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DEVELOPMENT OF STEM-BASED FLIPBOOK ON BIODIVERSITY MATERIALS TO TRAIN CRITICAL THINKING SKILLS FOR X-GRADE STUDENTS OF SENIOR HIGH SCHOOL

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Abstract

One of the skills of students in learning activities in 21st century education is critical thinking skills. Critical thinking skills can be developed by means and appropriate learning resources. The COVID-19 pandemic condition requires the distance learning process (PJJ) of course to require learning resources that can be accessed by teachers and students even though they are not in one place. One of the learning resources used in the learning process is electronic media, one of which is flipbook. Flipbook is an electronic book that is presented digitally and can be flipped that contains text, images, audio, video, and hyperlinks. Flipbook contains various features that can be used as learning resources for students on biodiversity material and can train students to think critically. The purpose of this research was produced a valid and practical STEM-based flipbook (Science, Technology, Engineering, Mathematics). Research used 4D models (Define, Design, Develop, and Disseminate stage) but Disseminate stage was not carried out. The theoretical feasibility of the flipbook was obtained from validation by expert lecturers, namely material and education expert lecturers and high school biology teachers. Flipbook validation was measured based on presentation, content, and linguistic aspects. The practicality test was evaluted based on student's responses collected by questionnaire of 13 students X MIA 4 SHS 14 Surabaya. The analysis technique was quantitative descriptive. The flipbook was said to be very feasible with a validity result of 90.75 % with very valid criteria. Flipbook is also stated to be very practical based on the results of the student response questionnaire of 93.1% with very practical criteria. It can be concluded that theflipbook based on STEM (Science, Technology, Engineering, Mathematics) on biodiversity material to train critical thinking that has been developed is declared valid and practical.

Keywords:Distance Learning Process (PJJ), Electronic Book, Biodiversity material, STEM (Science, Technology, Engineering, Mathematics), Critical Thinking

PRELIMINARY

The skills of students in learning activities in 21st century education are life and career skills, information technology and media skills as well as learning and innovation skills (Kemendikbud, 2013). Learning and innovation skills cover various criteria such as critical thinking, problem solving processes, communication, collaboration, and creativity. These criteria are packaged and developed in the 2013 curriculum (Wijaya, 2016). The 2013 curriculum is expected to be able to support the learning process of students to achieve the criteria for learning and innovating. So that in the next few years it can improve the quality of students to become productive, creative, and innovative human beings. These skills and abilities will be used by students as a provision for global competition after graduation.

Critical thinking is a process of making rational decisions that are directed at deciding to believe or do something. Critical thinking is a continuous, active, and thorough process but critical thinking skills are still not applied in schools, students in schools are generally encouraged to give correct answers rather than come up with new ideas or rethink existing conclusions (Syahbana, 2012). These activities will certainly improve students' critical thinking, but based on the results of a survey conducted by PISA (Program for International Student Assessment) the critical thinking skills of Indonesian students are still below the international average. Indonesia occupies the 3rd position from the bottom in Science performance in both the male and female divisions when viewed from the average score by the two divisions (OECD, 2016).

To support the ability of students to develop their critical thinking skills, the role of learning media is needed. Learning media is something that contains messages that are intentionally developed or used as a means for students to gain experience and carry out practices that allow the learning process to occur (Kemendikbud, 2013). There are various types of learning media that can be used by students in supporting the learning process, according to Sudjana, there are several learning media that can be used by students to support the learning process, the media are printed media, electronic media, techniques, and the environment (Sudjana, 2010) .

Based on Circular no. 4 of 2020 concerning the implementation of education policies in the emergency period of the spread of COVID-19, the COVID-19 pandemic that hit Indonesia caused a change in the order of life, namely by working, attending school, and worshiping from home. Of course this affects the learning paradigm in Indonesia. Educational institutions require the process of learning activities to be carried out remotely. Teachers continue to teach students through online which can be done from their respective homes. This new policy certainly requires teachers to develop learning media by utilizing online media (online). Electronic media is an alternative that can be used during the COVID-19 pandemic. One form of electronic media that can be used for online learning media is flipbook. Flipbook is a collection of pictures that vary from one page to the next so that when the picture is flipped back and forth quickly it will look like animate and become a simple book(Ricky, 2014). Flipbook is designed in three dimensions so that it gives the impression of reading a book in general and is able to display audio, visual, sound, and movie which can be used as learning media by students. The three-dimensional design developed on the flipbook makes it easier for students to understand a learning material and students can use more senses that are used in the learning process.

STEM-based flipbook (Science, Technology, Engineering, Mathematics) is an approach to the learning process that links aspects of science, technology, engineering skills, and mathematics. STEM-based education is expected to be able to form human resources who can reason and think critically, logically, and systematically, so that in the future they are expected to be able to face global challenges and solve life's problems. STEM is designed to increase global competitiveness in both science and technology innovation in an effort to improve understanding of the integration of STEM education in society (Kemendikbud, 2013).

METHOD

This research was a development research using a 4D development model (Define, Design, Develop, and Disseminate) without the Disseminate stage. This research process was from March 2021 to July 2021. The Define, Design, Develop process was taken place at the Department of Biology, FMIPA, State University of Surabaya. While the trial phase was carried out on 13 students of class X MIA 4 SHS 14 Surabaya. The trial process was carried out using the Whatsapp group and google form.

At the Define stage, it was done by analyzing the objectives in the material to be developed in the flipbook. There were five stages of defining analysis, namely curriculum analysis, student analysis, learning objectives analysis, concept analysis, and task analysis. Curriculum analysis based on the 2013 curriculum for Biodiversity K.D. 3.2 analyze various levels of biodiversity in Indonesia and their threats and conservation and K.D. 4.2 presented the results of observations of the level of biodiversity in Indonesia and proposed conservation efforts. At K.D. The material contained in the form of the definition of biodiversity, the level of biodiversity, the grouping of living things based on the level of biodiversity, and the role of biodiversity for biodiversity. Analysis of students was doing at the beginning of planning by taking into account the abilities of each individual student and the ability of students in groups. This stage was to find out how much the ability of students to learn the material to be studied. The results of this analysis would be used as a reference for the preparation of the flipbook that will be developed. Analysis of learning objectives based on the reference indicators to be achieved. The analysis of learning objectives was used to determine the direction of the learning material that will be delivered to students. Concept analysis was done by analyzing the concepts that will be conveyed to students and used as an integrated concept for the preparation of flipbooks. Task analysis was a stage to determine the content of learning materials that are packaged in the form of tasks that are adjusted to the indicators.

The Design or planning phase was designed a STEM-based Flipbook on Biodiversity material and consult the results of the flipbook design to the supervisor. Flipbook development flow in the form of:

1. Selection of the type of learning device
   The type of learning device chosen was in the form of a flipbook which was designed based on indicators of the achievement of student competencies that must be achieved. As well as the delivery of material in a flipbook that refered to STEM.

2. Flipbook compilation
   The preparation of the flipbook refered to the 2013 curriculum section of K.I. and K.D material on biodiversity. The strategy used in this flipbook was STEM-based.
3. Initial flipbook design
   The initial design of the flipbook was in the form of a STEM-based flipbook designed on Biodiversity material which contained various sub-chapters of biodiversity material, instructions for using flipbooks, features that support the delivery of material in each sub-chapter, as well as test questions at the end of each sub-chapter to test students' understanding of the material that has been studied. (Thiagarajan, 1974)

The Develop or development stage was carried out by assessing experts or validating and conducting limited trials. The assessment of the expert was based on the scope of the material and the systematics in the flipbook design that has been made. A limited trial was conducted with a SHSll group of students using the flipbook. This limited trial used a trial design of One-Group Pre-test Post-test Design on 13 students of class X MIPA 4 SHS 14 Surabaya.

The validity of the STEM-based flipbook was validated by experts, namely one material expert lecturer, one education expert lecturer, and one high school biology teacher. The validity of the STEM-based flipbook was theoretically carried out using a validation sheet instrument that was assessed by experts. The validation sheet was in the form of an assessment rubric based on the results of flipbook analysis based on STEM biodiversity material. The validity of this STEM-based flipbook was based on criteria adapted from the Likert Scale by Riduwan (Riduwan, 2013). The validation score assessment was calculated using the following formula:

$$p\ validation\ score\ (\%) = \frac{\Sigma obtained\ score}{\Sigma maximum\ score} \times 100\%$$

Based on the presentation of the validation scores obtained, then interpreted using the validity criteria (Table 1). The developed flipbook was said to be valid if it gets a percentage score of 71% (Riduwan, 2013).

Table 1. Criteria for flipbook validity based on Likert Scale

Percentage (%) Criteria

Percentage (%)	Criteria
25-40	Invalid
41-55	Not valid
56-70	Sufficiently valid
71-85	Vakid
85-100	Very valid

(Riduwan, 2013)

The practicality of flipbooks was seen from the students' responses to STEM-based flipbooks. Obtaining student responses is carried out through a google form that is provided by whatsapp group. The practical response of STEM-based flipbooks was obtained from 13 X MIPA 4 students at SHS 14 Surabaya. Furthermore, the results of student responses were reviewed based on the Guttman Scale using "Yes" or "No". The percentage of student responses related to the practicality of flipbooks could be calculated using the following formula:

$$p\ response\ (\%) = \frac{\sum yes\ answer\ score}{\sum maximum\ score} \times 100\%$$

The results of the calculation of the percentage were obtained then interpreted using practicality criteria as shown in Table 2. Flipbooks were said to be practical if they get a percentage score of 71% (Riduwan, 2013).

Table 2. Criteria for practicality of flipbooks

Percentage (%)	Criteria
25-40	Invalid
41-55	Not valid
56-70	Sufficiently valid
71-85	Vakid
85-100	Very valid

(Riduwan, 2013)

Based on the results of the percentage scores of validity and practicality values that have been obtained, it was followed by a quantitative descriptive analysis.

RESULTS AND DISCUSSION

The STEM-based flipbook on biodiversity material to train critical thinking that was developed was declared valid and practical theoretically and empirically. The results of the presentation scores of the validity and practicality criteria were obtained from the value of the results of the validation by experts and the value of the student's OK response questionnaire. The flipbook development had four sub-chapters, named biodiversity, level of biodiversity, threats to biodiversity, and efforts to preserve biodiversity. In the sub-chapter on biodiversity contained the definition of biodiversity by experts. The subsection on the level of biodiversity contained definitions and examples of the three levels of biodiversity, namely biodiversity at the level of genes, populations, and ecosystems). The sub-chapter on threats to biodiversity contained various kinds of threats that could disrupt the balance of biodiversity. The sub-chapter on efforts to conserve biodiversity contained various

efforts and examples of activities that could support efforts to conserve biodiversity.

There were three parts to the flipbook that were developed, named introduction, content, and closing. Flipbook wasdesigned using B5 paper and used Book Antiqua and Times New Roman font size 12 which contained text content, files, images, videos, and hyperlinks that were connected directly to the internet. The flipbook that was developed was designed using Canva and Microsoft Office Word 2013 and then converted to Flip PDF Professional software to be used interactively and can be flipped (back and forth).

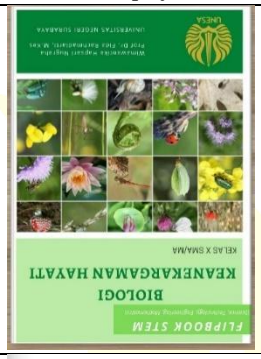
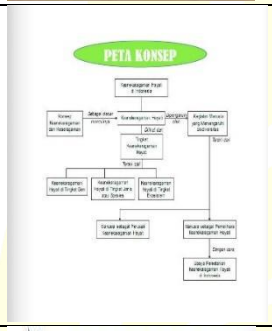
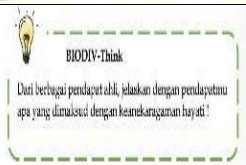
Some of the characteristics of the Biodiversity flipbook are presented in Table 3.

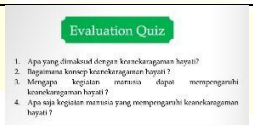
Table 3. Characteristics of the Biodiversity Flipbook

No.	Crriteria	Characteristic
1	Introduction	a. Electronic form (flipbook) b. Files in the form of .exe c. There was an effect of moving pages by flipping d. There were various supporting content in the form of images, videos, and audio e. There were hyperlinks to certain websites or pdf files. f. It was interactive because it combines various types of media to support the delivery of material in flipbooks
2.	Contens	a. Materials in the form of KD 3.2 and 4.2 curriculum 2013 grade 10 SHS b. Contained the concept of biodiversity clearly and interactively c. Had several features that can support students' critical thinking skills
3.	Usage	a. Could be used using a laptop or SHSrtphone b. Could be used online and offline (in the form of pdf.) c. Used in .pdf format could reduce the interactive functions contained in flipbooks

The developed flipbook had several components and features in it. The components contained in the flipbook are front cover, preface, table of contents, book characteristics, material concept maps, materials, quizzes at the end of each material sub-chapter, reflection, glossary, bibliography, back cover, and various features that support critical thinking skills. learners. The features in this flipbook are BIODIV-Thik, BIODIV-Read, BIODIV-Watch, BIODIV-Search, BIODIV-Trends, BIODIV-Act. (**Table 4**).

Table 4. Flipbook appearance and features

No.	Display	Feature
1.		The cover of the flipbook at the beginning contained pictures of various biodiversity that directs students to understand the study of the discussion contained in the book. •STEM-based flipbook by developing the four STEM elements, namely Science, Technology, Engineering, and Mathematics.
2.		Concept maps made it easier for students to understand the flow and concepts of the learning material in this flipbook. As well as mapping the main concepts in the material on Biodiversity.
		**BIODIV-Think**There were questions related to the material of each sub-chapter of the flipbook to determine students' understanding of the explanation of the material.
		BIODIV-Read Contained readings related to the discussion of sub-chapters to increase students' knowledge.
		BIODIV-Watch this feature contained videos or video links related to the material for each sub-chapter to increase students' understanding
		BIODIV-Search feature that contained instructions for students to browse the web for journals related to research in the field of Biodiversity

		BIODIV-Trends feature contained the latest technological discoveries related to Biodiversity.
		BIODIV-Act Containedexperimental activities that could be done by students to apply the material in real activities
		**Evaluation Quiz** contained questions to test students' understanding of the material available in the flipbook
		Refleksi contained reflection activities on subject matter that has been understood to be reflected in daily activities.

The development of this flipbook refered to KD 3.2 and 4.2 as well as critical thinking indicators developed by Facione (2015) which are integrated using STEM-based learning. The six critical thingking indicators developed by Facione (2015) explained like this :

1. Describing – by clearly defined what you were talking about, what specifically was involved, where it took place and under what circumstances.
2. Reflecting – reconsidered a topic by taking into account new information or a new experience, or considering other viewpoints.
3. Analyzing – examined and then explained how something was, including comparing and contrasting different elements and understanding relationships to your subject/topic.
4. Critiquing – identified and examined weaknesses in arguments, as well as acknowledging its strengths. It was important to think of critiquing as 'neutral' and not negative.
5. Reasoning – used methods such as cause and effect to demonstrate logical thinking, as well as presenting evidence that either refutes or proves an argument.
6. Evaluating – could include commenting on the degrees of success and failure of something, or the value of something

Science in the biodiversity flipbook was reflected in the features BIODIV-Think, BIODIV-Read, and BIODIV-Search. The science aspect was shown in each discussion material in these features which were still related to biodiversity material. In the BIODIV-Think feature, the critical thinking indicator that was trained is interpretation. Activities in the feature that develop interpretation indicators were where students explain using their own language related to the concept of biodiversity based on the understanding of several experts. In the BIODIV-Read feature, the critical thinking indicator developed was analysis. Activities in the features that support the analysis indicators were that students understanding the contents of reading articles about the level of biodiversity and finding the characteristics of differences between the three levels of biodiversity. In the BIODIV-Search feature, the critical thinking indicator developed was inference. Activities in features that supported inference indicators are that students searched journal web browsing to find out various threats to biodiversity.

The technology in the biodiversity flipbook was listed in the BIODIV-Watch and BIODIV-Trends features. The technology aspect was shown in the explanation topic about various technologies that could be used to protect biodiversity from the threat of extinction. In the BIODIV-Watch feature, the critical thinking indicator developed was explanation. The activity in the feature that developed explanation indicators was that participants analyzed the content of the video and explained the procedure for protecting orangutans in Tanjung Puting National Park. In the BIODIV-Trend feature, the critical thinking indicator developed was inference. Activities in the feature that develop inference indicators were predicting every latest technological trend that was useful in efforts to preserve and protect biodiversity.

Engineering on the biodiversity flipbook was listed in the BIODIV-Act feature. The engineering aspect was shown in the various techniques used in the pilot process to classify various levels of biodiversity. In the BIODIV-Act feature, the critical thinking indicator developed was evaluation. The activity in the feature that developed evaluation indicators was that students make simple observations to find out the used of biodiversity for biodiversity in various fields.

Mathematics on the biodiversity flipbook was listed in the BIODIV-Act feature. Aspects of mathematics was shown in the way of mathematical calculations to show the level of density of species or populations in an ecosystem. In the BIODIV-Act feature, the critical thinking indicator developed was self-regulation. Activities in the feature that develop self-regulation or self-regulation were environmental observation activities to carry out censuses of various species and populations in an ecosystem then calculations were carried out to determine the percentage of species and population density, self-regulation was needed in examining the results of calculations whether they are in accordance with conditions in the environment. environment.

The integration of STEM activities could cultivate student thinking skills which could help students form the ability to analyze, evaluate, make conclusions and arguments correctly and logically about problems to be solved (Chia & Maat, 2018). This was in accordance with the contents of the book which contained various STEM integrated activities as seen in the various features above, such as the ability of science shown in the BIODIV-Read feature with readings on the characteristics of the three levels of biodiversity as well as a hyperlink that lead to a pdf file of a website for read biodiversity threats. The technology aspect was shown in the BIODIV-Trends feature which provided reading about the latest technology used to overcome the threat of extinction of biodiversity. Engineering aspects were shown in the BIODIV-Act feature in the form of various techniques used to classify species into three levels of biodiversity. The mathematical aspect was shown in the BIODIV-Act feature in the form of calculating the percentage density of a population in a particular ecosystem. Of course, the various activities on these various features that refered to the STEM aspect could lead students to solve the threat of biodiversity conservation.Of course, the ability to solve problems using integrated aspects of STEM would train students' critical thinking skills in an effort to solve problems in everyday life. It is based onArizkah, Herman, & Palloan (2018)the application of critical thinking skills in learning would make students accustomed to identifying, analyzing, thinking logically, and making the right decisions in solving problems found in everyday life.

The flipbook that has been developed was then validated by experts to obtain theoretical feasibility. This feasibility test was conducted to determine whether the developed flipbook was in accordance with the validation criteria. The validation criteria used were obtained from the adaptation of the National Education Standards Agency (BSNP, 2014) namely the feasibility of presentation, content feasibility, and language feasibility. The results of the validation of the biodiversity flipbook were shown in **Table 5** below.

Table 5. Flipbook validation results recapitulation

No	Aspects assessed	V1	V2	V3	Average	Percentage(%)	Criteria
A. Serving Eligibility							
1.	Ease of access	4	4	3	3.67	91.67	Very valid
2.	Visual display	3	4	4	3.67	91.67	Very valid
3.	Design	3	4	4	3.67	91.67	Very valid
4.	Image quality	3	4	4	3.67	91.67	Very valid
5.	Sentence arrange Ment	4	4	3	3.67	91. 67	Very valid
6.	Use of symbols and terms	4	3	4	3.67	91.67	Very valid
The average presentation feasibility score					3.67	91.67	Very valid
B. Content Eligibility							
1.	Completeness of components	4	4	4	4	100	Very valid
2.	Accuracy of material coverage	3	3	4	3.33	83.25	Valid
3.	Up-to-date flipbook content	3	3	3	3	75	Valid
4.	Content skills	3	3	4	3.33	83.25	Valid
5.	Conformity of concept with KD	4	3	4	3.67	91.67	Very valid
6.	The suitability component of STEM aspects	4	3	4	3.67	91.67	Very valid
7.	The suitability component of critical thinking aspects	4	3	4	3.67	91.67	Very valid
8.	Critical thinking study activities	4	3	4	3.67	91.67	Very valid
The average content feasibility score					3.54	88.52	Very valid
C. Language Eligibility							

1.	Presentation language technique	4	3	4	3.67	91.67	Very valid
2.	Supporting presentation language	4	3	4	3.67	91.67	Very valid
Average language eligibility score					3.67	91.67	Very valid
Overall aspect average					3.63	90.75	Very valid

The presentation eligibility criteria obtained an average percentage of 91.67% which was classified as very valid. In addition to calculating the average value of the assessment, the mode is also sought from each aspect of one category. The mode was determined to find out the shortcomings of the validation results provided by the validator, the maximum score was that all three aspects or all aspects are met, on the contrary if the score given was not optimal then there were several criteria that could not be achieved during flipbook development (Wijayanti & Mulyono, 2019). The mode of each aspect in the presentation feasibility category was 4 which is the maximum value, this indicated that all aspects have been met. This percentage value was based on aspects of ease of access, flipbook display, sentence structure and the use of appropriate images, symbols, and terms. According to the National Education Standards Agency (BSNP, 2014) that the feasibility of presenting a book paid attention to presentation techniques, presentation support, learning presentation, and learning completeness. The presentation technique on the biodiversity flipbook used a flipbook model with the .exe file type to make it easier for students to access. In accordance with Syuryani's statement (2020) the type of interactive e-book file in the form of .exe could be operated easily. This biodiversity flipbook also contained pictures, symbols, and terms that could increase students' understanding. This was in accordance with the statement (Agustina, 2020) Supporting the presentation in the form of pictures, symbols, and terms to make it easier for students to understand the content of the material.

The content eligibility criteria obtained a validation value percentage of 88.52% which was categorized as very valid. The mode value obtained was 4, indicating that all aspects of the content eligibility criteria have been met. According to the National Education Standards Agency (BSNP, 2014) the content feasibility category takes into account the accuracy of the material, the up-to-dateness of the material, and the breadth of the material. Aspects of completeness, accuracy, up-to-date, skill, material suitability belong to the category of material accuracy. The material on biodiversity contained in the flipbook is based on KD 3.2 analyzing various levels of biodiversity in Indonesia and their threats and conservation and 4.2, named presenting the results of observations of the level of biodiversity in Indonesia and proposed conservation efforts. The description of Basic Competencies in the Biodiversity material stated that students were required to analyze data in the form of solutions to a problem. The activity of analyzing and presenting solutions was a learning activity that was included in high order thinking skills (HOTS), so that to achieve competence in these materials in learning activities students must be trained to think at a high level in order to achieve high learning outcomes in accordance with the demands of competence (Akbar & Wisanti , 2018). High Order Thinking Skill (HOTS) learning activities could train students' critical thinking skills. Gradini (2019) suggested HOTS learning by emphasizing critical thinking skills. Aspects of critical thinking in flipbooks were shown in each activity in various features of the biodiversity flipbook which were able to develop six critical thinking skills. Six critical thinking skills according to Facione (2015) were interpretation, analysis, evaluation, inference, and self-regulation. Critical thinking could improve students' ability to think logically and find solutions to a problem, for example in the matter of biodiversity, that was, students were trained to find efforts to overcome the threat of extinction at various levels of biodiversity. The application of critical thinking skills in learning would make students accustomed to identifying, analyzing, thinking logically, and making the right decisions in solving problems found in everyday life (Arizkah, Herman, & Palloan, 2018). STEM components were also seen in every activity on various flipbook features. We found the four STEM components, named science, technology, engineering, mathematics in our daily activities. It aimed to make students more interested in learning because it wasrelevant and real so that it could be found in the surrounding environment. Students could apply the concepts obtained from the latest research results so that they could add insight to students regarding current research and technology developments (Pratiwi & Rachmadiarti, 2021). Learning that involved STEM components to train students' critical thinking skills on biodiversity material by finding solutions to biodiversity threats with various STEM aspects.

The feasibility of the language obtained an average validity value of 90.75% which was categorized as very valid. The mode value obtained was 4, indicating that the linguistic criteria have been met. According to the National Education Standards Agency (BSNP, 2014) the language used in books should be informative, communicative, and in accordance with the level of

thinking of students. The choice of words in the book was one of the languages of communication in delivering material to students so that the choice of language must be adjusted to the character of the students. This was in accordance with the opinion of Utami (2011) using the communicative language method, the results of which were greater students' speaking abilities which indicated that students understood the content of the material.

Critical thinking was a mental process. From this, individuals needed to actively and skillfully conceptualize, apply, analyze, synthesize, and evaluate information to reach an answer or conclusion (Costa & ., 2014). They need to be able to determine alternative solutions and to analyze the influence of their own values and the values of those around them (Hove, 2011). The integration of STEM in school curricula aimed to strengthen the ability of students to be critical thinkers and analytical problem-solvers (Nasarudin, Halim, & Zakaria, 2014) . The average of all aspects showed a percentage of 90.75% which was classified as a very valid category. Of course, this shows that STEM-based flipbooks on biodiversity materials were able to train students' critical thinking. Various features in the flipbook such as BIODIV-Think, BIODIV-Read, BIODIV-Search, BIODIV-Watch, BIODIV-Trends, and BIODIV-Act were able to train students' critical thinking skills in biodiversity material. Students' critical thinking skills were trained by finding solutions to the problems of biodiversity threats with STEM aspects. this lead to KD. 3.2 analyze various levels of biodiversity in Indonesia and their threats and conservation

In addition to the validity value obtained from the validator, there was also data from the recapitulation of positive response questionnaires of students to determine the practicality of flipbooks as shown in **Table 6.**

Table 6. Flipbook validation results recapitulation

No.	Aspects assessed Positive response (%)	Positive response	Criteria
1.	Biodiversity flipbook presentation	91.66	Very practical
2.	Contents of the flipbook on biodiversity	89.22	Very practical
3.	The language of the biodiversity flipbook	100	Very practical
4.	STEM (*Science, Technology, Engineering, Mathematics*) aspects	86.53	Very practical
5.	Aspects of critical thinking	98.46	Very practical
Rata-rata		93.17	Very practical

The percentage obtained from the results of student responses regarding the practicality of the biodiversity flipbook is 93.17% which was categorized as very practical. The flipbook presentation aspect received a positive response of 91.66% which was classified as very practical. Flipbook presentation that could be flipped over and could be accessed easily using a smartphone or laptop. According to Faradiba's opinion (2020), the practicality of learning media shown by easy access such as flipping through like an ordinary book could make it easier for students to use flipbooks. The content aspect of the flipbook received a positive response of 89.22% and was classified as very practical. Explanation of biodiversity material was easily understood by students with pictures, audio, and videos that made it easier for students to understand the content of the material. In accordance with Wilianto's research (2015) as well as helping to increase the imagination of students in accordance with the purpose of making electronic modules, one of which is a flipbook. Also, Wong and Wong (2010) claimed meaningful STEM activities do not solely improve the understanding of concepts but increase student interest in these subjects (Kutch, 2011). The linguistic aspect got a percentage of 100% and was classified as a valid category. The use of language that was clear and did not cause multiple interpretations makes it easier for students to understand the content of the material. According to Ariningrum's research (2016) that the language used was based on the General Guidelines for Enhanced Spelling and the Big Indonesian Dictionary. The language aspects in the development of this assessment instrument included, 1) grammar and spelling according to the rules of the General Guidelines for Indonesian Spelling (PUEBI), 2) the use of short and clear language, 3) the formulation of sentences did not cause multiple interpretations or misunderstandings. Aspects of STEM (Science, Technology, Engineering, Mathematics) obtained a positive response percentage of 86.53% which was classified as very practical. This practicality made students motivated to learn using STEM-based flipbooks. These results were supported by Stolk et al (2021) which states that STEM was able to increase learning motivation through testing the relationship between motivation, pedagogy, and gender identity of students. Aspects of critical thinking got a percentage of 98.46% and belong to the very valid category. Participants were able to find solutions to problems that indicated students have been able to think critically. This was in accordance with the critical thinking indicators in the high category, named the indicators of analyzing, synthesizing, recognizing and solving problems, concluding, evaluating and making decisions (Rachmedita, Sinaga, & Pujiati, 2011). The STEM learning cycle fulfils the Piaget'slearning theory and it has specific features, for example, it helps students

to think from concrete things to abstract things, it needs students' active role to solve contextual problems critically, and it helps students to construct new concept based on their initial knowledge (Yenilmez & Ersoy, 2008).In STEM education, students solve daily contextual problems based on their relevant experience. This could be seen in the Activities in each flipbook feature inviting students to find solutions to the problem of biodiversity extinction. This causes the rise in students' motivation which leads to more concepts to be learned and understood (Guthrie, Allan, & Clare, 2000) . STEM education can prepare the students to face global challenge with exercises in collaboration, problem solving, critical thinking, creativity, and innovation (Selisne, Sari, & Ramli, 2019). The practicality of flipbooks was expected to be useful for students to be used as one of the learning media for Biology, especially on biodiversity material.

CLOSING

Conclusion

STEM-based flipbooks on biodiversity material to train critical thinking for class X high school students are declared to be theoretically and empirically valid. The validity obtained was 90.75% which was classified as very valid criteria. The practicality of this flipbook was based on the results of the student response questionnaire of 93.17% which was classified as very practical category.

Suggestion

This study does not yet know the effectiveness of flipbooks, so further research is needed on this matter, adding features such as games that can be directly accessed in the flipbook. As well as the need for the development of STEM-based flipbooks on other materials based on positive suggestions from student responses

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