac{SP}{ST} \times 100$$

A class completes learning if the PKK obtained by students is ≥ 80% (Siswono, 2019). Calculating learning completeness is classically formulated based on Trianto (2010) as follows.

$$DSK = \frac{\sum_{i=1}^{N} M_i}{N} \times 100 \ \%$$

The criteria that state students have completed if they are more than or equal to 80% have an average score of at least 75. To find out the percentage of students' self-efficacy level, this can be done by using a questionnaire that has been filled in and then looking for the

students' average score on a scale of 100 each student based on Sudjana (2005) with the following formula.

$$\overline{RS} = \frac{\sum_{i=1}^{N} S_i}{N} \times 100$$

The criteria for students' self-efficacy level in mathematics learning modified from Sunaryo (2017) as follows.

Table 3. Self-Efficacy Level Criteria

Interval Score	Interpretation Criteria
$81 \leq \overline{RS} \leq 100$	Very High
$61 \leq \overline{RS} < 81$	High
$41 \leq \overline{RS} < 61$	Medium
$21 \leq \overline{RS} < 41$	Low
$0 \leq \overline{RS} < 21$	Very Low

Analyze student response data to the developed learning media to understand their reactions to its use. The data obtained used the Guntman scale with the option "Yes" for positive response criteria and the option "No" for negative response criteria with the formula according to Trianto (2017) as follows.

$$RS = \frac{\sum_{i=1}^{N} A_i}{N} \times 100\ \%$$

The N – Gains analysis is intended to determine the increase in students' metacognition abilities and mathematical self-efficacy from before to after using the developed e-book. The formula for calculating N-gain based on (Hake, 1999) is as follows.

$$g = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}}$$

The interpretation of the N-gain calculation based on Hake (1999) is as follows.

Table 4. N-Gain Classification

Magnitude g	Category
$g < 0{,}3$	Low
$0{,}3 \leq g \leq 0{,}7$	Medium
$g > 0{,}7$	High

RESULTS AND DISCUSSION

The product developed from this research is an e-book on statistics material for class 10th students at SMA Dharma Pancasila Medan which is valid, practical and effective with the help of flip pdf pro software. The e-book developed is published in Hypertext Markup Language 5 (HTML5) where the data is easily accessed via Android devices and computers. This e-book consists of teaching materials, example questions, teaching videos, student

project assignments, practice questions and is designed with an attractive design so that it will make students more interested in learning mathematics. Analysis of research data obtained at each stage of development will be presented as follows.

1. Analysis Stage

The first stage is analysis where the results of the analysis will be used as consideration in preparing the e-book to be developed. This analysis takes the form of analysis of school needs, analysis of student characteristics, curriculum analysis, and analysis of learning media.

2. Design Stage

The design stage is the stage where the e-book is designed and how the learning media components to be developed are arranged and designed so that they can be used effectively and efficiently. One of the main success factors of developing learning media lies in the design phase. This stage is also related to the content of the media and the content of the teaching materials, so that there is no double meaning in the e-book being developed.

3. Development Stage

Validation is carried out by verifiers who are mathematics teachers and namely 3 mathematics lecturer at Medan State University. The validation process includes validating the media appearance and validating the content of the material in the learning media. The results obtained are presented as follows.

Table 5. Learning Media Validation Results by Experts

Appraised Object	Percentage of Validation Results	Information
Media Expert	87.77%	Eligible/Valid
Material Expert	88%	Eligible/Valid
Lesson Plan	88.82%	Eligible/Valid
Student worksheets	89.25%	Eligible/Valid
Metacognition Ability Test	90%	Eligible/Valid
Mathematical Self-Efficacy Questionnaire	91.25%	Eligible/Valid

Table 5 shows that media expert validation is 87.77%, teaching material expert validation is 88%, lesson plan validation is 88.82%, student worksheets validation is 89.25%, metacognitive ability test validation is 90%, and validation of the mathematical self-efficacy questionnaire was 91.25%. Overall it can be said that the validation results provided by the validators obtained results in the Eligible/Valid category. Next, to see the appearance of the learning media being developed, see Figure 2 below.
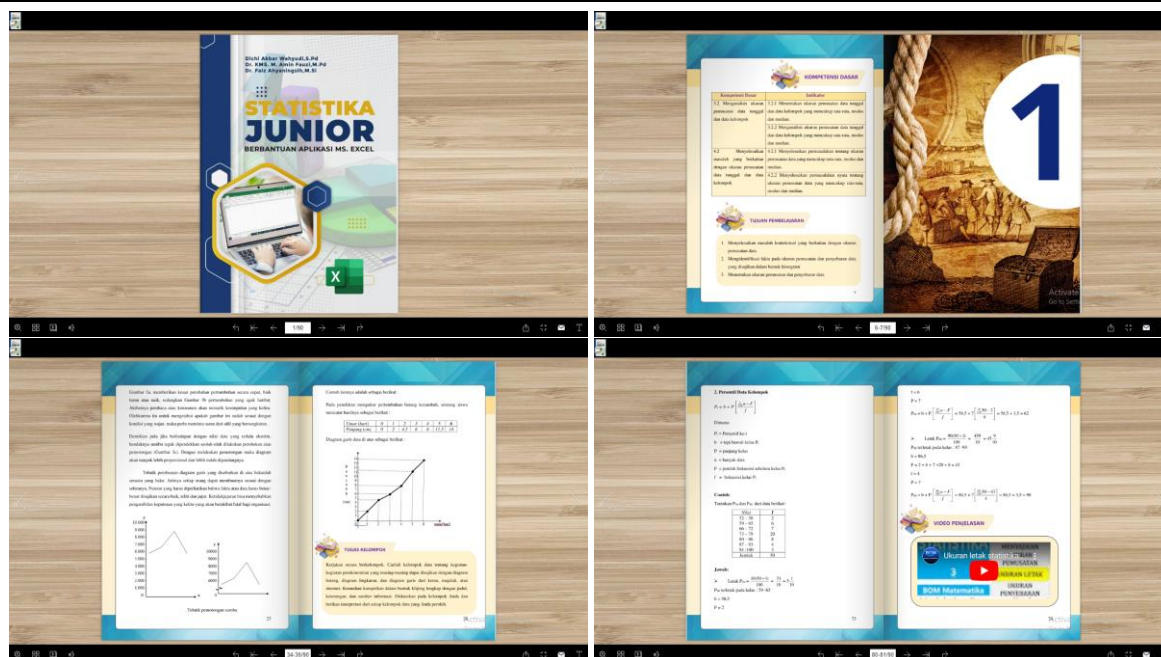
Figure 2. Several views of learning media

The research instrument was tested in a classroom outside the sample before being used for field testing, namely class 12th at SMA Dharma Pancasila Medan who had previously studied statistics material, then validity and reliability tests were carried out.

a. Question Item Validity Test Results

The validity of a question is based on the relationship between the question point score and the total score using the mutual significance formula. Below are the results of the metacognitive ability test.

Table 6. Validity of Pretest and Posttest Items for Metacognition Ability

Test Item	Pretest		Posttest		t_{table}	Interpretation
	r_{xy}	t_{Count}	r_{xy}	t_{Count}		
1	0.838	7.977	0.848	8.298	1.073	Significant/Valid
2	0.855	8.561	0.878	9.537	1.073	Significant/Valid
3	0.925	12.684	0.675	4.757	1.073	Significant/Valid
4	0.892	10.258	0.635	4.273	1.073	Significant/Valid

Based on the Table 6 above, with a significance level of 5%, *dk* = 32-2=30, we get t_{table} = 1.073. If we refer to the testing criteria, $t_{count} > t_{table}$ then for all metacognition ability test items can be used or are valid. The results obtained are as follows.

Table 7. Metacognition Ability Reliability Test Results

Test	Koeficient Reliability	Interpretation Scores	Information
Pretest	0.803	$0,80 < r_{11} \leq 1,00$	Very High
posttest	0.758	$0,60 < r_{11} \leq 0,80$	High

From the Table 7 above, The reliability of the metacognitive ability test for the pre-test was 0.803 with a very high interpretation, while for the post-test it was 0.758 with a high interpretation.

b. One to One and Small Group Trials

One to One and Small Group test were carried out before field trials. This stage carried out a limited trial of the e-book that had been developed for students who were experimental subjects. The results of this implementation are used to revise the designs that have been created and the material used is statistics. Researchers chose students from class 2 persons. The results of this trial are used to find out whether the e-book that has been prepared can be understood by students, avoiding ambiguity/dual meanings so that they can understand the meaning and can answer questions correctly. The results obtained are as follows.

Table 8. Results of One to One and Small Group Trials

Trials	Average Percentage (%)	Information
One to One	85.56	Eligible/Valid
Small Group	85.93	Eligible/Valid

Based on Table 8 above, the overall average score for One to One trials was 85.56% and for Small Group trials was 85.93% with the Eligible/Valid criteria. The results of the One to One test and Small Group test will be revised according to suggestions given by students before the field test is carried out.

4. Implementation Stage

After analyzing the results of expert validation and making improvements to the ebook being developed and testing equipment that meets valid criteria, it will enter the implementation stage. Implemtation stage, learning media and research instruments are used in field tests to determine their usefulness and validity in the learning process. The test was carried out twice, namely Field Test I (Class 10th-3) and Field Test II (Class 10th-1).

a. Practicality of Learning Media

In this research, the implementation of learning using e-books with the MMP learning model developed is reviewed from 3 aspects of observation, namely: a) implementation of learning steps, b) implementation of social systems, and c) implementation of management reaction principles with the support system provided. The results obtained are as follows.

Table 9. Practicality Test Results of Trials I and II

Trials	Average Category Trial	Category
I	2.96	Not well implemented
II	3.56	Well done

Based on Table 9, it was found that In Trial I, the practicality results were in not well implemented category with an average score of 2.96. Meanwhile, in Trial II, the average score was 3.56, placing it in the well done category.

b. Effectiveness of Learning Media

Effectiveness is seen from classical learning completion, student response questionnaires, and the results of mathematics self-efficacy questionnaires.

1) Students' Classical Learning Completeness

Students' classical learning mastery is seen from the percentage of students who pass after being given a posttest. The results obtained are as follows.

Table 10. Pretest and Posttest Achievement Levels of Students' Mathematical Metacognition Ability

Trial	Average Class		Students Who Complete Classical	Classical Achievement Percentage	Improvement	Category
	Pretest	*Posttest*				
I	30.32	75.39	15	55%	0.65	Medium
II	42.90	85.03	22	81.5%	0.74	High

Based on Table 10, it shows that 55% of students completed classical learning in Trial I, while 81.5% in Trial II. The increase in students' mathematical metacognitive abilities in Trial I was classified as moderate, namely 0.65. In contrast, the increase in Trial II reached 0.74. In the classical learning mastery test, more than 80% of students obtained a score of 75 or more from the KKM after using the learning media developed. In this case, the effectiveness of the learning media developed in Trial II was in accordance with the expected level of achievement.

2) Student Response

After being given a student learning outcomes test (posttest), students were asked to fill out a special questionnaire for the e-book being developed. The results obtained are as follows.

Table 11. Results of Student Response Questionnaire

Trial	Positive Responses	Negative Responses
I	80.74%	19.26%
II	84.44%	15.56%

Table 11 shows students' positive responses to the use of the e-book being developed, namely 80.74% in Trial I and 84.44% in Trial II. Overall the developed learning media had a positive impact on the students with more than 80% students in each class responding positively to the developed learning media.

3) Mathematical Self-Efficacy Questionnaire

The results of the mathematics self-efficacy questionnaire before and after students received treatment are as follows.

Table 12. Description of Student Mathematical Self-Efficacy Questionnaire Data

Trial	Average Class		Achievement of High Category Student Self-Efficacy	Improvement	Category
	Pre	Post			
I	50,33	68.41	48.15%	0.36	Medium
II	51,19	72.96	52%	0.45	Medium

Based on Table 12, it shows that there was an increase in mathematics self-efficacy in Trial I in the high category by 0.36 and in Trial II by 0.45 in the medium category.

Overall, Trial I was deemed not valid based on the results of the Classical Learning Completeness Analysis, Response Questionnaire Analysis, and Mathematics Self-Efficacy Questionnaire Analysis. On the other hand, Trial II was declared effective based on these effectiveness parameters. So it can be said that e-books using Flip Pdf Pro through the Missouri Mathematics Project (MMP) learning model are "effective".

5. Evaluation Stage

At the evaluation stage, errors and deficiencies found during the research process are analyzed and used as consideration in improving the learning media being developed. The evaluation takes the form of an assessment using media validation sheets and validation of teaching materials, as well as opinions and suggestions for improving the learning media being developed to make it even better. Furthermore, as consideration for evaluation, the practicality sheet and response questionnaire given to students are used to revise the media being developed. This evaluation stage is intended to perfect the learning media that has been developed.

CONCLUSION

The validity of the e-book using Flip PDF Pro through the Missouri Mathematics Project (MMP) learning model developed is included in the valid category. Research instruments which include lesson plans, student worksheets, metacognitive ability tests and mathematical self-efficacy questionnaires are included in the valid and reliable categories. The e-book developed meets the practicality criteria in analyzing the results of observations of learning implementation. The e-book with the MMP model developed meets the validity criteria in terms of: (1) achievement of students' metacognitive abilities, (2) students' response to the e-book, and (3) achievement of students' self-efficacy. E-books with the developed MMP learning model have an increase in students' metacognitive abilities and mathematical self-efficacy which are categorized as Medium.

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