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Development of Electronic Modules (E-Module) Assisted by Book Creator in Science Learning with Critical Thinking Skills Activities for Junior High School Students

Listiyorini[1], Leni Marlina[1*], Muhamad Yusup[1]

[1]Master of Physics Education Study Programme, Faculty of Teacher Training and Education, Sriwijaya University, Palembang, Indonesia.

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Corresponding Author:
Leni Marlina
leni_marlina@fkip.unsri.ac.id

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Abstract: This study aims to enhance students' critical thinking skills on the topic of substances and their changes using Book Creator. The research employed the Rowntree development model, with the research subjects being students at SMPN 1 Air Kumbang, Banyuasin Regency. The method used in this study was research and development (R&D) with the Rowntree development model and Tessmer evaluation, tested on 100 junior high school students. The results showed very high validity, with a Content Validity Index (CVI) and a Content Validity Ratio (CVR) of 0.8333, classified as very high. In the One-to-One evaluation stage, the practicality test results showed a percentage of 96.3% for the usefulness aspect and 91.67% for the ease-of-use aspect. In the Small Group Evaluation stage, the practicality of the e-module reached 97.53% for usability, classified as very practical, and 91.67% for ease of use. These results indicate that the e-module is considered very practical. The field test stage was conducted on 100 seventh-grade students to assess the effectiveness of the e-module in improving critical thinking skills. The results showed an N-Gain score of 56.11%, categorized as moderately effective. These findings indicate a significant improvement in students' critical thinking skills using Book Creator.

Keywords: E-module; Book creator; Critical thinking skills

Introduction

21st-century education demands that students possess critical thinking skills that enable them to solve problems independently (Indawati et al., 2023). In the context of the Merdeka Curriculum, critical thinking is one of the core dimensions in the Pancasila Student Profile, aiming to shape students into reflective, analytical individuals capable of evaluating information rationally (Fitri & Asrizal, 2023). However, various studies indicate that students' critical thinking skills remain relatively low (Sulastri et al., 2022). Research by Hikmah et al. (2023) shows that students' average critical thinking skills only reach 43.73%, while PISA test results also indicate a low level of scientific problem-solving ability at 58.1%. An analysis of student questionnaire responses at SMPN 1 Air Kumbang reveals that 60% of students struggle to articulate scientific concepts, 55% face difficulties in solving scientific problems, 65% encounter challenges in analyzing questions, and 60% have trouble maintaining concentration while answering.

These findings further highlight the low level of critical thinking skills among junior high school students (Marlina et al., 2022). One of the main contributing factors to this issue is the use of conventional teaching methods that are less interactive and fail to accommodate students' learning needs optimally (Marlina et al., 2023).

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Science learning, particularly in the topic of matter and its changes, requires strong conceptual understanding so that students can connect scientific phenomena to everyday life (Sulisetijono et al., 2023). However, many students struggle to grasp scientific concepts due to unengaging and less contextual learning materials. Research by Fricticarani et al. (2023) indicates that students' lack of interest in science is caused by monotonous and non-interactive content delivery (Antika et al., 2022). Therefore, innovative teaching materials are needed to enhance student engagement and develop their critical thinking skills (Erkek, 2022).

One innovative solution that can be implemented is the development of interactive e-modules based on technology (Hafizah & Sauqina, 2023). E-modules have the advantage of presenting learning materials in a more engaging, interactive, and flexible manner, accessible anytime and anywhere (Sachyani et al., 2022). Book Creator, as an e-module development platform, offers features that allow teachers to create diverse learning content, including text, images, videos, and interactive quizzes (Ujud et al., 2023). Several previous studies have demonstrated the effectiveness of e-modules in improving student learning outcomes and critical thinking skills (Krisnawati et al., 2023). However, research specifically developing Book Creator-based e-modules for the topic of matter and its changes within the Merdeka Curriculum context remains very limited (Marlina et al., 2018).

The novelty of this study lies in the development of an e-module that not only focuses on digital content delivery but also integrates a problem-based learning approach to train students in solving real-world problems (Sopa et al., 2023). This e-module is designed to actively engage students in learning through various interactive activities that encourage independent exploration of concepts (Ariefiani & Laksono, 2024). Additionally, this research incorporates an adaptive formative assessment feature that provides immediate feedback to help students improve their understanding (Azzahra et al., 2022). Thus, this study not only enriches science teaching methods but also contributes to the implementation of more effective and student-centered educational technology (Haleem et al., 2022).

Therefore, this study aims to develop a Book Creator-based e-module that is valid, practical, and effective in enhancing students' critical thinking skills in the topic of matter and its changes (Jasmi et al., 2023). With a more innovative and technology-driven approach, this research is expected to make a significant contribution to the development of more effective teaching methods and support the implementation of the Merdeka Curriculum in improving the quality of science education in Indonesia (Daryanes et al., 2023).

Method

The research method used is the Research and Development (R&D) model. The purpose of this study is to develop a Book Creator-assisted e-module on the topic of Matter and Its Changes, which is valid, practical, and effective in enhancing students' critical thinking skills (Sanjaya et al., 2023). This research is conducted at SMPN 1 Air Kumbang, with a primary focus on producing an effective e-module for student use.

The development model used to create the e-module is the Rowntree development model, which consists of three stages: Planning Stage, Development Stage, and Evaluation Stage (Tessmer, 1993). The research timeline spans from August to October 2024, as illustrated in Figure 1.

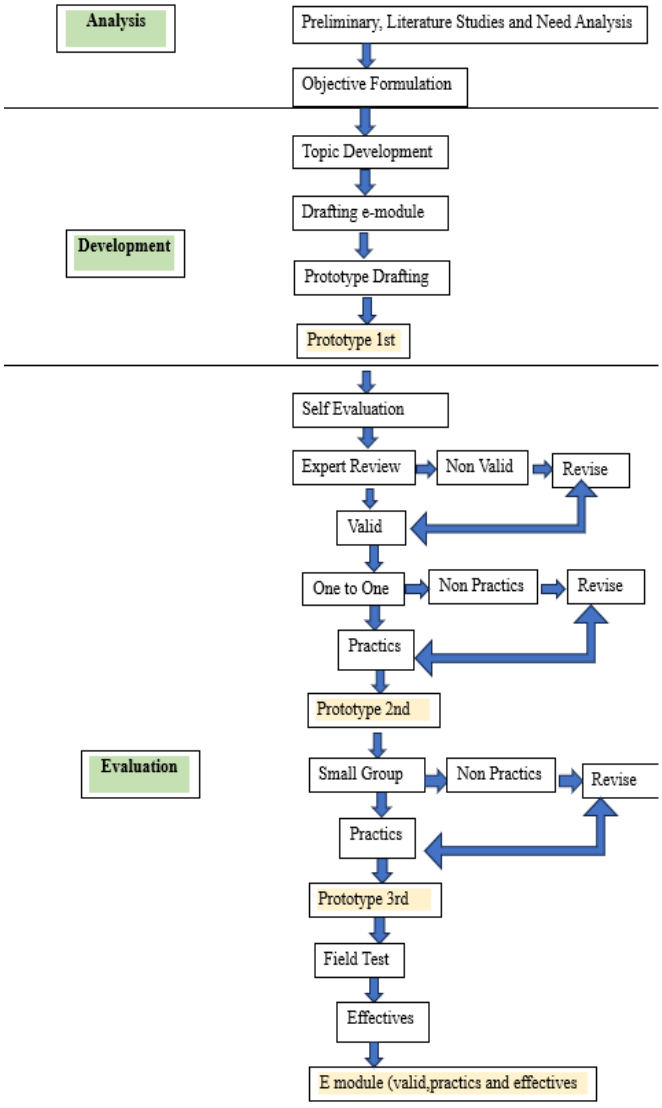

Figure 1. Research flow of e-module development using book creator (Rowntree development model and Tesmeer evaluation)

The development of the e-module on Matter and Its Changes is based on Ennis's critical thinking skill indicators (Zandvakili et al., 2019). Ennis's critical thinking skills are also used as a reference in designing the assessment instruments included in the e-module (Rizki et al., 2024). The five critical thinking skills proposed by Robert Ennis are presented in Table 1.

Table 1. Critical thinking skills indicator according to Ennis (2018)

Critical Thinking Skill	Indicator
Elementary clarification	Focusing question; Analyzing arguments; Asking and answering questions that require an explanation
Bases for decision	Considering the credibility of sources; Observing and considering the results of observation
Inference	Performing deduction considering the results of deduction; Performing induction and considering the results of induction; Making and reviewing consideration values
Advanced Clarification	Defining a term and considering a definition
Strategies dan Tactic	Identifying assumptions; Deciding on a course of action; Interacting with people Other

The analysis/planning stage begins with topic selection, curriculum/learning objective analysis, needs analysis, and teacher interviews (Marlina & Sriyanti, 2020). In the development stage, the researcher develops the e-module topic by drafting a prototype of the e-module (Endaryati et al., 2021). The prototype is then validated by expert reviewers in language, content, media, design, and critical thinking skills through validation questionnaire sheets. The validation questionnaire results will be analyzed using Content Validity Ratio (CVR) and Content Validity Index (CVI) calculations. According to Srirahayu & Arty (2018), the CVR formula proposed by Lawshe (1975) is:

$$\mathrm{CVR} = \frac{\mathrm{ne} - \frac{\mathrm{N}}{2}}{\frac{\mathrm{N}}{2}} \quad (1)$$

Critical CVR values can be categorized as in Table 2.

Table 2. Characteristics of CVR critical value

Sum of Subject Matter Experts	Critical Limit CVR
5	0.736
6	0.672
7	0.622
8	0.582

CVI/UA values can be categorized as in Table 3.

Table 3. Criteria for validity of CVI/UA calculation results

Scale	Criteria
0–0.33	Not Valid
0.34–0.67	Valid
0.68–1	Very Valid

The Content Validity Index (CVI) is calculated with the following formula:

$$\mathrm{CVI} = \frac{\sum \mathrm{CVR\ \ of\ accepted\ item}}{\sum \mathrm{Accepted\ item}} \quad (2)$$

The Validity Criteria for CVI categories are presented in Table 4.

Table 4. Validity criteria for CVI calculation results

Scale	Criteria
0.8–1	Very high
0.6–0.79	High
0.4–0.59	Medium
0.2–0.39	Low
0.0–0.10	Very low

(Puspitasari & Febrinita, 2021)

The product practicality test uses a questionnaire with a guttman scale where the value of: 1 for yes and 0 for no. The practicality questionnaire was given to students with the indicators presented in Table 5.

Table 5. The aspects of questionnaire

Apects	Question Number
Aspect of expediency	1, 2, 3, 4, 5, 6, 7, 8, 9
Convenience aspect	10, 11, 12

The categories of practicality of prototype e-module by One to One Group Evaluation and Small Group Results are presented in Table 6.

Table 6. Interpretation of the practical criteria

Practicality (%)	Criteria
80.01–100	Very practical, can be used without revision
60.01–80.00	Practical, can be used but needs minor revisions
4001–60.00	Less practical, recommended not to be used because it needs major revisions
20.01–40.00	Not practical, should not be used
00.01–20.00	Very impractical, should not be used

(Chairatunnisa et al., 2023)

The effectiveness test results are measured using pretest and posttest assessments with critical thinking skill-based questions to evaluate students' knowledge scores (Souza et al., 2017). The pretest and posttest scores are analyzed using the t-test or N-gain, which is formulated as follows.

$$\text{N} - \text{Gain} = \frac{\text{Posttest} - \text{Pretest}}{\text{Maximum value} - \text{Pretest}} \quad (3)$$

The gain score division categories are presented in Table 7.

Table 7. Criterion of N-gain score

N-Gain score	Criteria
$0.7 \leq [g] \leq 1.00$	High
$0.3 \leq [g] < 0.7$	Medium
$0.00 < [g] < 0.3$	Low

The categorization of the N-gain score can be determined based on the N-gain value or the value of the N-Gain value in the form of percent (%).

Table 8. Criterion of effectiveness percentage

Effectiveness percentage (%)	Criteria
< 40	Not Effective
40–55	Less Effective
56–75	Moderately Effective
> 76	Effective

(Hake, 2002)

Result and Discussion

Result

Analysis Stage

The analysis of the questionnaire results shows that 89.10% of students enjoy learning science, while 10.90% disagree. This indicates that science is considered an engaging subject among students in the school environment. However, 49.10% of students find science learning quite difficult, while 50.90% do not find it difficult. Additionally, 98.20% of students state that all science subjects taught in school are very important to understand.

In terms of critical thinking skills, 60% of students struggle to answer critical thinking questions related to Matter and Its Changes. This suggests that most students are not yet proficient in critical thinking and perceive the topic as quite challenging. These findings serve as the basis for developing a Book Creator-assisted e-module designed to enhance students' critical thinking skills in this subject. By understanding the challenges faced by students, the e-module will be developed with a more interactive and problem-based approach to help students grasp concepts more deeply while practicing their critical thinking skills (Sriyanti et al., 2021).

Objective Formulation

Table 9. Learning objectives is formulated from the learning outcomes prototype e-module

Learning Outcomes	Learning Objectives
By the completion of phase D, students will demonstrate proficiency in identifying the properties and characteristics of substances, along with the capacity to differentiate between physical and chemical transformations.	Learners can explain the differences in the state of particles in solids, liquids and gases so that they have different properties; Learners can explain the process of changing the form of substances on a particle scale and interpret the form of substances at various temperatures based on boiling point and melting point data; Learners can identify changes in substances in everyday life as physical or chemical changes, describe the water cycle and mention signs of chemical reactions; Learners can determine the density of a solid, and describe the effect of differences in substance density on floating and sinking events and compare the density of liquids.

Development Stage

Topic Development

The topic development stage is the initial step in creating a Book Creator-assisted e-module on Matter and Its Changes. At this stage, an in-depth analysis of the curriculum and students' needs is conducted to ensure a better understanding of matter and its changes. This topic was selected due to its strong relevance to everyday phenomena and its role as a foundation for further physics concepts. Additionally, this stage defines the critical thinking skills to be developed in the e-module, referring to Ennis's critical thinking indicators. Topic identification includes the fundamental concepts of matter and its changes.

Drafting Phase

Once the topic is developed, the next step is to create the initial draft of the e-module. This stage includes designing the learning structure, compiling learning materials, and determining interactive elements to be used in Book Creator. The drafting process begins with the development of an e-module framework, which consists of an introduction, learning objectives, main content, practice questions, and evaluation. Additionally, this stage involves selecting credible learning resources, crafting instructional narratives suited to junior high school students, and integrating multimedia elements such as images, videos, and interactive simulations to enhance learning engagement. The draft must ensure that students not only understand the concept of matter and its changes but also develop their critical thinking skills through various activities presented in the e-module.

E-Module Development

This stage marks the initial implementation of the drafted content into the Book Creator platform, where all materials are integrated into an interactive digital

format. The prototype development involves organizing text, images, and videos to ensure that the e-module is presented in a systematic and engaging manner. Additionally, the user interface is designed to provide students with a comfortable learning experience and facilitate easy navigation. The prototype also includes various interactive features, such as multiple-choice quizzes, essay-based exercises, and project-based exploration activities to enhance students' critical thinking skills. Furthermore, compatibility is considered to ensure that the e-module can be accessed across different devices, including computers, tablets, and smartphones. The e-module consists of four learning activities, namely States of Matter and Particle Models, Properties of Matter, Physical Changes in Liquids, and Physical and Chemical Changes. The e-module components are illustrated in Figure 2.

Figure 2. Substance of e-modules with activities based on critical thinking indicators

Figure 2 in this e-module presents the main components of the Book Creator-assisted e-module, developed based on needs analysis results, including interactive videos and Higher Order Thinking Skills (HOTS)-based exercises. Thus, this figure does not merely serve as an illustration but also demonstrates how the e-module is systematically developed to enhance critical thinking skills using Ennis' critical thinking indicators in relation to the concepts covered in the material.

Prototype 1

Once the first prototype was fully developed, a limited trial was conducted to assess its effectiveness and alignment with learning objectives. The initial evaluation was carried out through expert reviews from both content and media perspectives to ensure the quality of the e-module's content and design. Additionally, the initial e-module product was tested with a small group of students to observe how they interacted with the e-module and to identify any difficulties they encountered in understanding the material. Feedback from this stage served as the basis for revisions and improvements before proceeding to a broader formative evaluation using the Tessmer model. This process ensures that the developed e-module is more optimal in enhancing students' critical thinking skills while also providing a more effective and engaging learning experience.

Evaluation Stage

Self Evaluation

At the stage of self-evaluation, the researcher engages in a thorough assessment of the draft e-module, considering factors such as the attractiveness of the design, the correctness of the writing, the accuracy of concept representation, and the appropriateness of the language utilized. This process is essential for evaluating the accuracy and validity of the teaching materials. Additionally, the researcher reviews the prototype product in relation to language, design, media, and critical thinking skills to ensure that it adheres to the prescribed e-module writing guidelines.

Expert Review

The expert review stage, prototype 1 e-modul has valuated by 8 subject matter expert, S-CVI/Average is the average value of agreement of all SMEs of 0.9167, meaning 91.67% of the appraisers agreed to the items on the questionnaire sheet. SWith an S-CVI/UA value of 0.3333, it is evident that only 33.33% of the statement items, which corresponds to 16 out of 48, achieved complete consensus among the researchers. CVI is the CVR value is the average result of the CVI is the average of the CVR value of 0.8333, meaning that it is stated that

the validity of the questionnaire instrument is classified as very high on the relevance of the e-module product. Therefore, as shown in the previous section, Academics underscore the implementation of two methodologies for acquiring content validity through expert input (Souza et al., 2017). The overall Content Validity Index (CVI), represented by both the Item-CVI (I-CVI) and the Scale-CVI (S-CVI), suggests a high level of universal acceptance with a score of 1.0. However, the utilization of percentage metrics in assessing content validity can also illuminate specific dimensions that require further refinement (Tarmizi & Janan, 2022).

One to One Evaluation

Stage one to one evaluation, e-module products in the form of prototype 1 were tested on 3 students of class VIII SMPN 1 Air Kumbang who had implemented the independent curriculum and studied substance material and its changes, the results of this stage are presented in Figure 3.

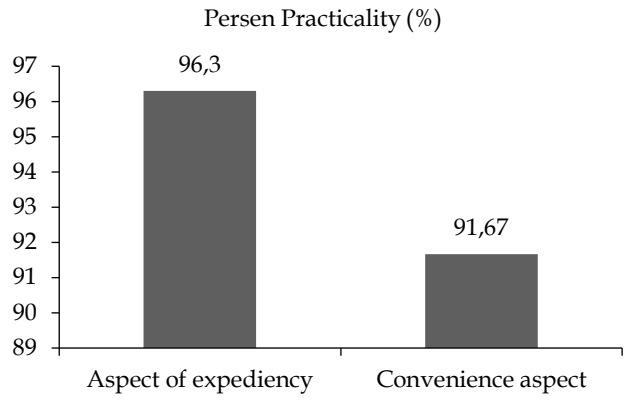

Figure 3. Percentage results of practicality of e-module product prototype 1 stage one to one evaluation

Based on the practicality test, a percentage of 96.3% was obtained on the aspect of expediency and 91.67% on the convenience aspect, this shows that prototype 1 was tested with Very practical criteria, can be used without revision.

Small Group Evaluation

At the small group evaluation stage, Prototype 2 was assessed once more with a group of 9 students representing high, medium, and low performance categories. The result shows that prototype 2 So that the resulting prototype 2 e-module is valid and very practical the students participated by completing a questionnaire designed to gather their responses to Prototype 2 product shown in Figure 4.

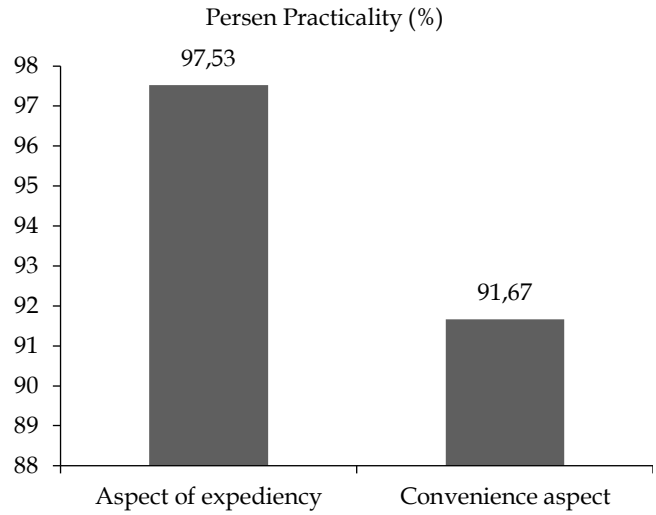

Figure 4. Percentage results of practicality of e-module product prototype 2 stage small group evaluation

Field Test

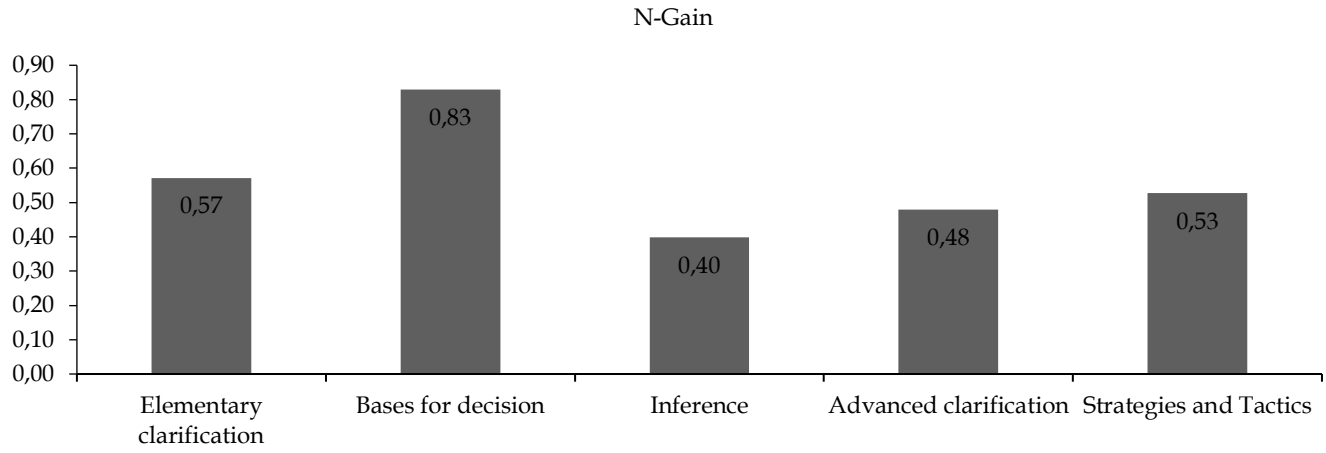

Figure 5. N-gain results for each indicator of critical thinking skills

The analysis of data collected from both the pre-test and post-test regarding various indicators of critical thinking skills revealed a notable enhancement following the implementation of the e-module, which utilized Book Creator, during the field test phase. Specifically, the indicator assessing elementary clarification skills demonstrated a medium N-gain of 0.57. In contrast, the indicator evaluating decision-making bases achieved a high N-gain of 0.83. Additionally, the ability to draw conclusions was measured with an N-gain of 0.40, categorizing it within the medium range. The advanced clarification indicator recorded an N-gain of 0.48, also classified as medium. Lastly, the strategies and tactics indicator exhibited a medium N-gain of 0.53.

Discussion

The data shows a significant increase in various aspects of students' critical thinking skills after the application of e-modules with critical thinking skills assisted by book creator in learning. This is in line with research (Sulisetijono et al., 2023; Hakim & Talib, 2024). The electronic module (e-module) serves as a crucial educational resource essential for facilitating an optimal learning process. The percentage of effectiveness of the overall indicator is 56.11% with a moderately effective category. Thus, the development of e-modules with critical thinking skills assisted by book creator proved moderately effective in improving students' critical thinking skills. Based on previous research findings, developing digital teaching materials in lessons can attract the attention and interest of students so that they are motivated to learn and prepare themselves before learning in the classroom (Lilis et al., 2019).

The study results also highlight issues that need to be considered in an effort to improve critical thinking skills by designing learning and developing e-modules with various approaches such as the development of e-modules with a PBL approach that improves the critical thinking skills of junior high school students (Maris & Setiawan, 2023), e-modules developed pjBL STEM also improve students' critical thinking skills (Sopa et al., 2023).

Students can benefit from independent learning with e-modules, which reduces dependence on educators as the sole source of knowledge. E-module teaching resources are good and practical to be used with students and teachers in science learning if implemented through the programme (Krisnawati et al., 2023). Therefore, the evolution in the development of e-modules can be packaged in a more attractive learning technology format, because it is proven to be more effective in facilitating students' independent learning. The advantages of e-modules as interactive learning media include text, animation, video, and links to websites, all accompanied by instructional guides. Book Creator serves as a technology platform for teachers to create digital teaching materials, providing resources for students to engage in self-directed learning through the use of smartphones. Educators are encouraged to creatively utilise technology in their teaching practices to enhance students' critical thinking skills.

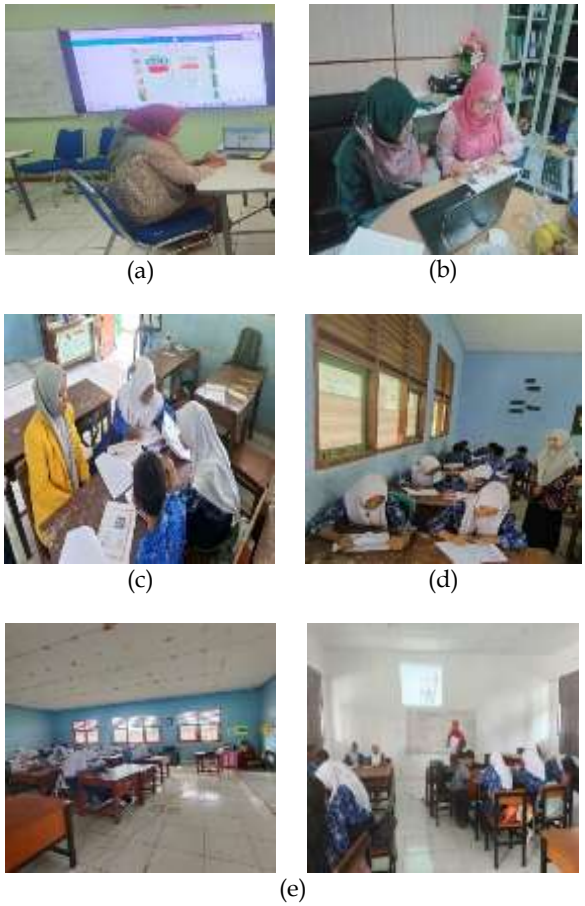

Figure 6. Activity Evaluation By Tessmer (a) self evaluation (b)expert review (c) one to one evaluation (d) small group evaluation (e) Field Test

A monotonous teaching approach that only relies on traditional textbooks can cause students to be disengaged, making the process of developing critical thinking skills less effective and efficient. Based on a review of previous literature, the development of e-modules has proven effective Advancing the development of students' critical thinking competencies. Flipbook e-modules, which use a practical and efficient problem-based learning (PBL) model, empower science students' critical thinking skills (Endaryati et al., 2021). The development of an environmentally-focused e-module based on PBL has been validated as a suitable module to improve junior high school students' critical thinking skills (Ansori et al., 2022; Rahmat et al., 2020).

In addition, e-modules developed using the SETS framework, supported by Professional Flip PDF, are recognised as valid, practical, and effective modules in improving the critical thinking skills of junior high school students (Putri et al., 2023). The development of Physics e-modules utilising Kvisoft Flipbook Maker is also considered appropriate and effective for improving the critical thinking skills of high school Physics students (Latifah et al., 2020). And also mind mapping, as an educational technique, can enhance the development of critical thinking abilities (Sari & Murdiono, 2021).

Therefore, for further research, researchers recommend that the development of e-modules with critical thinking learning activities with the help of Book creator can be applied to other science materials with various learning strategies and approaches. Further research should focus on the development of other 21st century skills. Given the significance of critical thinking, collaboration, communication and creativity skills in the modern educational context, further research should include these elements (Fricticarani et al., 2023; Hadzhikoleva et al., 2019; Octaviana et al., 2022). In addition, it is important to implement a science-based learning approach so that students' 21st century skills can be honed comprehensively. Overall, with these steps, it is expected that the integration of technology utilisation in education can be more effective in improving critical thinking skills and relevant skills.

Conclusion

This study aims to enhance students' critical thinking skills in the topic of matter and its changes using Book Creator. The research employs the Rowntree development model with research subjects consisting of students from SMPN 1 Air Kumbang, Banyuasin Regency. The method used in this study is Research and Development (R&D), incorporating the Rowntree development model and Tessmer's evaluation, which was tested on 100 junior high school students. The results indicate a very high validity, with a Content Validity Index (CVI) and Content Validity Ratio (CVR) of 0.8333, classified as very high. In the One-to-One Evaluation stage, the practicality test results showed a 96.3% score for usability and 91.67% for ease of use. In the Small Group Evaluation stage, the practicality of the e-module reached 97.53% for usability, categorized as highly practical, and 91.67% for ease of use. These results confirm that the e-module is considered highly practical. The field test stage was conducted on 100 seventh-grade students to assess the effectiveness of the e-module in improving critical thinking skills. The findings revealed an N-Gain score of 56.11%, classified as moderately effective. These results indicate a significant improvement in students' critical thinking skills when using Book Creator. This study successfully achieved its objective of developing a valid, practical, and effective e-module for enhancing critical thinking skills in science learning. The findings demonstrate that the e-module effectively improves students' ability to analyze and evaluate scientific concepts, contributing to better conceptual understanding and the development of higher-order thinking skills.

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Author Contributions

Conceptualization, L. and L.M.; methodology, formal analysis, investigation, writing original draft, preparation, visualization, L.; software, resources, project, administration, M.Y.; validation, L., L.M., and M.Y.; data curation, supervision, writing review and editing, L.M.; funding, acquisition, M.Y. All authors have read and approved the published version of the manuscript.

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Conflicts of Interest

Authors declare that there is no conflict of interest.

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