Effect of Science Flipbook Based on Learning Styles and Multiple Intelligences (LSMI) For Facilitating Students' Understanding and Critical Thinking Skills

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Abstract

The purpose of this research is to develop flipbook based on LSMI, analyze the increase in students' understanding and critical thinking skills, and analyze the effectiveness of flipbook. This research is a design-based research, where the development model used is the ADDIE model. The developed flipbook contain features arranged in such a way as to facilitate students with different learning styles and dominant intelligences, as well as train students' understanding and critical thinking skills. This flipbook has met the eligibility criteria in the aspects of content, language, presentation, and graphics. The increase in students' understanding is classified as moderate and the increase in students' critical thinking skills is classified as low. In addition, the effectiveness of flipbook in improving students' understanding and critical thinking skills are included in the large category.

Keywords: *Critical Thinking Skills, Learning Styles, Multiple Intelligences, Science Flipbook, Student's Understanding.*

Introduction

Teaching materials must contain factors that can trigger students to learn which consist of apperception, material guidance, processing activities (discussions/practices), application of knowledge, and feedback/assignments (Butcher, Davies, & Gisewhite, 2019). Well-prepared teaching materials can determine student success in understanding the material being studied (Widodo & Jasmadi, 2008). Teaching materials that can improve thinking skills are teaching materials that are independent, meaning that teaching materials can be studied independently because they are systematic and complete, so they are useful in the learning process (Budiastra, Wicaksono, & Sanjaya, 2020). Critical thinking need to be trained so that students can gain a deeper understanding of what they are learning, analyze problems around them, and find solutions (Gallardo-Estrada, *et.al*., 2024).

Teachers view that digital teaching materials will be more attractive to students in the digital era, easier to understand, more practical, cheaper, and more diverse so as to create expectations and satisfaction for students, and good sustainability of digital textbooks (Joo, Park, & Shin, 2017). One example of an electronic (non-printed) teaching material that has animation and video features is e-flipbook. Flipbook is digital media created using software (Azhary, *et.al*., 2020). Digital learning as delivery in the form of digital media (eg text or images) via the

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internet; as well as the learning content and teaching methods provided are to enhance student learning and aim to increase learning effectiveness or increase personal knowledge and skills (Roemintoyo & Budiarto, 2021).

Another factor that influences student learning success is intelligence. The integration of multiple intelligences theory in learning activities allows a more student-centered approach, meeting the learning needs of students with certain characteristics so that it has a positive effect on learning (Chen, Chiang, & Lin, 2013). The benchmark of intelligence is not only assessed from its logical skills, but also from other abilities which are referred to as multiple intelligences. Multiple intelligence indirectly influencing thinking patterns through critical thinking skills (Dawahdeh & Mai, 2021). Multiple intelligences based learning plays an important role as an educational approach that considers most of the uniqueness of each individual as a learner, where an educator provides several learning activities based on current student intelligence (Pratiwi, Rochintaniawati, & Agustin, 2018). For addition, multiple intelligences have been much talked about in recent years, but there is no evidence of their effectiveness (Muijs, *et.al.*, 2014).

Everyone with different intelligence certainly has a different learning style. Learning style is a student's preferred way of learning and is considered an important factor in personalized learning (Barry & Egan, 2018). Learning styles provide knowledge about various ways of student learning, important information about student preferences, so that they can be used to optimize student learning processes (Husmann & O'Loughlin, 2019). The learning styles used by students are driven by their motivation to be actively involved in classroom learning activities (Aidoo, *et.al.*, 2024). There are several learning style classification models. The VAK learning style framework is the most popular and widely used (Almasri, 2022). Kolb noted that different learning styles are like cycles over time that students must go through, while more recent researchers conceptualize learning styles as choices that students can choose when they feel like it (Muijs & Reynolds, 2017). People with a visual learning style can learn optimally when information is conveyed in the form of pictures, tables, charts, maps or diagrams. Auditory learners like interesting information by listening, they feel comfortable when given instructions orally. Whereas kinesthetic learners learn best by feeling and doing (Almasri, 2022).

In previous studies, the material on temperature, heat, and expansion was known to be difficult for students to understand (Royani, *et.al.*, 2022). Various learning media have been developed to improve students' ability to understand that material, such as electronic modules (Serevina, *et.al.*, 2018) and digital comics (Rosdiana & Kholiq, 2021). Therefore, the researcher designed a learning media in the form of a flipbook to help teachers develop students' understanding and critical thinking skills (Al-Taie & Khattak, 2024). Flipbooks are one of the relevant teaching materials for students in the digital era, because they present material that is more practical, easier to understand, cheaper, and more diverse (Budiastra, Wicaksono, & Sanjaya, 2020). Researchers developed a flipbook by providing multiple intelligences approach content that supports the development of critical thinking skills for students (Alhamuddin, *et.al.*, 2023). The flipbook is also equipped with a learning style approach that is in accordance with the characteristics of students so that it supports improving their learning outcomes (Labib, Canós, & Penadés, 2017).

Research Methods

Method, Model, and Design

This research is Design Based Research (DBR). DBR is a systematic but agile methodology that

is widely used in educational contexts (Anderson & Shattuck, 2012); (Papavlasopoulou, Giannakos, & Jaccheri, 2019). DBR offers strategies for understanding the learning process through design, exploration, implementation, evaluation, and redesign (Papavlasopoulou, Giannakos, & Jaccheri, 2019). DBR done using sequential and detailed stages, starting from problem identification and initial needs analysis, conceptualizing suitable teaching materials for students, implementing teaching materials to students, reflecting and revising teaching materials as needed. The flipbook development model used is ADDIE, which is a development model consisting of five steps (analyze, design, development, implementation, and evaluation). The application of teaching materials in classroom learning takes into account the results of the implementation and evaluation stages in the ADDIE model. Where, research design used in this research is quasy-experimental design with pretest and posttest (Creswell & Creswell, 2017). The sample in this study were 65 of 1ˢᵗ grade junior high school students (32 students in the experimental group and 33 students in the control group).

Instrument

The research instruments used included: expert validation sheets (used to determine the feasibility of flipbook) and test sheets consisting of student's understanding test items (multiple choice) and critical thinking skills test items (essay). The understanding test items are made by referring to the understanding aspects in the revised bloom taxonomy. Meanwhile, the critical thinking skills test items are made by referring to the critical thinking skills elements according to Inch (2002) which consist of eight elements. The understanding and critical thinking skills test items used have been tested for validity, reliability, level of difficulty, and differentiating power and have been assessed by experts (teachers and lecturers). So the test items used in this study are test items that have been revised according to the test results and suggestions from experts.

Data Analysis

The level of feasibility of flipbook which includes eligibility in 4 aspects, namely the feasibility of content, presentation, language, and graphics is calculated using the percentage score of the evaluator. Improved understanding and critical thinking skills are analyzed by the N-Gain formula (Hake, 1999). The effectiveness of the use of flipbook analyzed by using effect size. Effect size in this study is calculated using the Cohen's D, as one way to do non-parametric analysis, because the distribution of data included in non-normal distribution, as ahown in the normality analysis.

Results and Discussion

The results of the research to be discussed include: the feasibility of science flipbook based on LSMI, increased students' understanding, increased students' critical thinking skills, as well as the effectiveness of science flipbook based on LSMI.

Development Of Science Flipbook Based on Lsmi with the Addie Model

1.   **Analysis**

At this stage, needs analysis is carried out by conducting literature review and field studies. Based on the field studies, it was found that students have different characteristics in terms of the type of learning style and multiple *i*ntelligences. Based on the literature review, we can see that the multiple intelligences approach in learning is very important because it can improve learning outcomes, student interest, mastery of concepts, high order thinking skills (HOTS),

problem solving skills, and other competencies. On the other hand, the results of the preliminary study showed that the average test score of students' understanding and critical thinking skills in the topic of temperature, heat and expansion was still relatively low, which was 46.91 on the test of understanding and 40.23 on the test of critical thinking skills. Findings in the field show that most students still use textbooks that are not yet oriented towards the characteristics of students and have not trained critical thinking skills.

The use of flipbook in learning activities is supported by the Problem Based Learning (PBL) model. The PBL model was chosen according to the purpose of flipbook development, namely to improve students' understanding and critical thinking skills. PBL is a learning approach that uses real-world problems as a context for students to learn about problem-solving skills. PBL is also one of the active learning that can help students develop high-level thinking skills such as critical thinking and problem solving (Juleha, Nugraha, & Feranie, 2019). Students will find their own knowledge through a problem that must be solved and the teacher acts as a facilitator who guides them to find solutions to solve a problem (Akinoğlu & Tandoğan, 2007). Therefore, in this study, flipbook was developed and applied together with the PBL model in learning are expected to be able to improve understanding and critical thinking skills. Learning activities referring to the PBL syntax are shown in Table 1.

PBL Syntax	Features in Flipbook	Experimental Group Activity
Phase 1: Orient students to the problem	What's around us?	Pay attention to the teacher's apperception and write down questions related to temperature, heat, and expansion according to the form provided in the flipbook.
Phase 2: Organizing students for learning	Let's Read	Accessing materials in science flipbook based on LSMI.
Phase 3: Guiding individual and group investigations	Let's Do It	• Form groups of 5-6 students to follow up on the questions that have been asked. • Make a simple experimental design by filling out the experiment form and consult with the teacher. • Do a simple experiment
Phase 4: Develop and present the work	Let's Show	• Discuss experimental results and prepare simple presentations. • Presenting the results and conclusions of the experiment. • The other groups respond by asking questions or suggestions for the presenter.
Phase 5: Analyze and evaluate the problem-solving process	Let's Practice	• Together with the teacher, students conclude the results of the presentation and discussion verbally. • Practice working on understanding and critical thinking skills test questions contained in the science flipbook based on LSMI.

Table 1. Learning activities refer to the PBL syntax.

Features Let's Understand; Let's Sing; and Temperature, Heat and Expansion in the Qur'an outside the PBL syntax but have other purposes and benefits. The "Let's Understand" feature is an independent activity that is carried out outside of class hours and can be repeated accordingly their respective needs, namely studying again the material of temperature, heat, and expansion so that students better understand the concept. Students can choose one of three options, namely: re-reading text, listening to audiobooks, or watching videos based on their individual learning style preferences. This feature is also expected to be able to train intrapersonal intelligence, where students can know themselves, know their learning preferences and organize themselves in such a way as to be able to understand the subject matter. On the other hand, the "Let's Sing" feature is made to make it easier for students to remember important concepts as well as entertainment to enhance learning enthusiasm, as well as facilitate students with musical intelligence. While the features of Temperature, Heat, and Expansion in the Qur'an which contain verses of the Qur'an related to this material can train students' existential intelligence and motivate students to always be grateful for all the blessings that have been given by the God. The textbook and printed worksheets used by the control group were not integrated with students' learning styles and multiple intelligences so that there were no similar features such as "Let's Understand", "Let's Sing", and "Temperature, Heat and Expansion in the Qur'an" found in science flipbook based on LSMI.

2.   Design

At this stage, the layout of flipbook is made to facilitate the development of flipbook because it contains an overall picture of flipbook to be developed. The layout of flipbook was created using microsoft word (can be seen in Figure 1).
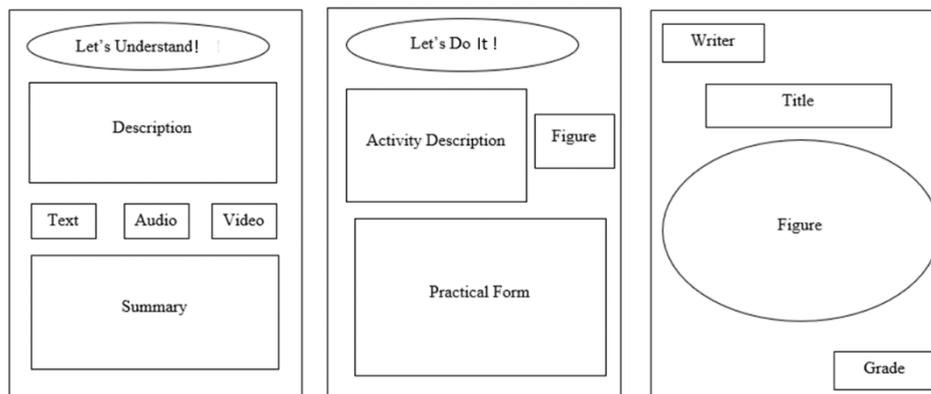

Figure 1. Flipbook Layout.

The layout that has been created is then developed by adding content, adjusting the size of the text, adding images/illustrations, and adjusting the colors. Thus, the display of flipbook can be seen in Figure 2.

Figure 2. Display of Flipbook.

Researchers developed flipbooks with features that can facilitate students with various learning styles. One of the most popular and widely used learning style models is the VAK (Visual, Auditory, and Kinesthetic) learning style (Almasri, 2022). This flipbook facilitates students with a visual learning style, namely students can learn optimally through information presented in the form of images, tables, charts, maps, or diagrams contained in the "Let's Read!" feature. This flipbook also facilitates students with an auditory learning style, namely through information provided in an interesting way by listening to audiobooks about the material being studied contained in the "Let's Understand" feature. In addition, this flipbook also supports students with a kinesthetic learning style, where students can learn by feeling and doing experimental activities contained in the "Let's Do It" feature.

The developed flipbook also facilitates students with different types of multiple intelligences. The theory of multiple intelligences was put forward by Howard Gardner, which consists of nine multiple intelligences (González-Treviño, *et.al*., 2020). First, verbal-linguistic intelligence is related to the ability to use language effectively, which is supported by the "Let's Show!" feature. Second, logical-mathematical intelligence concerns the ability to count and think logically in problem solving, which is supported by the "Let's Practice!" feature. Third, spatial-visual intelligence is related to the ability to understand the concept of space, which is supported by the "Let's Read!" feature. Fourth, kinesthetic-bodily intelligence is related to the ability to maximize body parts to express ideas and feelings, which is supported by the "Let's Do!" feature. Fifth, musical intelligence means the ability to think or digest music, which is supported by the "Let's Sing!" feature. Sixth, intrapersonal intelligence is the ability to understand oneself, which is supported by the "Let's Understand!" feature. Seventh, interpersonal intelligence is related to the ability to establish social interactions, which is supported by the "Let's Do It" feature. Eighth, naturalist intelligence is the ability to recognize and understand the natural environment, which is supported by the feature "What's around us?". Ninth, existential intelligence is the ability to recognize Allah through the verses of the Qur'an, which is supported by the feature "Temperature, Heat and Expansion in the Qur'an" (Cavas & Cavas, 2020).

In the next stage, flipbook draft in PDF format converted into flipbook so that it can be accessed online. Software used to convert draft into flipbook is flip PDF corporate edition. With flip PDF

corporate edition, audio and video can also be embedded. Then, the end result is in the form of a link which will later be shared with students so they can access flipbook on a laptop/PC or Android.
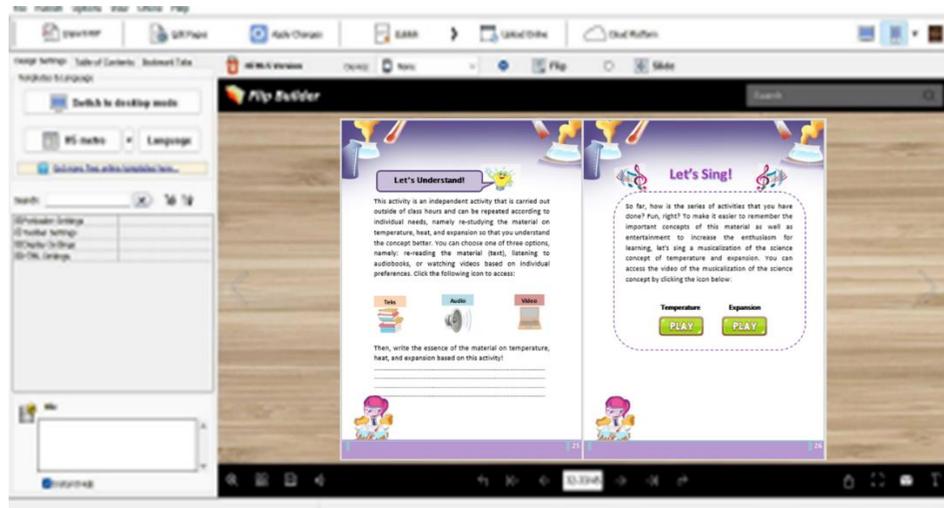

Figure 3. Display of Flip PDF Corporate Edition.

3.   Development

At this stage, the experts judgement is carried out by five experts to determine the feasibility of flipbook in terms of content, language, presentation, and graphics. The instrument used is a validation sheet consisting of a checklist with "yes" or "no" options, equipped with suggestions and conclusions column. Table 2 shows the results of the judgement.

Aspects of feasibility	Percentage (%)	Category
Content	85,45	Feasible
Language	94,29	Very Feasible
Presentation	95,00	Very Feasible
Graphics	98,52	Very Feasible
Total	**93,31**	**Very Feasible**

Table 2. Expert Judgement Results

The total feasibility of flipbook were 93.31% included in the very feasible category. Aspects of content feasibility include material coverage, material accuracy, up-to-date, and cohesiveness. The feasibility of language is reviewed from several criteria, namely: in accordance with the development of students, communicative, dialogic and interactive, straightforward, coherence and sequence of thought lines, conformity with language rules, and consistency of terms and symbols used. Presentation aspect consists of presentation techniques, supporting material presentation, as well as presentation that is appropriate for students. Graphic aspects include consistent layouts, harmonious layout elements, layouts that accelerate understanding, simple typography, easy-to-read typography, easy-to-understand typography, and illustrations.

4.   Implementation

Science flipbook based on LSMI which has been corrected according to the suggestions of the evaluator is then applied in limited learning to 65 of 1st grade students from one of the Public Junior High Schools in Banyumas Regency, Central Java, Indonesia to find out the increase in students' understanding and critical thinking skills, as well as the effectiveness of flipbook on understanding and critical thinking skills.

5.   Evaluation

Science flipbook based on LSMI that have been tested are then evaluated and revised based on the increased of student's understanding and critical thinking skills and the effectiveness of flipbook in improving these abilities as a whole. The results of this stage are science flipbook that are ready for use in general and can improve students' understanding and critical thinking skills.

Increase In Student's Understanding

First, we have examined the distribution priorities of the data and non-parametric statistics. The results are showed in the Table 3 and Table 4.

	Kolmogorov-Smirnov			Shapiro-Wilk		
Group	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Pretest (experiment group)	0.195	32	0.003	0.863	32	0.001
Postest (experiment group)	0.166	32	0.025	0.855	32	0.001
Pretest (control group)	0.138	33	0.114	0.950	33	0.130
Postest (control group)	0.153	33	0.048	0.957	33	0.211

Table 3. Tests of Normality of the Understanding Data.

Significance <0.05 means that the data is not normally distributed. Based on the results of the normality test, the significance for understanding pretest and posttest for control groups are 0.130 and 0.211, which means >0.05 so that the data is normally distributed. However, for the data understanding pretest and posttest for experimental groups are 0.001 and 0.001, which means <0.05, so the data is not normally distributed. Therefore, data analysis was then carried out using non-parametric statistics, namely the Mann-Whitney test and the Cohen's D Effect Size test.

	Ranks			Result			
Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	**Wilcoxon**	**Z**	**Asymp. Sig. (2-tailed)**
Experiment (Postest)	32	40.98	1311.50				
Control (Postest)	33	25.26	833.50	272.500	833.500	-3.384	0.001
Total	65						

Table 4. Mann-Whitney Test Result for the Understanding Data.

Based on the results of the Mann-Whitney test, the Sig. (2-tailed) value was obtained at 0.001 <0.05. Thus, there is a significant difference in the value of student understanding after using science flipbooks, with the average understanding of students in the experimental group being 73.13 higher than the understanding value of students in the control group, which is 64.09. Thus, it can be concluded that the use of science flipbooks has high effectiveness in increasing student understanding values.

Increase in students' understanding is analyzed based on pretest and posttest data. The experimental group took the posttest after taking part in learning activities using science flipbook based on learning style and multiple intelligences. The research design was aimed at determining the effect of increasing students' understanding who studied using science flipbooks and without using science flipbooks. Thus, this research design was fair because the test instrument used was the same for both the experimental and control groups, consisting of twenty multiple-choice questions. Increase in student's understanding in the experimental group and control group can be seen in Table 5. The control group receives comparable learning treatment, but without using science flipbooks based on LSMI. The control group uses commonly used textbook and printed worksheet. The goal is that differences in outcomes (understanding and critical thinking skills) can be attributed to the use of flipbook itself. The material, duration, learning objectives, and assessment instrument remain the same as the experimental group. In addition, there is consistency in other variables such as: the same teacher and comparable class condition.

Group	Score				Category
	Ideal	**Pretest**	**Postest**	**N-Gain**	
Experiment	100	55,78	73,13	0,39	Moderate
Control		51,36	64,09	0,26	Low

Table 5. Increase in Student's Understanding

In the experimental group that using this flipbook, obtained an N-Gain of 0.39 which is included in the "moderate" category. While the increase in understanding in the control group was lower than the experimental group. A learning process that is designed according to the dominant type of intelligence of students will be more enjoyable (Madkour & Mohamed, 2016). In this study, the understanding aspect is based on the revised bloom taxonomy (Conklin, 2005). These aspects consist of interpretations, examples, classifications, summaries, conclusions, comparisons, and explanations. The increase in each aspect is presented in Figure 4.
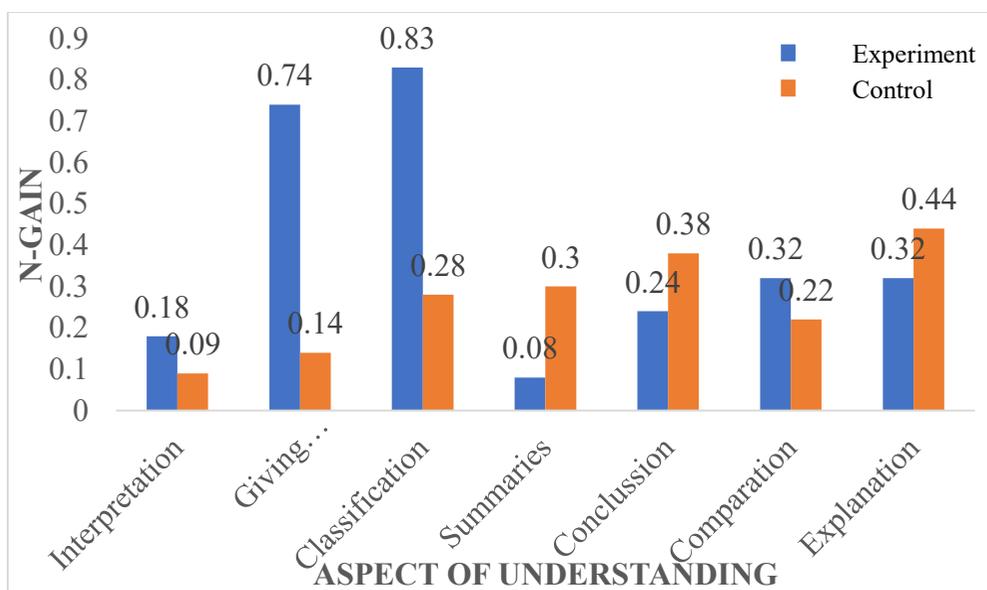
Figure 4. The Increase in Each Understanding Aspects

In the experimental group, the aspects of giving examples and classifying have a high increase because before the learning process, students have not learned about the concepts of temperature, heat, and expansion related to definitions, examples, grouping, and their application in everyday life. Aspects of comparison and explanation increased in the moderate category. In the understanding test instrument, the items used to measure comparative aspects require logic and calculating skills in solving them. While in the explanation aspect, students need to explain concepts and explain the causes and effects of an event. Science flipbook based on LSMI provides an opportunity for students to rewrite what they have learned in their own words in the "Let's Understand" feature. Students are also trained to explain in discussion and presentation activities. In the "Let's Show" feature, students are given the opportunity to explain their findings, relate them to the concepts being studied, and provide suggestions and responses when other groups make presentations.

Aspects of interpretation, summary, and conclusions have increased in the low category. Interpretation in this case refers to the ability to translate information in a certain form so that its meaning can be understood. In fact, some students are not used to capturing information from tables, pictures, graphs, diagrams or data sets correctly. Especially in science learning, the ability to interpret is important because the phenomena that occur are not always explained in sentences, but can also be in the form of equations and symbols. In addition, the results of observations/experiments are also presented in various forms. If it cannot be interpreted, then the collection of data and information becomes meaningless and furthermore can lead to erroneous interpretations. In this flipbook, students are given the opportunity to be able to interpret data based on their findings when doing simple practicums. However, there are not many practice questions and features that allow students to practice their ability to interpret, so the improvement is not very significant.

Whereas in the conclusion aspect where students need to provide a brief statement of the entire discussion or analysis also experienced a relatively low increase. Students are directed to be able to provide conclusions based on the results of simple experiments, and together with the

teacher to conclude what has been learned during learning activities. However, to get a conclusion requires a lot of information, data, points of view, and theories to be synthesized later. Of course, the expertise in giving these conclusions requires a process, so it cannot be achieved instantly with just three or four learning activities. In general, we can see that there is no improvement in the understanding aspect in the control class which is included in the high category.

Increase in Critical Thinking Skills

First, we have examined the distribution priorities of the data and non-parametric statistics. The results are showed in the Table 6 and Table 7.

	Kolmogorov-Smirnov			Shapiro-Wilk		
Group	Statistic	df	Sig.	Statistic	df	Sig.
Pretest (experiment group)	0.119	32	0.200	0.976	32	0.690
Postest (experiment group)	0.178	32	0.012	0.928	32	0.034
Pretest (control group)	0.113	33	0.200	0.952	33	0.149
Postest (control group)	0.182	33	0.007	0.942	33	0.077

Table 6. Tests of Normality of the Critical Thinking Data.

Based on the results of the normality test, the significance for critical thinking pretest for experimental group, critical thinking pretest for control group, and critical thinking posttest for control group are 0.690, 0.1499, and 0.077, which means > 0.05 so that the data is normally distributed. However, for the critical thinking posttest data for experimental group is 0.034, which means < 0.05, so the data is not normally distributed. Therefore, data analysis was then carried out using non-parametric statistics, namely the Mann-Whitney test and the Cohen's D Effect Size test.

	Ranks			Result			
Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Wilcoxon	Z	Asymp. Sig. (2-tailed)
Experiment (Postest)	32	39.75	1272.00				
Control (Postest)	33	26.45	873.00	312.000	873.000	-2.852	0.004
Total	65						

Table 7. Mann-Whitney Test Results for the Critical Thinking Data.

Based on the results of the Mann-Whitney test, the Sig. (2-tailed) value was obtained at 0.004 <0.05. Thus, there is a significant difference in the value of students' critical thinking skills after using flipbook based on LSMI, with the average value of students' critical thinking skills in the experimental group being 51.9544 higher than the value of students' critical thinking skills in the control group, which is 42.5215. Thus, it can be concluded that the use of science flipbooks has high effectiveness in increasing students' critical thinking skills.

The increase of students' critical thinking skills analysis using data pretest and posttest. The instrument used consisted of eight essay questions which represents eight aspects of critical thinking skills, namely: objectives, questions to problems, assumptions, point of view, information, concepts, interpretations and inferences, as well as implications and consequences. The increase of critical thinking skills can be seen in Table 8.

Group	Score				Category
	Ideal	**Pretest**	**Postest**	**N-Gain**	
Experiment	100	35,94	51,95	0,25	Low
Control	100	29,45	42,52	0,19	Low

Table 8. The Increase in Critical Thinking Skills

Table 8 shows that there is an increase in students' critical thinking skills as indicated by the positive N-Gain, although the increase in the experimental group and the control group is relatively low. This is influenced by several things, one of which is that students are not used to working on questions that are the same type as those tested when pretest and postest. Most students only answer with short and incomplete sentences because they are not proficient in expressing their knowledge using their own sentences. Therefore, students need to be given lots of examples and exercises on critical thinking skills. In the developed flipbook there are several practice questions, but they are not sufficient to practice critical thinking skills optimally because there are not many of them. In order to obtain better results, it is necessary to increase the case examples and practice questions in flipbook.

Students are more able to think critically in solving existing problems related to temperature, heat, and expansion which are marked by increased scores compared to before learning was carried out. This is because students are active in participating in every learning activity contained in the features of teaching materials. The development of flipbook based on learning style and multiple intelligence refers to problem-based learning syntax. Problem-based learning leads students to find useful facts and find concepts that are difficult to find. PBL can change students from passive recipients of information to become active, independent learners, and problem solvers, thus helping students learn new knowledge through problems they encounter. The solution to this problem is not absolute, it only has one correct answer, meaning that students are required to study continuously critical and creative.

The features in science flipbook based on LSMI provide opportunities for students to be able to develop their critical thinking skills. Starting with the "What's around us" feature where students are trained to find problems and find unique phenomena that exist in their environment. This not only motivates students to find the correct answer, but also motivates them to follow each stage in solving problems (Lestari & Winanti, 2017). Then students make a simple experimental design in "Let's Do It". Students are also trained to be able to determine hypotheses or initial guesses related to the problem to be studied, as well as methods and methods of analysis. After carrying out the experiment in small groups, students make conclusions based on the data/phenomena found and the results of discussions with their group mates. After that, students present their results in front of the class (the "Let's Show" feature) where other groups will respond by providing input and suggestions. Critical thinking skills are needed so that in the future students are able to filter information, choose whether or not a need is appropriate, question the truth, and all things related to life. Critical thinking allows students to find the truth amidst the many events and information in everyday life (Kurniati, Pujiastuti, & Kurniasih,

2017).

Critical thinking includes component skills in analyzing arguments, making conclusions using inductive or deductive reasoning, assessing or evaluating, and making decisions or solving problems. Critical thinking allows students to study problems systematically, face various challenges in an organized manner, formulate innovative questions, and design solutions. People who have ideal critical thinking skills are people who have high curiosity, extensive experience, full of confidence, open-minded, flexible, diligent in searching for relevant information, and reasonable in the selection of criteria (Facione, 2000). Critical thinking is something very complex. By Therefore, to practice critical thinking skills it is not enough just to have one learning cycle, but continuously. Science flipbook based on LSMI trains critical thinking skills within a limited scope, because it only contains one material, namely temperature, heat, and expansion. Each topic may require a different thought process different. In order to obtain a more significant increase, the development of science flipbook in the future needs to contain more elements or activities that train every aspect of critical thinking.

In "question at issue" aspect, students are expected to be able to ask questions that identify problems. During the learning process using science flipbook based on LSMI, there is a feature "What's around us?" which gives students the opportunity to write down whatever comes to mind when they hear about temperature, heat, and expansion, and detects problems that exist in everyday life related to the topic the. Asking problems or questions by the students themselves has more potential for students to better understand the learning material than if they were only asked to answer questions from the teacher (Brown & Walter, 2005).

For the "concept" aspect, students are expected to be able to explain concepts related to material and or phenomena discussed from one or several disciplines. Before treatment is given in the form of learning using science flipbook based on LSMI, students have not learned about the concepts of temperature, heat, and expansion. So, the pretest score is quite low. Then the concept is obtained when students are active in participating in learning activities so the postest score is better. The "Let's Read" feature contains concepts related to temperature, heat, and expansion. In addition, learning activities that involve students to conduct experiments and discuss with their group mates can also strengthen the concepts being studied. If students are not trained to find the knowledge concepts they have, then there can be problems that will hinder the development of their thinking skills (Hadisaputra, Gunawan, & Yustiqvar, 2019); (Ramdani, *et.al*., 2020).

The next aspect that has increased in the moderate category is implications and consequences. In this aspect, students are expected to be able to make implications of the observed phenomena by associating the concepts that apply in them and predict the consequences that occur from a phenomenon based on the concepts learned. In addition to the three aspects of critical thinking skills that have been described previously, five other aspects experienced a relatively low increase. In the critical thinking skills aspect of "objectives", students are expected to be able to analyze the objectives of the actions taken. In teaching materials, this ability is trained when students make simple experimental designs and write down the objectives of the experiment. Furthermore, for the aspect of critical thinking skills "assumptions", the ability expected is that students are able to formulate assumptions from a phenomenon that occurs. Assumptions are temporary conjectures that are accepted as the basis/foundation of thinking because they are considered correct. In science flipbook based on LSMI, aspects of assumptions are trained when students in groups make simple experimental designs where students need to write hypotheses.

The next aspect of critical thinking skills is "point of view", where the ability expected is that students can interpret and understand other people's points of view. Diagram of the increase of each aspect of critical thinking skills can be seen in Figure 5.
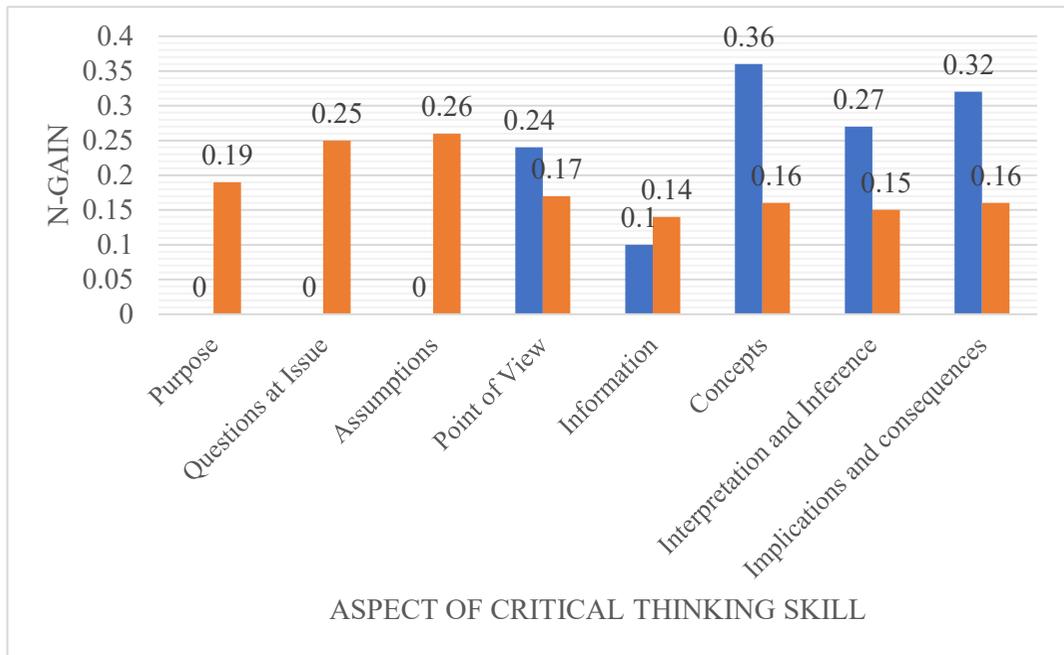

Figure 5. The Increase in Each Aspect of the Critical Thinking Skills

Each aspect of critical thinking skills in the control group experienced an increase, but all of them increase in the low category. This is because the science teaching materials used in the control class have not facilitated students to be actively involved in various learning activities. The information aspect has experienced the least increase compared to other aspects because students tend to be passive and only listen to the teacher's explanation.

The Effectiveness of Science Flipbook Based on Learning Styles and Multiple Intelligences

The effectiveness of science flipbook based on LSMI in improving students' understanding and critical thinking skills can be known through the Cohen's D effect size test. The Cohen's D effect size test results can be seen in Table 9.

Effect Size	d	Interpretation
Understanding	0.759303	Large
Critical Thinking Skills	0.797884	Large

Table 9. Effect Size Calculation Results

From the table 9 we can see that the effectiveness of using flipbook to students' understanding and critical thinking skills included in the large category. This effectiveness is due to the developed science flipbook presenting structured material descriptions, guiding students to build

their concepts independently through each stage of learning, and there are examples that exist in everyday life so as to provide opportunities for students to acquire concepts more easily.

Conclusions

Science flipbook based on LSMI which was developed with the ADDIE model does not only present material in text form but also includes audio and video. It aims to facilitate students with different learning styles. In addition, there are features that facilitate student's multiple intelligences, such as: what's going on around us, let's read, let's do it, let's show, let's understand, let's practice, let's sing, as well as temperature, heat, and expansion in the Qur'an. The flipbook developed have met the eligibility criteria in the aspects of content, language, presentation, and graphics.The use of science flipbook based on LSMI can improve student's understanding in the moderate category and increase students' critical thinking skills in the low category. The effectiveness of science flipbook based on LSMI in improving students' understanding and critical thinking skills are included in the large category.

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