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ANALYSIS OF FLIPBOOK MATHEMATICS LEARNING MEDIA IN IMPROVING STUDENTS' CRITICAL THINKING SKILLS

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Abstract
This research and development study aims to determine the condition of students' critical thinking skills in mathematics learning and analyze the effectiveness of the results of developing flipbook-based mathematics learning modules in improving critical thinking skills. This research method uses the RnD approach, namely research carried out by developing flipbook-based learning modules. The development procedure model adapts the Borg and Gall development model, 1) research and data collection; 2) Implementation of planning 3) development of original products; 4) conducting initial field trials; 5) Check the original product; 6) conducting limited field trials; 7) making other product versions; 8) conducting functional field tests; 9) Check the final product; and 10) carrying out production and implementation.The determination of the subject used the Simple Random Sampling technique, which is taking samples from the population randomly without considering the strata in the population. The subjects of this study were 83 students from the pretest and posttest classes. Based on the results of the study, the conditionsMathematics learning at SMA MTA Surakarta, many students have difficulty developing critical thinking skills. Students feel bored and uninterested in following mathematics lessons, because there is no variation in learning (monotonous). In addition, it turns out that there are no modules that can be used by teachers and students other than LKS. In the needs analysis, it was discovered that students and teachers needed a new module that could be applied with current technological advances. The test results showed a t-value of -11.230 and a Sig. (2-tailed) value of 0.000. This can be concluded that there is a significant difference between the pretest and posttest groups. So it can be concluded that Flipbook-based mathematics learning modules are effective in improving critical thinking skills.
Keywords: Development, Learning Modules, Mathematics, Flipbook, Critical Thinking

Abstrak
Penelitian riset dan pengembangan ini bertujuan untuk mengetahui kondisi kemampuan berpikir kritis siswa dalam pembelajaran matematika dan menganalisis efektivitas hasil pengembangan modul pembelajaran matematika berbasis flipbook dalam meningkatkan kemampuan berpikir kritis. Metode penelitian ini menggunakan pendekatan RnD, yaitu penelitian yang dilaksanakan dengan mengembangkan modul pembelajaran berbasis flipbook. Model prosedur pengembangan mengadaptasi model pengembangan Borg and Gall, 1) penelitian dan pengumpulan data; 2) Pelaksanaan perencanaan 3) pengembangan produk asli; 4) melakukan uji coba lapangan tahap awal; 5) Periksa produk asli; 6) melakukan uji coba lapangan terbatas; 7) membuat versi produk lain; 8) melakukan uji lapangan fungsional; 9) Periksa produk akhir; dan 10) melakukan produksi dan implementasi. Penentuan subjek menggunakan teknik Simple Random Sampling, yaitu pengambilan sampel dari populasi secara acak tanpa memerhatikan strata yang ada dalam populasi tersebut. Subyek penelitian ini 83 siswa dari kelas pretest dan kelas posttest. Berdasarkan hasil penelitian, kondisi pembelajaran Matematika di SMA MTA Surakarta, banyak siswa yang kesulitan mengembangkan kemampuan berpikir kritis. Siswa merasa jenuh dan tidak tertarik mengikuti pelajaran matematika, karena tidak ada variasi dalam pembelajaran (monoton). Selain itu, ternyata juga tidak ada

modul yang dapat digunakan oleh guru dan siswa selain LKS. Pada analisis kebutuhan, barulah diketahui bahwa siswa maupun guru memerlukan adanya modul baru yang bisa diterapkan dengan kemajuan-kemajuan teknologi yang ada sekarang. Hasil uji menunjukkan nilai t_{hitung} sebesar -11.230 dan nilai Sig. (2-tailed) sebesar 0.000. Hal ini dapat disimpulkan ada perbedaan yang signifikan antara kelompok pretest dan kelompok postest. Sehingga dapat disimpulkan bahwa modul pembelajaran matematika berbasis flipbook efektif dalam meningkatkan kemampuan berpikir kritis.
Kata Kunci: Pengembangan, Modul Pembelajaran, Matematika, Flipbook, Berpikir Kritis

INTRODUCTION

Critical thinking skills in mathematics are very important because they are the basis for solving problems and making the right decisions.[1] A deep understanding of mathematical concepts involves not only the ability to memorize formulas, but also to analyze, evaluate, and interpret information in a logical and structured manner.[2] In the context of mathematics education, critical thinking enables students to connect ideas and principles that may seem unrelated, and to apply appropriate strategies in solving problems. A study conducted[3] shows that developing critical thinking skills can significantly improve understanding of mathematical concepts and problem-solving skills. Therefore, strengthening these skills is very necessary, especially in mathematics learning which aims to prepare students to face real-life challenges that require decisions based on logic and sharp analysis. By integrating critical thinking skills in mathematics learning, students will not only be able to solve problems correctly, but also be able to develop cognitive skills that are useful in various fields.

In addition, critical thinking skills in mathematics also play a role in increasing students' creativity and flexibility of thinking. The critical thinking process facilitates students not to only focus on one method or approach in solving problems, but to explore various alternative solutions

[1] Ardi Ardi et al., "Validity and Reliability Questionnaire of Students' Critical Thinking Skills in General Biology Course," *Jurnal Penelitian Pendidikan IPA* 9, no. 3 (2023): 1436–44, https://doi.org/10.29303/jppipa.v9i3.2761; L L Huda et al., "Analisis Kemampuan Berpikir Kritis Matematis: Dampak Pembelajaran Treffinger Berbantuan Media Audio Visual," *MAJU: Jurnal Ilmiah Pendidikan Matematika* 8, no. 1 (2021): 8–18; Retno Andriyani and Nisvu Nanda Saputra, "Optimalisasi Kemampuan Higher Order Thinking Skills Mahasiswa Semester Awal Melalui Penggunaan Bahan Ajar Berbasis Berpikir Kritis," *Al-Khwarizmi: Jurnal Pendidikan Matematika Dan Ilmu Pengetahuan Alam* 8, no. 1 (2020): 77–86, https://doi.org/10.24256/jpmipa.v8i1.948.

[2] Arista Suriati et al., "Analisis Kemampuan Berpikir Kritis Pada Siswa Kelas X SMA Islam Kepanjen," *Rainstek Jurnal Terapan Sains Dan Teknologi* 3, no. 3 (2021): 176–85, https://doi.org/10.21067/jtst.v3i3.6053; Wahyu Wulandari and Attin Warmi, "Kemampuan Berpikir Kritis Siswa Dalam Menyelesaikan Soal Pisa Konten Change And Relationship Dan Quantity," *Teorema: Teori Dan Riset Matematika* 7, no. 2 (2022): 439–52, https://doi.org/10.25157/teorema.v7i2.7233.

[3] Rizki Dwi Siswanto and Rega Puspita Ratiningsih, "Korelasi Kemampuan Berpikir Kritis Dan Kreatif Matematis Dengan Kemampuan Pemecahan Masalah Matematis Materi Bangun Ruang," *ANARGYA: Jurnal Ilmiah Pendidikan Matematika* 3, no. 2 (2020): 96–103, https://doi.org/10.24176/anargya.v3i2.5197.

and test the validity of each approach they choose. This is important because many mathematical problems, especially at advanced levels, do not have one definite answer, but rather involve various possibilities that must be considered carefully. A study by Wardani[4] and Retnawati et al.[5] highlighted that students who were trained to think critically were better able to adapt their strategies when faced with complex problems, which ultimately helped them to more easily reach deeper understanding and more appropriate solutions.

The importance of critical thinking in mathematics is also seen in its contribution to the development of other skills, such as the ability to work collaboratively and communicate effectively. In many cases, solving mathematical problems involves discussions or debates between individuals with different approaches or perspectives. In these situations, the ability to think critically is essential so that individuals can identify valid arguments, suggest alternatives, and ask relevant questions. Therefore, mathematics education that emphasizes the development of critical thinking skills not only results in more efficient problem solving but also equips students with analytical thinking skills that are useful in various aspects of their lives. This supports the findings by Hidayat et al.,[6] who suggests that teaching that focuses on developing critical thinking skills can produce students who are more skilled at collaborating and discussing in the context of mathematics learning.

Critical thinking skills that involve analyzing, evaluating, and reflecting on information greatly support the use of flipbooks as a tool in mathematics learning. One of the main elements of critical thinking is the ability to break down problems into smaller parts, identify assumptions or biases, and evaluate possible solutions. Flipbooks provide a space that allows students to systematically record and visually illustrate their problem-solving steps. This supports a deeper thinking process because students can see, modify, and reflect on each step in solving the problem directly, thereby strengthening their analytical and evaluative skills.

In addition, flipbooks allow students to organize information in a flexible and structured way, which is essential for critical thinking. The process of writing and drawing in a flipbook requires students to not only construct a solution, but also to explain and articulate the reasoning behind each step they take. In this way, flipbooks encourage students to not only seek the final answer, but also to think logically and critically about the process they went through to get there. This provides an opportunity for students to explore different approaches to solving mathematical

[4] Dewi Ayu Wisnu Wardani, "Problem Based Learning: Membuka Peluang Kolaborasi Dan Pengembangan Skill Siswa," *Jawa Dwipa* 4, no. 1 (2023): 1–17, https://doi.org/10.54714/jd.v4i1.61.

[5] Heri Retnawati et al., "Teachers' Knowledge about Higher-Order Thinking Skills and Its Learning Strategy," *Problems of Education in the 21st Century* 76, no. 2 (2018): 215–30.

[6] Mansyur Hidayat et al., "Pengembangan E-Modul Berbasis Web Untuk Mendukung Kemampuan Representasi Matematis Untuk Meningkatkan Karakter Mandiri Dan Critical Thinking," *Jurnal Pendidikan Transformatif* 2, no. 4 (2023): 521–40, https://doi.org/10.9000/jpt.v2i4.635.

problems, consider the strengths and weaknesses of each approach, and make more informed and informed decisions. Thus, flipbooks are a very effective tool in developing critical thinking skills, as they facilitate a process that involves in-depth analysis and reflection on each step in solving a mathematical problem.

The choice of flipbooks as a tool to develop critical thinking skills in mathematics is based on their ability to present information visually and structured in an interactive way. While there are many other options, such as digital applications or traditional textbooks, flipbooks offer the advantage of providing a more concrete and hands-on learning experience. With flipbooks, students can physically manipulate and organize information, which strengthens their cognitive processes in understanding the relationships between mathematical concepts. In addition, flipbooks allow students to gradually see and evaluate the steps they take in solving problems, which is the essence of critical thinking.

In the context of critical thinking, flipbooks provide a space for students to visually and sequentially describe their problem-solving process. They can write notes, create diagrams, or organize ideas in a systematic way, making it easier to identify errors or flaws in their logic. This is in contrast to other, more passive methods, such as the use of digital applications, which sometimes provide less opportunity for students to think reflectively and deeply. Research by Firdaus et al.,[7] and Marwan & Yuliantri[8] showed that flipbooks can significantly increase student engagement due to their nature of allowing active exploration of mathematical problems, which in turn encourages the development of critical thinking skills. Flipbooks provide opportunities for students to develop multiple perspectives and solutions, while deepening their understanding of mathematical material in a more in-depth and analytical way.

The theory presented by Polya[9] In his book “How to Solve It: A New Aspect of Mathematical Education” he makes a major contribution to the development of critical thinking skills in mathematics learning. Polya[10] proposes a problem-solving method that focuses on systematic steps, such as understanding the problem, planning a solution, implementing the plan, and re-examining the results. Although this concept is very influential in mathematics education, Polya's research is more theoretical and not supported by direct experiments in modern learning contexts. His focus is more on the theory of problem solving than on concrete applications in the

[7] Fery Muhamad Firdaus et al., “Promoting Collaborative Learning in Elementary Mathematics through the Use of Gamification Flipbooks: A Mixed-Methods Study,” *International Journal of Instruction* 16, no. 4 (2023): 987–1008.

[8] Marwan Marwan and Rhoma Dwi Aria Yuliantri, “Investigating the Impacts of Flipbook Media on Middle School Students’ Learning Interests in History,” *AL-ISHLAH: Jurnal Pendidikan* 15, no. 1 (2023): 795–804, https://doi.org/10.35445/alishlah.v15i1.3011.

[9] G. Polya, *How to Solve It: A New Aspect of Mathematical Education* (Princeton University Press, 2004).

[10] Polya, *How to Solve It: A New Aspect of Mathematical Education*.

classroom, especially in developing students' critical thinking skills through active interaction or the use of learning aids such as flipbooks. Therefore, the novelty of this research can be focused on experiments that integrate interactive learning tools such as flipbooks or digital applications in honing students' critical thinking skills, as well as assessing how students actively organize and reflect on their problem-solving process.

Other research by Ratnasari et al.[11] examines the use of problem-based learning (PBL) in improving students' critical thinking skills in mathematics. The results of this study indicate that PBL can improve students' analytical and problem-solving skills. However, the weakness of this study is that PBL focuses more on group work and provides less space for individual reflection and documentation of students' personal thinking processes. This study also did not test the use of concrete learning tools that can more deeply support the development of students' individual critical thinking skills. As a novelty, this study can be updated by including the use of flipbooks as a tool for individual reflection. With flipbooks, students can document their problem-solving steps, identify assumptions, and evaluate various approaches used in solving mathematical problems, which allows for deeper personal reflection.

Meanwhile, research Erna Setyawati et al.,[12] examined the impact of using interactive learning tools such as applications and digital devices on the development of students' critical thinking in mathematics. The findings suggest that interactive tools can help students understand mathematical concepts in a deeper way. However, this study tends to pay less attention to the aspect of physical activity in learning, as well as the possible limitations of using digital technology that can reduce opportunities for students to carry out manual reflection and personal exploration of critical thinking. Therefore, the novelty of this study can be focused on the use of flipbooks as an alternative to more concrete learning tools. Flipbooks provide opportunities for students to actively organize and modify information, which strengthens personal reflection and allows for a deeper understanding of their critical thinking processes.

RESEARCH METHODS

This research is a research and development (research and development) aimed at developing a Mathematics module in the form of a flipbook-based module for grade X SMA

[11] Anita Desy Ratnasari et al., "Penerapan Problem Based Learning Untuk Meningkatkan Hasil Belajar Peserta Didik Pada Pembelajaran Tematik," *Scholaria: Jurnal Pendidikan Dan Kebudayaan* 12, no. 3 (2022): 261–66, https://doi.org/10.24246/j.js.2022.v12.i3.p261-266.

[12] Erna Setyawati et al., "Pengaruh Penggunaan Multimedia Interaktif Terhadap Pemahaman Konsep Dalam Pembelajaran Matematika Di MTS Darul Ulum Muhammadiyah Galur," *Intersections: Jurnal Pendidikan Matematika Dan Matematika* 5, no. 2 (2020): 26–37, https://doi.org/10.47200/intersections.v5i2.553.

students on the material of two-variable linear inequality systems. The development carried out using a procedural model by adapting the Borg and Gall development model.

Development procedure according to Borg & Gall[13] consists of ten steps including: 1) research and data collection, including literature review, classroom observation and creation of research framework; 2) Implementation of planning which includes identification, formulation of objectives, determination of research period and small-scale feasibility study; 3) development of original product; 4) conducting initial field trial; 5) Check original product; 6) conducting limited field trial; 7) creating another version of the product; 8) conducting functional field test; 9) Check final product; and 10) conducting production and implementation. Development of guided discovery-based module did not continue to the dissemination phase and only completed the ninth phase, namely verification of final product according to research requirements.

Steps for each process

1. Research and data collection, including literature review, classroom observations and creation of a research framework;

   This activity includes steps to collect the necessary information, conduct a review of relevant literature or previous studies to understand the development of the topic being researched and look for research gaps that still need to be explored.
2. Implementation of planning which includes identification, formulation of objectives, determination of research period and small-scale feasibility studies;
3. original product development;
4. conduct initial field trials;
5. Check the original product;
6. conduct limited field trials;
7. create another version of the product;
8. conduct functional field tests;
9. Check the final product; and
10. carry out production and implementation.

Research methods include problem analysis, architecture or design of the method used to solve the problem. Problem analysis describes the problems that exist and are solved in this study. The design describes how to solve the problem and should be presented in the form of a diagram with a complete explanation. For example, a data processing diagram, from raw data to completion, a hardware design diagram.

[13] Walter R. Borg and Meredith D. Gall, *Educational Research: An Introduction* (Longman, 1983).

RESULTS AND DISCUSSION

Research Result

In developing flipbook media in Mathematics learning, researchers use the Borg and Gall development model, which consists of 10 systematic and structured stages. The following are the stages carried out by researchers:

Initial Research and Information Gathering

Before developing the product, the first stage carried out by the researcher is to conduct research and collect information on learning competency analysis. This is done by reviewing the Mathematics curriculum referring to Permendiknas No. 22 of 2006 concerning Core Competency Standards and Basic Competencies.

Planning

After conducting research and collecting initial information, the researcher created an initial product format related to the flipbook media that would be used.[14] In making the initial product format, there are several components that need to be included in the learning media so that it is neatly arranged, systematic and achieves learning objectives.[15]

Meanwhile, the equipment used is a laptop with the following specifications:

- Processor: Intel(R) Core(TM) i5-8250U CPU @ 1.60GHz 1.80 GHz
- Installed RAM 4.00 GB (3.87 GB usable)
- Device ID 1C073FD4-2854-4C8A-A9AC-89FA6B55808A
- Product ID 00331-10000-00001-AA645
- System type 64-bit operating system, x64-based processor

While the application used is the KVISOFT FLIPBOOK Application. The application is able to present in the form of Class Ebook (PDF), Sound, Video and Images

Product Development

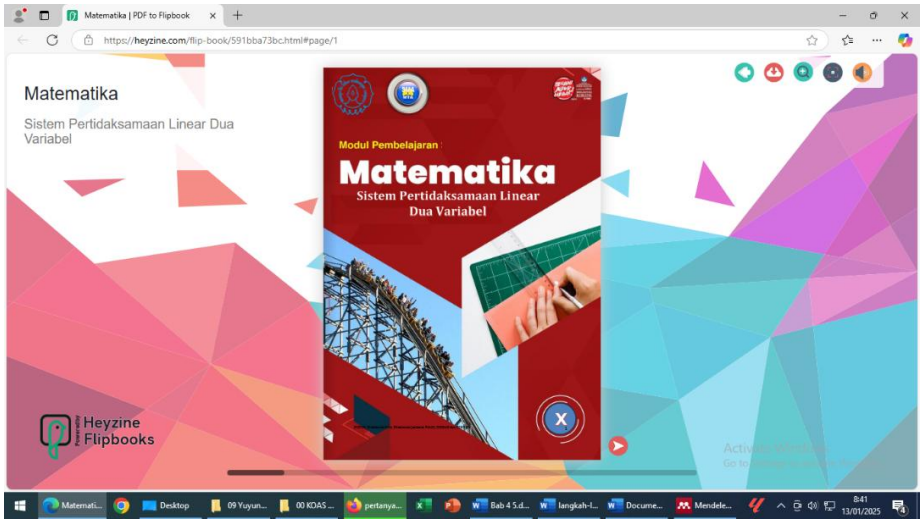
The next stage is the development of the design for the product being developed. Researchers created a flipbook media product version 4.2.2.0. The results of the development are used for Mathematics learning for class X students of SMA MTA Surakarta. The learning contained

[14] Arifin Syamsul, "Penggunaan Media Flipbook Maker Dalam Pembelajaran Tematik Untuk Meningkatkan Hasil Belajar Siswa," in *Tesis* (Jember: Universitas Islam Negeri Kiai Haji Achmad Siddiq Jember, 2022).

[15] Aulia Usman et al., "Bahan Ajar Elektronik Flipbook Pada Materi Kegiatan Ekonomi Untuk Siswa Kelas IV Sekolah Dasar," *Jurnal Educatio FKIP UNMA* 9, no. 3 (2023): 1293–301, https://doi.org/10.31949/educatio.v9i3.5300.

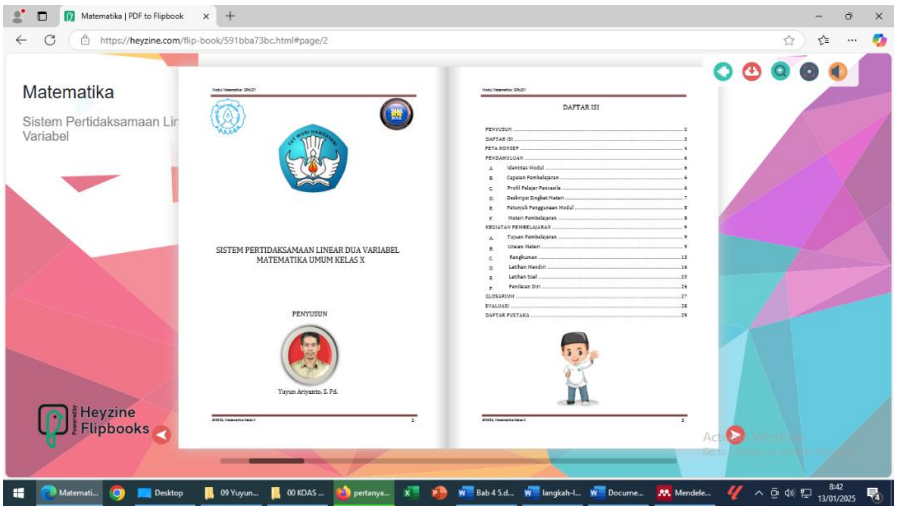
in this flipbook consists of several components that can be seen and studied. For more details, see the following description:

The display (Cover) aims to introduce flipbook-based learning media for grade X students of SMA MTA Surakarta. Before starting to the instructions for use and concept maps and learning objectives, in addition, the opening slide (cover) is equipped with several buttons, namely the "play, next, back, last page, etc." buttons. Because this flipbook media is equipped with buttons that support users, it will be easier to use it.



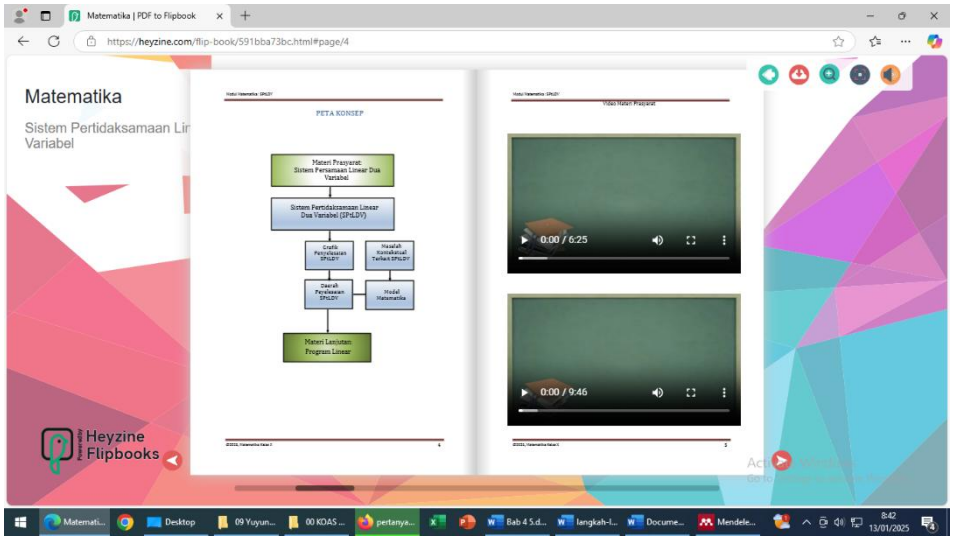
Picture 1. Front Page Cover Media

The table of contents in this developed media aims to explain the order of the material contained in this flipbook media, while the instructions for use contain buttons and explanations of the function of each button to make it easier to use.



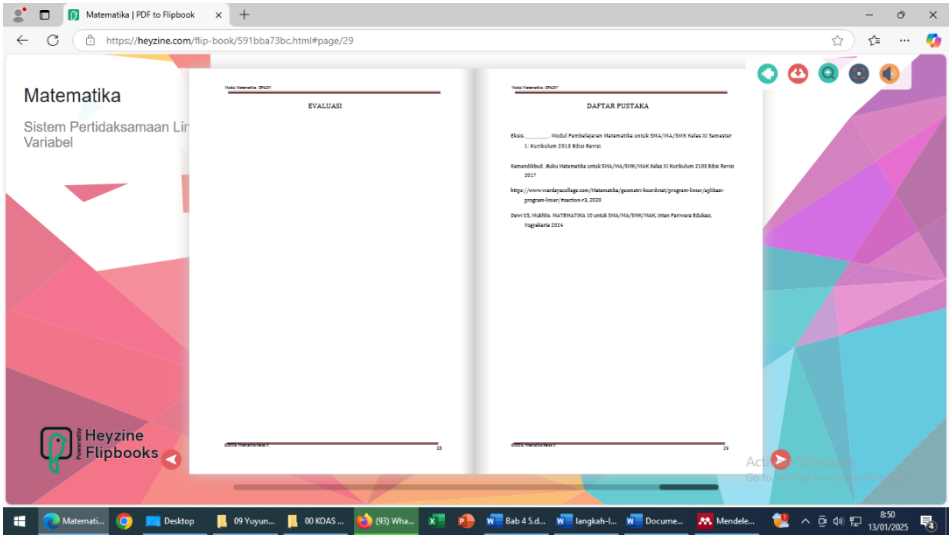
Picture 2. Table of Contents and Instructions for Use

Concept Map and Video of this material are used. The goal is for users to be able to understand and be directed in explaining the material contained in this flipbook media.



Picture 3. Basic Competencies and Core Competencies

The bibliography in this flipbook media is taken from the 2017 revised Ministry of Education and Culture book for class X K-13 and the LKS used at SMA MTA Surakarta.



Picture 4. Bibliography

Initial Expert Validation Trial

The trial data was obtained from the validation results of Flipbook-based Mathematics Learning Media for grade X students of SMA MTA Surakarta which was carried out by expert validators in language, design, and Mathematics learning which was carried out on April 25-May 25, 2022.

Mathematics Learning Expert Validation

The development product submitted to the material/content expert is in the form of a flipbook media. The descriptive presentation of the results of the validation of the material/content expert on the developed product is submitted through a questionnaire method with a questionnaire instrument so that it produces quantitative and qualitative data. Based on the calculation results, it is known that the percentage of the validation level is 88% after being converted with a scale 5 conversion table, the percentage of the achievement level of 88% is at a valid level so that the Flipbook-based Mathematics Learning Media does not need to be revised. The explanation of each criterion in the validation results above is as follows:

1. The suitability of the material with SK, KD, Indicators, and Learning Objectives obtained a score of 100%. This means that the material developed in the flipbook media is in accordance with SK, KD, Indicators, and learning objectives.
2. The material presented can be easily understood and gets a score of 100%. This shows that the material developed in the flipbook media is in accordance with the level of understanding at the MTA Surakarta High School level.
3. The systematic presentation of the material received a score of 100%. This shows that the material developed in the flipbook media is in order based on sub-themes and does not confuse students.
4. The truth of the content of the material delivered received a score of 100%. This means that the material developed on the flipbook media is in accordance with that which has been implemented by the government.
5. The description of the material presented in the learning media is clear and appropriate, obtaining a score of 80%. This means that the material developed in the flipbook media is appropriate.
6. The images presented in the learning media are in accordance with the material and get a score of 80%. This means that the material developed in the flipbook media is appropriate.
7. The video on the learning media is in accordance with the content of the material and has a score of 80%. This means that the material developed on the flipbook media is in accordance with the theme.
8. The language style used in the learning media is clear and in accordance with the level of understanding of students who get a score of 80%. This means that the language style developed in the flipbook media is easy to understand by class students.
9. The practice questions on the learning media are in accordance with the material and get a score of 80%. This means that the practice questions developed on the flipbook media are easy for students to understand.

10. Practice questions on learning media can measure the level of student understanding by getting a score of 80%. This shows that practice questions developed on flipbook media measure the level of student understanding.

Validation of Learning Media Design Experts

Results of Validation by Learning Media Design Experts

The development product submitted to the media design expert is in the form of a flipbook media. The descriptive presentation of the media design expert's validation results on the developed product is submitted through a questionnaire method with a questionnaire instrument to produce quantitative and qualitative data. The calculation results show that the percentage of the validation level is 80% after being converted with a scale 5 conversion table, the percentage of the achievement level of 80% is at the valid qualification level so that the flipbook media does not need to be revised. The explanation of each criterion in the validation results above is as follows:

1. The attractiveness of the initial display on the flipbook media received a score of 80%. This means that the initial display has attracted students' interest in learning.
2. The attractiveness of the design/display on the flipbook media received a score of 80%. This shows that the media design has attracted students' interest in learning.
3. The color composition of the flipbook media gets a score of 80%. This means that the color gradation in the media is appropriate so that it is easy to read.
4. The attractiveness of the display of the material content on the flipbook media received a score of 80%. This means that the display of the material content on the media has attracted students in the teaching and learning process.
5. The attractiveness of the image illustrations on the flipbook media received a score of 80%. This shows that the images displayed are easy to understand.
6. The suitability of the background to the theme obtained a value of 80%. This shows that the background is in accordance with the material of linear inequality of 2 variables.
7. The accuracy of the letter size and font type (clearly readable) received a score of 80%. This means that the material is easy to read by students because the letter size and font are correct.
8. The clarity of the use of backsound gets a score of 80%. This shows that the backsound is clear.
9. The ease of flipbook media to operate gets a score of 80%. This means that flipbook media makes it easier for students to learn.
10. The suitability of the media with the characteristics of the students obtained a value of 80%. This shows that the flipbook media is suitable for use for class X students at SMA MTA

Surakarta.

Expert Validation Product Revision

Product revision by mathematics learning experts is to make improvements to the bright-looking images so that they support the spirit of activity. Fonts are changed to be easier to read, Color gradations are adjusted to the background. Validation by learning media design experts, there are no revisions.

Initial Small-Scale Field Trials

In this field trial, the researcher asked for students' responses by taking a small class consisting of 53 grade X students from SMA MTA Surakarta. The development product submitted for the small field trial of Mathematics learning was in the form of flipbook media. This small field trial was conducted to determine the shortcomings of the media that had been developed to make it more perfect, and to determine the ease of use of this flipbook media. Based on the analysis, it was found that the percentage of the validation level was 84.8% after being converted with a scale 5 conversion table, the percentage of the achievement level of 84.8% was at the valid qualification level so that the flipbook media did not need to be revised.

Revision of Small Scale Initial Field Trial

Judging from the results of a small field test which shows a validation level percentage of 84.8% is in the valid qualification, which means that the flipbook media does not need to be revised again because it has gone through a trial conducted on a small class of 53 students in class X (experimental class) and received a positive response, the researcher concluded that the flipbook development product is feasible to be implemented in Mathematics lessons.

Large Scale Final Field Test

Large-Scale Final Field Test is conducted by testing the results of pre-test and post-test assessments. The pre-test class is the test result of the teaching and learning process with LKS taught by subject teachers before using flipbooks. While the post-test class uses flipbook media in the mathematics teaching and learning process.

The determination of the subjects in this study used a sampling technique with Simple Random Sampling, which is taking samples from the population randomly without considering the strata in the population. In the experimental method, the minimum number of acceptable samples is 200 subjects per group. However, in this study the researcher took 83 students from the pretest and posttest classes. The large-scale final field test process includes:

Test Iteman

Item test is a test procedure for test items used to measure student learning outcomes both before and after treatment. The number of questions tested was 20 items and tested on 27 students.

Table 1 Item Test Results

Item ID	Key	P	Total Rpbis	Total Rbis	Alpha w/o	Omit Freq
item01	C	0.556	0.393	0.494	0	
item02	B	0.704	0.144	0.190	0	
item03	D	0.593	0.417	0.528	0	
item04	A	0.630	0.177	0.226	0	
item05	E	0.407	0.564	0.713	0	
item06	A	0.741	0.037	0.051	0	K
item07	B	0.370	0.044	0.056	0	K
item08	D	0.556	0.260	0.328	0	
item09	B	0.556	0.175	0.220	0	K
item10	E	0.778	0.322	0.449	0	
item11	C	0.667	0.115	0.149	0	K
item12	A	0.630	0.220	0.282	0	
item13	D	0.444	0.478	0.602	0	
item14	B	0.741	0.084	0.114	0	K
item15	A	0.519	0.220	0.276	0	
item16	E	0.333	0.372	0.482	0	
item17	C	0.519	0.508	0.637	0	
item18	A	0.333	0.638	0.827	0	
item19	B	0.519	0.508	0.637	0	
item20	D	0.667	0.093	0.121	0	

Based on the results of the Iteman test, several items have a fairly high point-biserial correlation (Rpbis), such as items with ID item06 (Rpbis 0.741) and item18 (Rpbis 0.638), which indicates that these questions are very good at distinguishing between participants with high and low scores. Most of the questions show good discrimination power, with a fairly high point-biserial correlation (Rpbis) on several questions such as item06 and item18. This shows that these questions are able to distinguish between students who have good and poor understanding. The level of difficulty of the questions varies greatly. Some questions, such as item18 and item07, have a high level of difficulty, indicating that only a few students can answer correctly. On the other hand, questions such as item10 show a relatively easy level of difficulty, because many students can answer correctly. For a comprehensive test, it is better for questions to have varying levels of difficulty, so that they can measure students' abilities at various levels.

Normality Test

Table 2 Normality Test Results

One-Sample Kolmogorov-Smirnov Test

		Pretest	Posttest
N		83	83
Normal Parametersa,b	Mean	70.1205	84.2169
	Std. Deviation	7.11302	8.95388
Most Extreme Differences	Absolute	.151	.137
	Positive	.138	.104
	Negative	-.151	-.137
Test Statistics		.151	.137
Asymp. Sig. (2-tailed)		.000c	.001c

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

Based on the data analysis, it is known that the Pretest test results obtained a P-value of 0.000, or less than 0.05. This indicates that the Pretest data is not normally distributed, thus rejecting the null hypothesis (Pretest data is normally distributed). In the Posttest test results, the P-value is known to be 0.001, or also less than 0.05. This indicates that the Posttest data is not normally distributed, thus rejecting the null hypothesis (Posttest data is normally distributed).

Homogeneity Test

Table 3 Homogeneity Test Results

Test of Homogeneity of Variances

Mark

Levene Statistics	df1	df2	Sig.
3.194	1	164	.076

Based on the results of the analysis, it is known that the P-value = 0.076 or greater than 0.05, so it fails to reject H0. This means that there is insufficient evidence to state that the variance between groups is significantly different. Therefore, it can be concluded that the variance between groups is homogeneous or the same.

Difference Test

Table 4. Difference Test

		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)
Mark	Equal variances assumed	3.194	.076	-11,230	164	.000
	Equal variances not assumed			-11,230	156,019	.000

The results of Levene's Test show that the variances between groups are not significantly different, so we use the results of the t-test with the assumption of equal variances. The results of Levene's Test are known to be F of 3.194 and Sig. (p-value) of 0.076. If this value is greater than 0.05, then we do not reject the null hypothesis that the variances between the two groups are the same. In this case, the p-value is 0.076, which is greater than 0.05, meaning we fail to reject the null hypothesis. This means that there is not enough evidence to say that the variances between the two groups are different.

Based on the results of the Levene test showing that the variance between groups is the same, we will focus on the results for equal variances assumed. The results of the t count with equal variances assumed, it is known that t is -11.230: The negative value indicates that the average of the pretest group is lower than the posttest group. The Sig. value (2-tailed) is known to be 0.000: so the p value is much smaller than 0.05. The conclusion of the test results rejects the null hypothesis and concludes that there is a statistically significant difference between the pretest and posttest groups.

Final revision

Based on the results of the large class field test of Flipbook-based Mathematics Learning Media, it was revised and refined so that the learning media that had been developed became an effective and good media to be used by Mathematics X subject teachers on the material of 2-variable linear inequalities because later the product of this flipbook development will be submitted to the school, especially to class X subject teachers at SMA MTA Surakarta.

Dissemination and Distribution

At the dissemination stage, the researcher conducted a simulation of the use of learning media so that students understand its use, while at the distribution stage, the researcher only submitted the product to the school, especially for grade X Mathematics teachers to be used as learning materials, but the researcher did not mass duplicate the product due to time and cost constraints required.

Discussion

The results of the development of Flipbook-based Mathematics Learning Media in the Mathematics subject of class X of SMA MTA Surakarta show that the learning media is feasible to use and effective in improving students' critical thinking skills, seen from the results of the pre-test and post-test in small field tests and large field tests which show a significant difference between classes that use media and classes that do not use learning media.

Walter McKenzie[16] stated that media has an important role in classroom learning, which affects the quality and success of learning. Visual media itself helps understanding and remembering the contents of the material for students who are weak in reading.[17]

Mathematics learning in Senior High School is carried out using an integrated approach. The Ministry of Education and Culture of the Republic of Indonesia stated that the integrated learning model is essentially a learning approach that allows students, both individually and in groups, to actively seek, explore and discover concepts and principles holistically and authentically. Through integrated learning, students can gain direct experience, so that they can increase their strength to receive, store and produce messages and impressions about the things they learn.

Messages in the form of knowledge, skills and attitudes can be delivered with learning media, and can stimulate the attention and willingness of students to achieve learning goals. A medium used to deliver a material will be very much needed when students experience difficulties in the learning process. Teachers will also find it easier to deliver material if a teacher delivers it using media that suits their needs. In accordance with the main function of learning media, namely as a carrier of information from the source (students).

Learning media itself has four functions, namely attracting attention and directing the attention of students to concentrate on the contents of the lesson, increasing the enthusiasm of students to learn in the sense of reading illustrated texts, the presence of images and videos can facilitate the goal of understanding and remembering information in the text and remembering it again. Therefore, interesting learning media is needed in the teaching and learning process.[18]

The development of Flipbook-based Mathematics Learning Media in Mathematics subjects is based on a needs analysis that there is no interesting learning media available to support Mathematics learning at SMA MTA Surakarta, especially learning media that contain materials, videos, and images related to the material so that they can increase students' learning motivation. In addition, the results of this development are intended to increase the effectiveness of Mathematics learning in achieving learning objectives in accordance with those set out in the curriculum. This flipbook-based learning media was developed using the Borg and Gall development model which consists of systematic stages including the stages of research and initial information collection,

[16] Irma Salamah et al., "Peningkatan Kemampuan Guru-Guru SD Negeri 130 Palembang Dalam Menyajikan Presentasi Atraktif Melalui Pelatihan Microsoft Power Point," *Aksiologiya: Jurnal Pengabdian Kepada Masyarakat* 4, no. 1 (2019): 52, https://doi.org/10.30651/aks.v4i1.2197.

[17] Rahma M. Naser, "Meningkatkan Pembelajaran Bahasa Arab Siswa Melalui Media Audio Visual Dalam Manajemen Pendidikan Islam Tinjauan (Studi Di Madrasah Aliyah Negeri 2 Kota Palu)," *Jurnal Kolaboratif Sains* 5, no. 8 (2022): 466–80, https://doi.org/10.56338/jks.v5i8.2695.

[18] Ani Daniyati et al., "Konsep Dasar Media Pembelajaran," *Journal of Student Research* 1, no. 1 (2023): 282–94, https://doi.org/10.55606/jsr.v1i1.993.

planning, development of initial product formats, initial trials, product revisions, field trials, product revisions, field trials, final product revisions.[19]

Flipbook-based Mathematics Learning Media that has been developed by researchers is an interactive learning media that contains 2-variable linear inequality material, so that it can attract students' critical thinking skills. This Flipbook-based Mathematics Learning Media is published with a single file executable (exe) output so that it can be operated on a laptop/computer offline and can be viewed by all students in the class with the help of an LCD and laptop/computer.

Learning using flipbook media that has been developed by researchers, has a positive influence on learning motivation and critical thinking skills of experimental class students. The effectiveness of using this learning media is seen from the comparison of students' critical thinking skills in the pre-test and post-test. The comparison of critical thinking skills of the experimental class seen from the results of the pre-test and post-test shows that there is a significant increase in students' critical thinking skills in the pre-test scores using Flipbook-based Mathematics Learning Media compared to students' critical thinking skills in the post-test scores that do not use flipbook media.

In the development of Flipbook-based Mathematics Learning Media, there are still several shortcomings in the learning media, the shortcomings are that this flipbook-based learning media is only limited to the development of learning media in Mathematics subjects on the theme of 4 basic movements. Due to the limitations of researchers, the references used in the development of Flipbook-based Mathematics Learning Media are not enough for better development results. This Flipbook-based Mathematics Learning Media can only be used on computers/laptops so it needs to be further developed so that it can be accessed on smartphones or tablets, then this learning media also does not contain an evaluation in the form of a quiz creator in it so that the evaluation is only in the form of text which is done manually in each student's book. If there is a quiz creator, it will make it easier for students to work on it and it does not take long to write answers, as well as for teachers, the quiz creator makes it easier for teachers to assess the results of the evaluation that has been given.

Thus, there are still many shortcomings in the Flipbook-based Mathematics Learning Media that researchers have developed, so researchers need further suggestions to develop the media further so that further research is even better. However, on the other hand, this Flipbook-based Mathematics Learning Media is able to achieve effective learning objectives and improve students' critical thinking skills in Mathematics lessons.

[19] Sugiyono, *Metode Penelitian Kualitatif Kuantitatif Dan R & D*, edisi 2 (CV. Alfabeta, 2019).

CONCLUSION

At the beginning of Mathematics learning at SMA MTA Surakarta, many students had difficulty developing critical thinking skills. Students felt bored and uninterested in following mathematics lessons, because there was no variation in learning. In addition to monotonous learning activities, it turned out that there were no modules that could be used by teachers and students other than LKS. In the needs analysis, it was discovered that students and teachers needed a new module that could be applied with current technological advances.

In the process of developing a prototype of a flipbook-based mathematics learning module, it was carried out by adapting the Borg and Gall development model. The development procedure model adapts the Borg and Gall development model, 1) research and data collection; 2) Implementation of planning 3) development of the original product; 4) conducting an initial field trial; 5) Check the original product; 6) conducting a limited field trial; 7) making another version of the product; 8) conducting a functional field test; 9) Check the final product; and 10) conducting production and implementation. The test results showed a t-count value of -11.230 and a Sig. (2-tailed) value of 0.000. This can be concluded that there is a significant difference between the pretest and posttest groups.

SUGGESTIONS and RECOMMENDATIONS

Based on the results of the study showing a significant difference between the pretest and posttest groups, it is recommended that students be more active in utilizing flipbook-based mathematics learning modules as a learning tool to improve their critical thinking skills. For teachers, this module can be a means to create more varied and interesting learning, so as to increase student interest and participation in mathematics learning. Schools are also expected to support the implementation of this module more widely by providing adequate technological facilities, such as computers or tablets, as well as training for teachers to maximize their use. This aims to make the learning process more effective, innovative, and relevant to current technological advances.

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