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# Innovation in *Merdeka* Curriculum E-Module: Integrating Scientific Approach with Socio-Scientific Issues to Improve Students' Critical Thinking

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## *Abstrak*

*Kemampuan berpikir kritis siswa di Indonesia masih berada di bawah rata-rata, sehingga menjadi tantangan yang signifikan dalam mempersiapkan siswa untuk menghadapi tuntutan di abad ke-21. Penelitian ini bertujuan untuk mengembangkan e-modul Kurikulum Merdeka yang mengintegrasikan pendekatan saintifik dengan Socio-Scientific Issues (SSI) untuk meningkatkan keterampilan berpikir kritis. Pengembangan ini menggunakan model ADDIE, yang meliputi lima tahap: Analisis, Desain, Pengembangan, Implementasi, dan Evaluasi. Penelitian ini melibatkan siswa kelas VII yang mempelajari keanekaragaman hayati. Data kualitatif diperoleh dari wawancara guru serta kuesioner, sementara data kuantitatif dari nilai validator, guru, siswa, serta pretest dan posttest. Analisis data melibatkan teknik deskriptif kualitatif, analisis persentase, uji validitas dan reliabilitas, uji normalitas, uji homogenitas, uji t-test, dan uji N-Gain. Hasil validasi media dan materi masing-masing mencapai 93,75% dan 98,21%. Praktikalitas guru dan siswa masing-masing 95,97% dan 87,44%. Uji N-Gain menunjukkan nilai sedang pada lima indikator berpikir kritis. Dapat disimpulkan bahwa E-modul ini valid, praktis, dan efektif digunakan dalam pembelajaran.*

***Kata kunci*:** *E-Modul, Kurikulum Merdeka, Pendekatan Saintifik,* Socio-Scientific Issues, *Berpikir Kritis*

## Abstract

The critical thinking skills of students in Indonesia remain below average, presenting a significant challenge in preparing students to meet the demands of the 21st century. This study aims to develop an independent curriculum e-module integrating the scientific approach with Socio-Scientific Issues (SSI) to enhance critical thinking skills. The development process employs the ADDIE model, encompassing five stages: Analysis, Design, Development, Implementation, and Evaluation. The study involved seventh-grade students studying biodiversity. Qualitative data were collected through teacher interviews and questionnaires, while quantitative data were obtained from validator scores, teacher and student evaluations, as well as pre-test and post-test results. Data analysis included qualitative descriptive techniques, percentage analysis, validity and reliability tests, normality tests, homogeneity tests, t-tests, and N-Gain tests. The validation results for media and materials reached 93.75% and 98.21%, respectively. Practicality assessments by teachers and students achieved 95.97% and 87.44%, respectively. The N-Gain test demonstrated moderate improvements across five critical thinking indicators. It can be concluded that the e-module is valid, practical, and effective for use in teaching and learning.

**Keywords:** E-Module, *Merdeka* Curriculum, Scientific Approach, Socio-Scientific Issues, Critical Thinking

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## 1. INTRODUCTION

In Indonesia, the ability to think critically among students remains a significant concern. This is evident from the country's ranking of 73rd out of 79 countries in the 2018 PISA (Program for International Student Assessment) results, which indicate that Indonesian students' critical thinking skills are below average (Murtiyasa & Perwita, 2020; Yansen et al., 2019). Critical thinking is crucial for problem-solving and decision-making, yet many students struggle to develop this skill due to the dominance of lecture-based teaching methods in classrooms (Puspita & Aloysius, 2019; Sianturi et al., 2018). These methods often result in passive learning, where students are more inclined to listen to explanations rather than engage actively with the material. The introduction of the *Merdeka* Curriculum, which emphasizes teacher autonomy in developing teaching materials, offers an opportunity to address this gap. However, the lack of readiness among teachers and the scarcity of curriculum-aligned resources in schools pose challenges to its effective implementation

(Arifa, 2022; Asrifan et al., 2023). This is particularly concerning given that the *Merdeka* Curriculum aims to foster critical thinking skills, which are essential for students' success in the 21st century (Ibad, 2022; N. A. Kurniawan et al., 2020).

Developing e-modules requires new innovations to help students construct their own understanding. Learning in Indonesia is often ineffective, and effective learning is student-centered (Maula & Fatmawati, 2022; Yennita et al., 2020). The scientific approach, which includes observing, questioning, gathering information, processing information, and communicating, encourages active student participation and enhances critical thinking (Ellizar et al., 2018; Lee & Sen, 2018). This approach helps students examine and conclude information in a structured manner (Agustin, 2019; Lieung et al., 2020). Socio-Scientific Issues (SSI) in science learning stimulate students to argue and discuss, thereby improving critical thinking. SSI involves controversial social issues related to science, prompting critical analysis and decision-making (López-Fernández et al., 2022; Nida et al., 2021). Biodiversity, a complex concept within the *Merdeka* Curriculum, requires impactful learning methods for true understanding.

Based on the results of teacher interviews at SMPN 1 Pakis, it can be assessed that students' critical thinking skills have begun to be trained, but are still relatively low. In addition, the *Merdeka* Curriculum has been implemented in grade VII, but the textbooks used in learning are still K13 package books due to the lack of teaching materials that are aligned with the *Merdeka* Curriculum and the majority of learning is still centralized on the teacher. In addition, based on the student needs analysis questionnaire filled in by 82 respondents, it can be seen that 64.6% of students find biodiversity material difficult to understand, 95.1% of students prefer to solve problems using a more structured method, 87.8% of students find it easy to understand the material if it is related to controversial issues and 93.9% of students need digital teaching materials.

E-modules present a promising solution to this issue, offering flexible, interactive, and student-centered learning experiences that can be tailored to the specific needs of students (Gustinasari et al., 2017; Jailani & Almukarramah, 2020). Prior research has demonstrated that modules based on scientific approaches can enhance critical thinking skills, and that integrating Socio-Scientific Issues (SSI) into science learning can improve students' ability to analyse and discuss complex topics critically (Mudawamah, 2020; Nida et al., 2021). However, there is a gap in the existing literature regarding the development of teaching materials that combine the scientific approach with SSI specifically to enhance critical thinking skills in the context of the *Merdeka* Curriculum. The urgency of this research is underscored by the findings that students at SMPN 1 Pakis, where this study was conducted, exhibit relatively low critical thinking skills despite the initial implementation of the *Merdeka* Curriculum. Furthermore, a significant proportion of students find biodiversity difficult to understand and express a preference for structured learning methods that incorporate controversial issues

The purpose of this research is to produce an e-module for the *Merdeka* Curriculum based on the scientific approach integrated with Socio-Scientific Issues that is valid and practical and to test its effectiveness in encouraging students' critical thinking skills on biodiversity material. This teaching material is important to develop in order to encourage students' critical thinking skills and fulfill the need for teaching materials that are in accordance with the *Merdeka* Curriculum. This study is one of the first to develop e-modules based on the *Merdeka* Curriculum, which emphasizes project-based learning, independent learning, and material flexibility. This combination provides novelty in the design of learning materials to increase relevance and usefulness for students.

## 2. METHODS

The type of research conducted is Research and Development (R&D) which aims to design, develop, and determine the effectiveness of the product (Sugiyono, 2016). In this study, the product developed is an e-module based on the scientific approach integrated with Socio-Scientific Issues. The tests carried out on this product are validity tests by experts, teacher and student practicality tests, and effectiveness tests to measure the level of students' ability to think critically. This research uses the ADDIE model which consists of 5 stages, namely analysis, design, development, implementation, and evaluation (Patel et al., 2018). The research design used was a quasi-experimental type of non-equivalent control group design. Quasi experimental is a research design that uses at least two groups, one of which is the control group and the other is the experimental group. The non-equivalent control group design means that the two groups involved have the same background and are chosen non-randomly.

The first stage is analysis, which includes analysing the needs of teachers and students which is done by circulating a needs analysis questionnaire in the form of a google form link to class VIII students at SMPN 1 Pakis. In addition, interviews were also conducted with two science teachers at SMPN 1 Pakis. This needs analysis aims to find out problems in learning and obtain information related to the product to be developed.

The second stage is design, including material preparation, e-module design, and design of learning tools, such as teaching modules. The third stage is development including e-module products in the form of flipbooks in accordance with the e-module design precisely at the design stage, media expert validation, and material expert validation. Validity is a test used to measure the accuracy of an instrument in providing accurate answers. The data collection technique used in the validity test is a questionnaire, and the instrument is a media expert and material expert validation questionnaire sheet, with quantitative data analysed using percentage techniques and qualitative data analysed using qualitative descriptive analysis techniques.

The fourth stage is implementation (implement) including validity and reliability tests of pretest and post-test questions, teacher and student practicality tests, effectiveness tests using pre-test and post-test questions which are then carried out normality tests, homogeneity tests, t-tests, and N-Gain tests. The validity and reliability tests of pretest and post-test questions, normality tests, homogeneity tests, and t-tests were calculated using IBM SPSS Statistic 25. Practicality in question is a test conducted to see the ease of users in using the product developed (Alfiriani & Hutabri, 2017). The data collection technique used in the practicality test is a questionnaire, and the instrument is a questionnaire sheet for teachers and students, where quantitative data is analysed using percentage techniques and qualitative data in the form of comments and suggestions are analysed using qualitative descriptive analysis techniques. Meanwhile, the effectiveness of a product can be seen from whether or not a goal is achieved after using the developed product (Alfiriani & Hutabri, 2017). The data collection technique used in the effectiveness test is a question with the instrument is a pretest and post-test question and data analysis techniques in the form of validity and reliability tests, normality tests, homogeneity tests, t-tests, and N-Gain tests. Then at each stage in the ADDIE model, evaluation and revision are carried out so that it can produce a valid product (Rahayu et al., 2023). The five stages of ADDIE are shown in Figure 1.

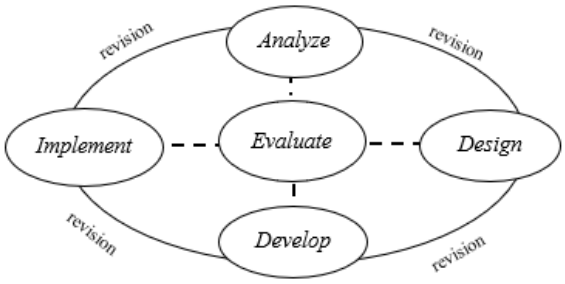


**Figure 1**. ADDIE Diagram

The e-modules were validated by material and media experts, followed by teacher and student practicality tests involving 31 seventh-grade students at SMPN 1 Pakis. Effectiveness tests were conducted on 31 control class students and 31 experimental class students using pre-test and post-test questions. This study used qualitative and quantitative data. Qualitative data came from interviews, and comments on validation questionnaires, and practicality tests. Quantitative data were obtained from final scores on validation and practicality tests using the Likert scale, as well as pretest and post-test scores to assess students' critical thinking skills. The Likert scale had four criteria: 4 (strongly agree), 3 (agree), 2 (disagree), and 1 (strongly disagree). The material validation used a Guttman scale with 1 (correct) and 2 (wrong) (Sugiyono, 2016). Pretest and post-test questions were based on Ennis' critical thinking indicators: basic clarification, basis for decision making, inference, further clarification, and additional skills (Susilawati et al., 2020).

In this study, the data collection techniques used were interviews, questionnaires, and questions with the instruments used were interview guidelines, needs analysis questionnaire sheets, validation sheets, and practicality test questionnaire sheets, pretest and post-test questions. Qualitative descriptive analysis techniques are used to examine qualitative data, while quantitative data are studied using percentage analysis techniques, validity and reliability tests, normality tests, homogeneity tests, t-tests, and N-Gain tests.

## 3. RESULTS AND DISCUSSION

### Results

This study developed a *Merdeka* Curriculum e-module based on a scientific approach integrated with Socio-Scientific Issues (SSI) on biodiversity material to enhance junior high school students' critical thinking. Interviews with two science teachers at SMPN 1 Pakis revealed that while students' critical thinking skills are being trained, they remain relatively low well. The *Merdeka* Curriculum is implemented in grade VII but faces challenges such as a scarcity of aligned teaching materials and limited teacher capacity to design suitable materials. A student needs analysis questionnaire, completed by 82 respondents, showed 64.6% find biodiversity material difficult, 95.1% prefer structured problem-solving methods, 87.8% understand material better when related to controversial issues, and 93.9% need digital teaching materials. E-modules can make learning more effective, efficient, interactive, and environmentally friendly.

The second stage is design. At this stage, an arrangement of biodiversity material is produced which is adjusted to the *Merdeka* Curriculum. In this study, only three sub-materials were taken from ecology and biodiversity material in the *Merdeka* Curriculum. Taking the sub-material is adjusted to differences in biodiversity in Indonesia, human influence on ecosystems and biodiversity, and biodiversity conservation. In addition, the e-module design and learning tools in the form of teaching modules were produced.

In the development stage, a *Merdeka* curriculum e-module based on a scientific approach integrated with SSI was created using Flip PDF Corporate software to produce an

attractive flipbook. This method proved effective for grade VII junior high school students. The 76-page e-module includes material descriptions, videos, student activities, reflection journals, summaries, self-evaluations, and glossaries. The student activities section follows the scientific approach stages and uses social science issues to enhance critical thinking. Students can complete activities and reflection journals via Liveworksheet and self-evaluations through Google Forms, accessible by buttons in the e-module as per the instructions. The developed e-module product is shown in Figure 2.


**Figure 2.** E-Module Display in Flipbook Form

Furthermore, the results of the media validation of the *Merdeka* Curriculum e-module based on the SSI integrated scientific approach obtained an average result of 93.75% with very valid criteria. In the media validation results, it is known that the graphic aspect obtained a percentage of 91.67%. The media validation results are presented in Table 1.

**Table 1.** Acquisition of Media Expert Validation

| Aspects | Percentage (%) | Criteria |
|---|---|---|
| Graphics | 91.67 | Very valid |
| Language | 95.83 | Very valid |
| **Average** | **93.75** | **Very valid** |

The results of the material validation of the *Merdeka* Curriculum module based on the SSI integrated scientific approach obtained an average result of 98.21% with very valid criteria. The material validation results are presented in Table 2.

**Table 2.** Material Expert Validation

| Aspects | Percentage (%) | Criteria |
|---|---|---|
| Content Feasibility | 96.87 | Very valid |
| Presentation Feasibility | 100 | Very valid |
| Contextual Assessment | 98.44 | Very valid |
| Correctness of Concept | 100 | Very valid |
| Teaching Module | 96.87 | Very valid |
| Pre-test and Post-test Questions | 97.09 | Very valid |
| **Average** | **98.21** | **Very valid** |

In the implementation stage, validity and reliability tests of the questions, practicality test, and effectiveness test are conducted. Pre-test and post-test questions validated by the

validator are tested for validity and reliability. A question is valid if the correlation coefficient is greater than 0.3. All 10 questions meet this criterion. For reliability, Cronbach Alpha values above 0.60 indicate reliability (Sugiyono, 2016). The instrument's Cronbach Alpha value is 0.743, confirming its reliability. The validity of the questions is presented in Table 3 and the reliability is presented in Table 4.

**Table 3.** Validity Test Results

| Question Number | Correlation Coefficient | Criteria |
|---|---|---|
| 1 | 0.598 | Valid |
| 2 | 0.664 | Valid |
| 3 | 0.633 | Valid |
| 4 | 0.387 | Valid |
| 5 | 0.462 | Valid |
| 6 | 0.688 | Valid |
| 7 | 0.539 | Valid |
| 8 | 0.531 | Valid |
| 9 | 0.780 | Valid |
| 10 | 0.437 | Valid |

**Table 4.** Reliability Test Results

| Cronbach's Alpha | Number of Questions | Criteria |
|---|---|---|
| 0.743 | 10 | Reliable |

In the teacher's practicality test, the results were 95.97% with very practical criteria. While the results of the student practicality test were 87.44% with very practical criteria. The results of the teacher and student practicality tests are presented in Table 5.

**Table 5.** Teacher and Student Practicality Test Results

| Indicator | Percentage (%) | Criteria |
|---|---|---|
| Teacher Practicality Test | 95.97 | Very Practical |
| Student Practicality Test | 87.44 | Very Practical |

The pre-test and post-test results in the control class and experimental class were tested for Shapiro Wilk normality first. In the control class, the pre-test value has a significance of 0.492> 0.05 and the post-test value has a significance of 0.842> 0.05. While the experimental class, has a pre-test value with a significance of 0.089> 0.05 and the post-test value has a significance of 0.133> 0.05. Since all data has a significance value greater than 0.05, it can be assumed that the data is normally distributed. The normality test results are presented in Table 6.

**Table 6.** Normality Test Results

| Class | Data | Significance Value | Criteria |
|---|---|---|---|
| Control | Pre-test | 0.492 | Normal |
| | Post-test | 0.842 | Normal |
| Experiment | Pre-test | 0.089 | Normal |
| | Post-test | 0.133 | Normal |

The data obtained were then tested for homogeneity. The pre-test value has a significance of 0.718 > 0.05 and the post-test value has a significance of 0.270 > 0.05.

Because all data have a significance greater than 0.05, it can be assumed that the data is homogeneous (Nuryadi et al., 2017). The homogeneity test results are presented in Table 7.

**Table 7.** Homogeneity Test Results

| Data | Significance Value | Criteria |
|---|---|---|
| Pre-test | 0.718 | Homogenous |
| Post-test | 0.270 | Homogenous |

Based on the normality and homogeneity tests Table 6 and Table 7, the data is normally distributed and homogeneous. Normally distributed and homogeneous data can proceed to the independent sample t-test. The pre-test significance is 0.126 > 0.05, indicating no significant difference between the control and experimental groups. The post-test significance is < 0.001, indicating a significant difference between the two groups (Payadnya & Jayantika, 2018). The independent sample t-test results are presented in Table 8.

**Table 8:** Independent Sample T-Test Results

| Data | Significance Value | Criteria |
|---|---|---|
| Pretest | 0.126 | There is no difference |
| Post-test | < 0.001 | There is a difference |

Then before the N-Gain test is carried out, based on Table 8 the paired sample t-test is first carried out, in the experimental class. In the experimental class, the significance value is obtained <0.001 which is less than 0.05 so that it can be assumed that the pre-test value and post-test value in the experimental class are significantly different because the significance value is less than 0.05. The paired sample t-test results are presented in Table 9.

**Table 9.** Paired Sample T-Test Results

| Data | Significance Value | Criteria |
|---|---|---|
| Experiment Class | < 0.001 | There is a difference |

Base on Table 9 based on the t-test there is a difference, the N-Gain test can be continued, the N-Gain test is carried out to determine the increase in critical thinking skills in each indicator. The next data analysis is a comparison of the N-Gain value of each critical thinking ability indicator on the control class and experimental class questions. Critical thinking ability consists of 5 indicators, namely basic clarification, decision-making basis, inference, further clarification, and additional skills. The comparison of N-Gain values between the control class and the experimental class of the five critical thinking indicators is shown in Figure 3.

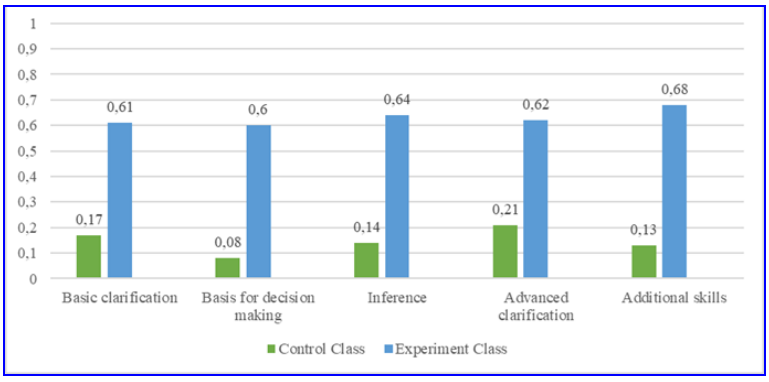


**Figure 3.** Comparison Results of N-Gain Value of Control Class and Experiment Class

## Discussion

The findings of this study indicate that the *Merdeka* Curriculum e-module, which integrates a scientific approach with Socio-Scientific Issues (SSI) on biodiversity material, effectively enhances the critical thinking skills of junior high school students. This is evident from the N-Gain test results, which show moderate effectiveness across all critical thinking indicators, with the highest gains in the additional skills indicator (N-Gain = 0.68) and the lowest in the basic decision-making indicator (N-Gain = 0.60).

These results align with previous research that highlights the effectiveness of SSI-based learning in promoting critical thinking. For example, previous study found that scientific discussions and debates on controversial issues significantly improve students' ability to think critically (Karisan & Zeidler, 2017). Similarly, other study noted that evaluating the results of observations can develop critical thinking skills (Mahanani et al., 2020). The findings of this study, therefore, corroborate the existing literature, affirming the positive impact of integrating SSI into science education.

The results indicate that integrating the scientific approach with Socio-Scientific Issues (SSI) in the *Merdeka* Curriculum e-module significantly enhances junior high school students' critical thinking skills. In the basic clarification indicator, sub-indicators include focusing on questions and analysing arguments. Focusing on questions involves designing questions to digest information, and analysing arguments involves identifying reasons to support arguments (A. B. Kurniawan & Hidayah, 2020; Payadnya & Jayantika, 2018; Susilawati et al., 2020; Widodo, 2021). The average pretest score was 45.56, the post-test score was 78.63, and the N-Gain test result was 0.61, indicating moderate effectiveness. These skills were practiced in the e-module's "let's observe" activity, which corresponds to the observing stage of the scientific approach. Students observed an article and video about the "Pros and Cons of GMO Plants" and identified reasons based on the presented arguments. Additionally, the "let's ask" activity, representing the questioning stage, required students to formulate questions to gather necessary information. This aligns with the theory that critical thinkers correctly judge by identifying reasons behind problems and that critical thinking can be taught through question formulation (Genisa et al., 2020; Imansari & Sunaryantiningsih, 2017).

In the basic indicators of decision making, the sub-indicators taken are observing and assessing observation reports and using existing knowledge/information. In the basic indicators of decision making, the average pre-test results were 56.87 and post-test 83.47 and obtained an N-Gain test of 0.60 which is classified as moderate effectiveness criteria. This is because this ability has been trained in the "let's gather information" activity which represents the stage of gathering information in the scientific approach. At this stage students are required to collect information to answer questions both from observation reports and other reliable sources. This is in accordance with theory which states that critical thinking skills can be developed through evaluating the results of observations of phenomena that occur (Mahanani et al., 2020; Zandkarimi., 2013).

In the inference indicator, the sub-indicator taken is making and evaluating inductive inference. Based on theory making and evaluating inductive inferences includes the ability to make conclusions (Rubiyanti et al., 2020; Widodo, 2021). In the inference indicator, the average pre-test result is 51.21 and the post-test is 82.26 and the N-Gain test acquisition is 0.64 which is classified as moderate effectiveness criteria. Meanwhile, in the additional skills indicator, the sub-indicator taken is deciding on an action. In the additional skills indicator, the average pre-test result is 40.32 and the post-test is 81.05 and the N-Gain test is 0.68 which is classified as moderate effectiveness criteria. This is because this ability has been trained in the student activity in the "let's conclude" section which represents the stage of processing information in the scientific approach. At this stage students are required to decide whether to choose pros or cons accompanied by logical reasons and students are also required

to conclude a problem and find the suitability between the problem and the material studied. In accordance with theory before making a decision a critical thinker will conclude the problem based on facts (Badjeber & Purwaningrum, 2018; Turan et al., 2019).

In the further clarification indicator, the sub-indicator taken is handling evasion accompanied by logical reasons. In the further clarification indicator, the average pre-test result is 35.08 and post-test 75.4 and the N-Gain test acquisition is 0.62 which is classified as moderate effectiveness criteria. This is because this ability has been trained in the student activity "let's communicate" which represents the communicating stage in the scientific approach. At this stage students are required to make presentations and conduct debates between pro and contra groups. In accordance with theory students' ability to think critically can be improved through scientific discussions and debates on controversial issues (Karisan & Zeidler, 2017).

Of the five indicators, the lowest N-Gain test result was on the basic decision-making indicator of 0.60. This can be caused by the frequent use of the lecture method, so that students do not have the opportunity to participate actively during learning and students become accustomed to only hearing explanations of material from the teacher without trying to understand it themselves (Puspita & Aloysius, 2019; Sianturi et al., 2018). This is in line with the results of the needs analysis which states that most of the methods applied by teachers are lecture methods so that students are not used to being required to gather their own information to solve existing problems (Allanta & Puspita, 2021; Husein et al., 2017). Meanwhile, the critical thinking indicator that has the highest N-Gain result is the additional skills indicator, which is 0.68. This can be caused because students feel that the e-module developed is very supportive in deciding on an action which is evidenced by the results of the student practicality test on the additional skills indicator which is the highest among other critical thinking indicators, namely 90.32%.

In general, students are quite capable of solving a problem critically. However, they are still accustomed to receiving learning with the lecture method so that their critical thinking skills are not optimally developed. In accordance with theory students can master a certain ability if the learning is carried out repeatedly (Saidah, 2021). Therefore, students need to be trained in critical thinking skills regularly so that students' ability to think critically can improve optimally. In addition, the teacher himself must also get used to student-centered learning so that students are able to actively participate in learning. The advantage of e-modules based on the scientific approach integrated with SSI is that this e-module combines the scientific approach and SSI so that it can be more optimal to encourage the improvement of students' ability to think critically.

This study contributes to the literature by demonstrating the effectiveness of integrating the scientific approach with SSI in an e-module format. While previous studies have highlighted the benefits of SSI and scientific approaches separately (Genisa et al., 2020), this research uniquely combines these methods, resulting in enhanced critical thinking skills. The use of digital tools like Flip PDF Corporate software further distinguishes this study, offering an innovative approach to teaching biodiversity.

In comparison to earlier research, this study aligns with and extends the findings of study by providing a practical, digital solution that addresses the challenges of limited teaching materials and teacher capacity (Arifa, 2022; Widodo, 2021). The e-module's interactive features and accessibility through platforms like Liveworksheet and Google Forms make it a scalable and sustainable solution for improving critical thinking in junior high school students.

In summary, the integration of the scientific approach with SSI in the *Merdeka* Curriculum e-module has proven to be an effective method for enhancing critical thinking skills among junior high school students. This study's findings highlight the need for a shift towards more interactive and student-centered learning environments to foster critical

thinking. Future research should focus on longitudinal studies to assess the long-term impact of this approach and explore its applicability to other subjects and educational contexts.

## 4. CONCLUSION

The development of the *Merdeka* Curriculum e-module, which integrates a scientific approach with Socio-Scientific Issues (SSI) on biodiversity material, has proven to be an effective tool for enhancing students' critical thinking skills. The e-module has been rigorously validated by experts, confirming its high validity. Both teachers and students have found the e-module to be highly practical, as indicated by the results of the practicality tests. The effectiveness of the e-module is further demonstrated by the significant improvement in posttest scores of students in the experimental group compared to the control group, as well as the moderate N-Gain results. These findings underscore the potential of the e-module to make a meaningful impact on student learning by providing an engaging and interactive educational experience that fosters critical thinking. This research highlights the importance of innovative teaching materials in supporting curriculum goals and improving educational outcomes.

## 5. ACKNOWLEDGEMENT

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## 6. REFERENCES

Agustin, N. (2019). Pengaruh Pendekatan Saintifik Terhadap Keterampilan Berpikir Kritis Siswa Subtema Keberagaman Makhluk Hidup Di Lingkunganku Kelas IV Sekolah Dasar. *Child Education Journal*, *1*(1), 36–43. https://doi.org/10.33086/cej.v1i1.912.

Alfiriani, A., & Hutabri, E. (2017). Kepraktisan Dan Keefektifan Modul Pembelajaran Bilingual Berbasis Komputer. *Jurnal Kependidikan*, *1*(1), 12–23. https://doi.org/10.21831/jk.v1i1.10896.

Allanta, T. R., & Puspita, L. (2021). Analisis keterampilan berpikir kritis dan self efficacy peserta didik: Dampak PjBL-STEM pada materi ekosistem. *Jurnal Inovasi Pendidikan IPA*, *7*(2), 158–170. https://doi.org/10.21831/jipi.v7i2.42441.

Arifa, F. N. (2022). Implementasi Kurikulum Merdeka dan Tantangannya. *Bidang Kesejahteraan Rakyat: Info Singkat*, *16*(9), 25–30. https://doi.org/10.21831/jk.v1i1.10896.

Asrifan, A., Seraj, P. M. I., Sadapotto, A., & Vargheese, K. J. (2023). The Implementation of Kurikulum Merdeka as The Newest Curriculum Applied at Sekolah Penggerak in Indonesia. *IJOLEH: International Journal of Education and Humanities*, *2*(1), 62–74. https://doi.org/10.56314/ijoleh.v2i1.130.

Badjeber, R., & Purwaningrum, J. P. (2018). Pengembangan Higher Order Thinking Skills. *Jurnal Pendidikan Dan Pembelajaran*, *1*(1), 36–43. https://doi.org/10.31970/gurutua.v1i1.9.

Ellizar, E., Hardeli, H., Beltris, S., & Suharni, R. (2018). Development of Scientific Approach Based on Discovery Learning Module. *IOP Conference Series: Materials Science and Engineering*, *335*(1). https://doi.org/10.1088/1757-899X/335/1/012101.

Genisa, M. U., Subali, B., Djukri, Agussalim, A., & Habibi, H. (2020). Socio-scientific issues implementation as science learning material. *International Journal of Evaluation and Research in Education*, *9*(2), 311–317. https://doi.org/10.11591/ijere.v9i2.20530.

Gustinasari, M., Lufri, & Ardi. (2017). Pengembangan Modul Pembelajaran Berbasis Konsep

Disertai Contoh pada Materi Sel untuk Siswa SMA. *Bioeducation Journal*, *1*(1), 2354–8363. http://ejournal.unp.ac.id/index.php/bioeducation/article/view/7154.

Husein, S., Herayanti, L., & Gunawan, G. (2017). Pengaruh Penggunaan Multimedia Interaktif Terhadap Penguasaan Konsep dan Keterampilan Berpikir Kritis Siswa pada Materi Suhu dan Kalor. *Jurnal Pendidikan Fisika Dan Teknologi*, *1*(3), 221–225. https://doi.org/10.29303/jpft.v1i3.262.

Ibad, W. (2022). Penerapan Profil Pelajar Pancasila Di Tingkat Sekolah Dasar. *JIEES : Journal of Islamic Education at Elementary School JIEES*, *3*(2), 84–94. https://doi.org/10.47400/jiees.v3i2.47.

Imansari, N., & Sunaryantiningsih, I. (2017). Pengaruh Penggunaan E-Modul Interaktif Terhadap Hasil Belajar Mahasiswa pada Materi Kesehatan dan Keselamatan Kerja. *VOLT: Jurnal Ilmiah Pendidikan Teknik Elektro*, *2*(1), 11–16. https://doi.org/10.30870/volt.v2i1.1478.

Jailani, J., & Almukarramah, A. (2020). Upaya Peningkatan Kualitas Pembelajaran Biologi melalui Pembelajaran Bermakna dengan Menggunakan Peta Konsep. *Jurnal Biology Education*, *8*(2), 122–130. https://doi.org/10.32672/jbe.v8i2.2371.

Karisan, D., & Zeidler, D. L. (2017). Contextualization of Nature of Science Within the Socioscientific Issues Framework: A Review of Research. *International Journal of Education in Mathematics, Science and Technology*, 139–152. https://doi.org/10.18404/ijemst.270186.

Kurniawan, A. B., & Hidayah, R. (2020). Kepraktisan Permainan Zuper Abase Berbasis Android Sebagai Media Pembelajaran Asam Basa. *UNESA Journal of Chemical Education*, *9*(3), 317–323. https://doi.org/10.26740/ujced.v9n3.p317-323.

Kurniawan, N. A., Saputra, R., Aiman, U., Alfaiz, A., & Sari, D. K. (2020). Urgensi Pendidikan Berpikir Kritis Era Merdeka Belajar bagi Peserta Didik. *Tarbawi : Jurnal Ilmu Pendidikan*, *16*(1), 104–109. https://doi.org/10.32939/tarbawi.v16i01.576.

Lee, C. Y., & Sen, A. (2018). Students Voice in their Learning: Incorporating Students' Expectations in Learning Design of E-learning of Pharmacotherapy. *International Journal of Learning and Teaching*, *4*(3), 203–208. https://doi.org/10.18178/ijlt.4.3.203-208.

Lieung, K. W., Rahayu, D. P., & Fredy. (2020). Scientific Approach to Improve the Critical Thinking Skills. *Advances in Social Science, Education and Humanities Research*, *473*(Icss), 480–483. https://doi.org/10.2991/assehr.k.201014.105.

López-Fernández, M. del M., González-García, F., & Franco-Mariscal, A. J. (2022). How Can Socio-scientific Issues Help Develop Critical Thinking in Chemistry Education? A Reflection on the Problem of Plastics. *Journal of Chemical Education*, *99*(10), 3435–3442. https://doi.org/10.1021/acs.jchemed.2c00223.

Mahanani, I., Rahayu, S., & Fajaroh, F. (2020). The Effect of Inquiry Based Learning With Socioscientific Issues Context on Critical Thinking Skills and Scientific Explanation. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, *3*(1), 53–68. https://doi.org/10.21831/jk.v3i1.20972.

Maula, N. R., & Fatmawati, L. (2022). Pengembangan Media Pembelajaran Kayaku (Kayanya Alam Negeriku) Berbasis STEM Kelas IV Sekolah Dasar. *Jurnal Ilmiah Sekolah Dasar*, *4*(1), 97. https://doi.org/10.23887/jisd.v4i1.22351.

Mudawamah, K. (2020). Peningkatan Hasil Belajar dan Literasi Sains Siswa SMPN 1 Ngoro Mojokerto melalui Penerapan Pendekatan Saintifik Berbasis Socio-scientific issues (SSI). *Science Education and Application Journal*, *2*(2), 52. https://doi.org/10.30736/seaj.v2i2.254.

Murtiyasa, B., & Perwita, W. R. G. (2020). Analysis of mathematics literation ability of students in completing PISA-oriented mathematics problems with changes and relationships content. *Universal Journal of Educational Research*, *8*(7), 3160–3172. https://doi.org/10.13189/ujer.2020.080745.

Nida, S., Pratiwi, N., & Eilks, I. (2021). A Case Study on the Use of Contexts and Socio-Scientific Issues-Based Science Education by Pre-service Junior High School Science Teachers in Indonesia During Their Final Year Teaching Internship. *Frontiers in Education*, *5*(January), 1–8. https://doi.org/10.3389/feduc.2020.592870.

Nuryadi, Astuti, T. D., Utami, E. S., & Budiantara, M. (2017). *Buku ajar dasar-dasar statistik penelitian*. Sibuku Media.

Patel, S. R., Margolies, P. J., Covell, N. H., Lipscomb, C., & Dixon, L. B. (2018). Using Instructional Design, Analyze, Design, Develop, Implement, and Evaluate, to Develop e-Learning Modules to Disseminate Supported Employment for Community Behavioral Health Treatment Programs in New York State. *Frontiers in Public Health*, *6*. https://doi.org/10.3389/fpubh.2018.00113.

Payadnya, I. P. A. A., & Jayantika, I. G. A. N. T. (2018). *Panduan Penelitian Eksperimen Beserta Analisis Statistik Dengan SPSS*. Deepublish.

Puspita, A. S., & Aloysius, S. (2019). Developing student's critical thinking skills through implementation of problem based learning approach. *Journal of Physics: Conference Series*, *1241*(1). https://doi.org/10.1088/1742-6596/1241/1/012020.

Rahayu, S., Wulandari, B. A., & Ali, M. (2023). Pengembangan Modul Matematika sebagai Penunjang Pembelajaran secara Online untuk Siswa SMK yang Melaksanakan Prakerin (Praktek Kerja Industri). *Jurnal Ilmiah Universitas Batanghari Jambi*, *1*, 786–791. https://doi.org/10.33087/jiubj.v23i1.3303.

Rubiyanti, R., Badaruddin, B., & Eka, K. I. (2020). Improving Critical Thinking Skills and Learning Independence Using Problem Based Learning Based On Science Literation. *Indonesian Journal of Educational Studies (IJES*, *23*(1), 34–43. https://doi.org/10.26858/ijes.v23i1.13342.

Saidah, Z.-. (2021). Relevansi Teori Belajar Konstruktivisme Perspektif Ibnu Khaldun Terhadap Karakteristik Belajar Siswa Milenial. *Al-Tarbawi Al-Haditsah: Jurnal Pendidikan Islam*, *6*(2), 110. https://doi.org/10.24235/tarbawi.v6i2.9333.

Sianturi, A., Sipayung, T. N., & Simorangkir, F. M. A. (2018). Pengaruh Model Problem Based Learning (PBL) terhadap Kemampuan Berpikir Kritis Matematis Siswa SMPN 5 Sumbul. *UNION: Jurnal Ilmiah Pendidikan Matematika*, *6*(1). https://doi.org/https://doi.org/10.30738/.v6i1.2082.

Sugiyono. (2016). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Alfabeta.

Susilawati, E., Agustinasari, A., Samsudin, A., & Siahaan, P. (2020). Analisis Tingkat Keterampilan Berpikir Kritis Siswa SMA. *Jurnal Pendidikan Fisika Dan Teknologi*, *6*(1), 11. https://doi.org/10.29303/jpft.v6i1.1453.

Turan, U., Fidan, Y., & Yıldıran, C. (2019). Critical Thinking as a Qualified Decision Making Tool. *Journal of History Culture and Art Research*, *8*(4), 1. https://doi.org/10.7596/taksad.v8i4.2316.

Widodo, A. (2021). *Pembelajaran Ilmu Pengetahuan Alam Dasar-Dasar untuk Praktik*. UPI Press.

Yansen, D., Putri, R. I. I., Zulkardi, & Fatimah, S. (2019). Developing PISA-like mathematics problems on uncertainty and data using Asian Games football context. *Journal on Mathematics Education*, *10*(1), 37–46. https://doi.org/10.22342/jme.10.1.5249.37-46.

Yennita, Y., Zulirfan, Z., Fakhruddin, F., & Azizahwati, A. (2020). The Design Phase of the Development of an Electrical Installation Prototype Kit as A Medium for the Stem Project of Junior High School Students. *Journal of Physics: Conference Series*, *1655*(1). https://doi.org/10.1088/1742-6596/1655/1/012072.

Zandkarimi., Y. (2013). The Impact of E-learning on some Psychological Dimensions and Academic Achievement. *International Journal of Education and Learning*, *2*(2), 49–56. https://doi.org/10.14257/ijel.2013.2.2.05.