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Development of Learning Tools Based on the Culturally Responsive Transformative Teaching Model with a Socio-Scientific Issues Approach: Evaluation of Validity and Practicality

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Abstract: The importance of conducting this research is based on observations indicating that the implementation of the Kurikulum Merdeka on the theme of local wisdom has been limited to Sabtu Budaya (Cultural Saturday) activities, without further integration into the learning process, particularly in the development of learning tools. This research aims to develop a learning tool based on the CRTT model with a SSI approach that is both valid and practical. The type of research employed is Research and Development (R&D), with a 4D development design limited to the define, design, and develop stages. The development stage is restricted to validation and practicality testing. Data collection techniques included expert validation sheets, student and teacher response questionnaires, and observation sheets for the implementation of learning activities. Data analysis techniques used Aiken's V validity index, Percentage of Agreement, and percentage method. The results of the content and construct validity tests indicate that the learning tool based on the CRTT model with the SSI approach is classified as highly valid, with the assessment agreement among validators being reliable. The results of the practicality test show that student responses had an average of 89.02%, categorized as practical, teacher responses were 92.81%, categorized as practical, and the implementation of learning activities reached 85.71%. These results indicate that the learning tool based on the CRTT model with the SSI approach is both valid and practical for use in the learning process.

Keywords: CRTT Model; Learning Tools; Practicality; SSI Approach; Validity

Introduction

The Fourth Industrial Revolution (Industry 4.0) and the challenges of Society 5.0 have prompted the introduction of a new educational policy in Indonesia, known as the Merdeka Curriculum (Sasikirana., 2022). The primary background of this policy is the demands of globalization and the shift in the educational paradigm in Indonesia. This policy aims to develop a more holistic education system that encompasses the development of students' character, skills, and thinking abilities (Vhalery et al., 2022). One of the themes in the implementation of the Merdeka Curriculum is local wisdom (Santoso et al., 2023). The development of a curriculum based on local wisdom is an effort to integrate traditional cultural values into the educational curriculum to produce graduates who are competent both academically and non-academically, while embodying the noble values of the Indonesian nation (Karsiwan et al., 2023).

The Merdeka Curriculum has very positive goals, but its implementation in the field still faces several challenges at the stages of planning, execution, and learning assessment (Mukhibin et al., 2022). Rindayati et al., (2022) revealed that teachers are still struggling to develop learning tools that include Learning Outcomes (CP), Learning Objectives (TP), and Learning Objective Pathways (ATP). Rosidah et al., (2021) noted teachers'

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lack of readiness in applying authentic assessments, while Utari et al., (2023) stated that teachers still do not fully understand the national assessment in the Merdeka Curriculum. In line with the implementation of the local wisdom theme in the Merdeka Curriculum, teachers also experience difficulties in integrating local wisdom into the learning process, particularly through teaching materials (Arifin et al., 2024).

Interviews with several teachers at upper secondary education institutions revealed that 75% had never integrated local wisdom or addressed socio-scientific issues in their teaching materials. In line with the implementation of the Merdeka Curriculum, the local wisdom theme is one of the applied themes, but its execution has been limited to cultural activities held on Saturdays. As a result, the integration of local wisdom into the learning process, particularly in learning tools, has not yet been implemented. Teachers in the interviews expressed that there is a significant need for innovative learning resources based on local wisdom combined with socio-scientific issues in the community to better support the implementation of the Merdeka Curriculum, particularly in the local wisdom theme.

Facilitating the integration of local wisdom through learning tools, the Culturally Responsive Transformative Teaching (CRTT) model is one of the most suitable models for implementation. The CRTT model is developed based on the principles of Culturally Responsive Teaching (CRT). CRT was designed to create meaningful learning by connecting the learning process with students' cultural contexts (Gay, 2000). CRT is built upon students' cultural experiences, recognizing that different heritages and languages influence their attitudes and approaches to learning (Bergantz & Gale, 2020). Educators must understand that there is a strong connection between culture and students' ways of thinking, as culturally responsive teaching leverages the knowledge, experiences, and diverse cultural backgrounds of students to enhance the effectiveness and relevance of the learning process (Walker, 2023).

According to Aceves & Orosco (2014), culturally responsive feedback is a form of individualized support provided by teachers to students, considering their preferences and cultural backgrounds. Teachers offer personalized support by understanding students' preferences and cultures. This strategy integrates students' responses, ideas, language, and experiences into the feedback cycle, while inviting students to construct new understandings of what they are currently learning (McIntyre & Hulan, 2013).

The concepts and principles of CRT outlined above were further developed by Rahmawati & Ridwan (2017) and Rahmawati et al., (2019) into Culturally Responsive Transformative Teaching (CRTT) by adding the concept of "Transformative." The transformative concept in CRTT adds a new dimension to culturally responsive teaching (CRT). This transformative concept aims to transform students' understanding and attitudes towards culture by emphasizing the addition of new values and knowledge that are relevant to students' cultural contexts. This enables students to integrate what they gain from learning into their everyday lives.

The Culturally Responsive Transformative Teaching (CRTT) model's strengths can help address issues such as the lack of relevance of learning materials to students' needs, environments, motivation, and interests in learning (Adawiyah et al., 2022). The application of the CRTT model allows students to learn in ways that are more connected to their daily lives and accommodates the cultural diversity around them (Rahmawati et al., 2020b). Additionally, it can create contextual learning because students are already familiar with their own cultures (Dwipayana et al., 2020). In this research, the cultural aspects highlighted include the Pedak Api tradition of the Narmada community, Ngome, Bebonto, and Awik-Awik.

The Pedak Api tradition is a birth ceremony, accompanied by the naming of the child, held on the seventh or ninth day after birth (Zuhriah & Warto, 2019). This tradition is relevant to the concept of biology education, particularly in the topic of interactions between abiotic components (the fire used in the Pedak Api ceremony) and biotic components (the baby placed above the fire) (Arifin et al., 2024). Ngome and Bebonto are traditional practices of farmers in Narmada for maintaining rice crops after planting. Ngome involves the removal of pests that could hinder rice growth, while Bebonto aims to scare away birds and other animals, such as rats, that might consume the rice. Both activities are crucial for understanding food chains and food webs in rice paddy ecosystems. Awik-Awik refers to customary laws or regulations developed by communities to protect their environment from damage, ensuring that resources remain sustainable for future generations (Irrubai, 2019).

Learning with the application of the CRTT model, which facilitates the integration of local wisdom aspects, is also potentially combined with the Socio-Scientific Issue (SSI) approach. Between 2017 and 2023, SSI, which integrates science and complex social issues, has become a major focus in efforts to create science education that is more contextual and relevant for students. This reflects a transformation in science teaching approaches, where science is no longer taught in isolation but is positioned as an integral part of the real-world context (Priyanka & Selamat, 2021). Additionally, research on SSI also examines the role of teachers in integrating socio-scientific issues into the curriculum and how learning materials can be adapted to achieve more contextual science education (Arifin et al., 2022; Munawaroh & Mustafid, 2023).

SSI-based learning is context-dependent (Cebesoy, 2021) and addresses open, unstructured, complex (Karahan & Roehrig, 2017; Saglam & Eroglu, 2022), and controversial issues with a problem-oriented approach. It introduces current socio-scientific topics (Asmah, 2022) and requires various considerations, perspectives, and solutions (Cebesoy, 2021; Es & Ozturk, 2021). The SSI approach is not only related to issues occurring in real life (Sadler et al., 2016), such as cloning (Ozden, 2015), genetic modification of organisms (Herman et al., 2020), pharmacogenomics (Cebesoy, 2021), and global warming (Herman, 2015), but also addresses controversial conceptual issues, such as evolutionary theory and climate change (Andryani et al., 2016; Sadler et al., 2016). In addition to global issues, SSI can also stem from local community concerns (Subiantoro & Ariyanti, 2013). In this study, the SSI aspects are derived from local community issues, such as tree cutting activities, post-harvest rice straw burning, and gold mining in Sekotong.

Tree cutting issues impact climate change because trees play a crucial role in absorbing carbon dioxide from the atmosphere. Preventing deforestation is important for maintaining environmental cycles and reducing greenhouse gas emissions, which are exacerbated by the open burning of rice straw waste (Iqbal & Ruhaeni, 2022; Risfany et al., 2022). Another socio-scientific issue, gold mining in Sekotong, poses threats to ecosystem sustainability due to potential deforestation, land degradation, and water and air pollution, all of which can accelerate global climate change (Pangemanan et al., 2022; Arifin et al., 2023). Therefore, integrating socio-scientific issues related to tree cutting, post-harvest rice straw burning, and gold mining in Sekotong into education, including through learning tools, is essential.

Based on the above description, this research aims to develop learning tools based on the Culturally Responsive Transformative Teaching model with a Socio-Scientific Issues approach that are valid and practical for use in the learning process. The cultural aspects addressed include the Pedak Api tradition of the Narmada community, Ngome, Bebonto, and Awik-Awik. The SSI aspects are derived from local community issues, such as tree cutting activities, post-harvest rice straw burning, and gold mining in Sekotong.

Method

Research Type and Design

The research type used is Research and Development (R & D) with a 4D development design (Thiagarajan et al., 1974). The design of learning tools using the 4D development model is limited to the define, design, and develop stages. In the define stage, front-end analysis, learner analysis, concept analysis, task analysis, and specification of learning objectives are conducted. In the design stage, test standards are developed, media and formats are selected, and the initial design of the learning tools based on the Culturally Responsive Transformative Teaching model with a Socio-Scientific Issues approach is prepared. In the develop stage, expert validation, reliability testing with percentage of agreement, and practicality testing are carried out.

Implementation Procedure

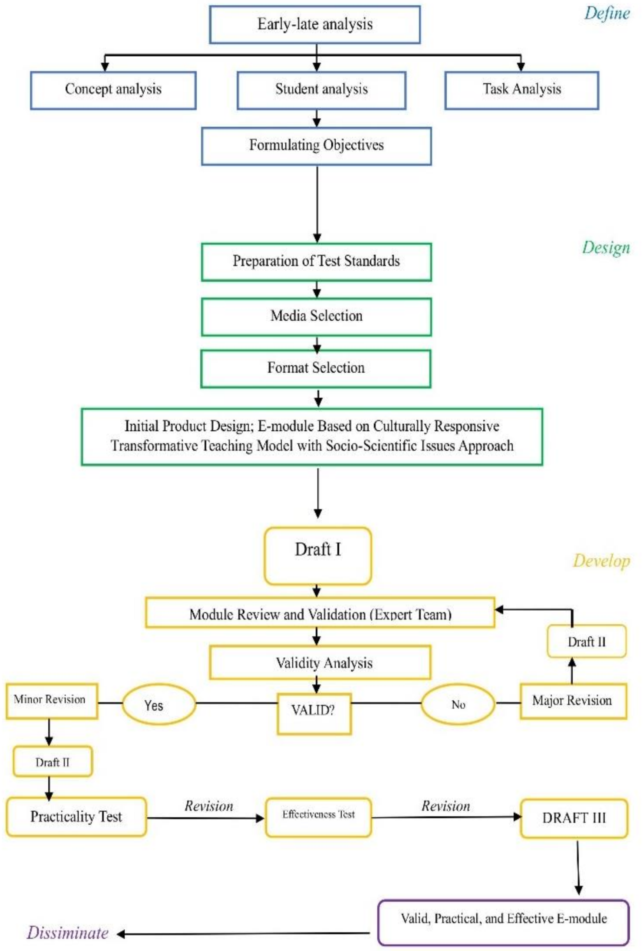

Figure 1. Development Procedure

Validity Testing

Validity testing or expert appraisal aims to produce valid and reliable products based on expert evaluations before field trials are conducted. The validity testing is performed in two stages by six expert validators to assess content validity and construct validity. Content validity measures the extent to which the instrument accurately covers all aspects of the concept to be measured, such as the alignment of the developed tools with the CRTT model with SSI approach and the relevance to indicators of scientific argumentation and scientific attitudes. Construct validity, on the other hand, reflects the construction in terms of organization, framework, language, and graphic presentation. The validity test is conducted to determine the validity of learning tools including ATP, teaching modules, e-modules, LKPD, argumentation skill test instruments, and scientific attitude questionnaires.

Practicality Testing

Practical testing is conducted after the e-modules and developed tools have been validated and found reliable. The goal of practicality testing is to obtain direct feedback from students and teachers regarding the e-modules and learning tools. Practicality testing is carried out using a quantitative descriptive method. The testing involves a group of students as respondents. According to Mahmud (2011), the minimum sample size for practicality testing is 30 students. In this study, the trial subjects include 36 students from class X7 at SMAN 1 Narmada, as well as teachers as users and observers to assess the implementation of the learning process.

Data Collection Techniques

Validity Testing

The data collection technique for validity testing involves using expert validation questionnaires. These questionnaires are employed to assess both content validity and construct validity of the developed learning tools. The scoring guidelines on the validation questionnaires use a Likert scale from 1 to 5, with the following scoring criteria: very poor (1), poor (2), fair (3), good (4), and very good (5). The results of the validation are used to determine whether the developed product is suitable for use.

Practicality Testing

The data collection techniques for practicality testing include questionnaires on the implementation of learning, teacher responses, and student responses. Scoring guidelines also use a Likert scale from 1 to 5, with the following criteria: very poor (1), poor (2), fair (3), good (4), and very good (5).

Data Analysis Techniques

Validity Testing

The data analysis process for each statement item on the validation questionnaire uses the following Aiken's V formula:

$$V = \frac{\Sigma s}{(n\ (c-1)} \quad \dots (1)$$

Symbols		Descriptions
V	:	Validity Index
S	:	r – lo
R	:	Rating given by the evaluator
Lo	:	Lowest rating score, which is (1)
C	:	Highest rating score, which is (5)

Based on the results of the validity test from the validators, the data is interpreted according to the validity criteria. The validity level is determined based on Table 1.

Table 1. Validity Levels of the Tools

Range of V	Validity Level
V ≥ 0.4	Less valid
0.4 > V < 0.8	Valid
V ≥ 0.8	Very valid

(Aiken, 1997)

Reliability analysis is conducted using the Borich method, known as Percentage of Agreement (PA). The purpose of using the Borich method for reliability analysis is to assess the consistency of judgments or agreement among multiple evaluators (validators). This method is used to measure the extent to which two or more evaluators agree in their assessment of components of the learning tools, including aspects of content appropriateness, presentation appropriateness, and language appropriateness.

In this study, six validators are used, so the analysis involves combining each pair of the six validators, resulting in 15 validator pairs for which the percentage of agreement must be calculated. The combinations of validator pairs are (V1,2), (V1,3), (V1,4), (V1,5), (V1,6), (V2,3), (V2,4), (V2,5), (V2,6), (V3,4), (V3,5), (V3,6), (V4,5), (V4,6), and (V5,6). The formula for percentage agreement (PA) is as follows:

$$PA = (1 - \frac{A - B}{A + B})\ x\ 100\% \quad \dots (2)$$

Based on the formula above, A represents the higher score and B represents the lower score. The higher score (A) is always subtracted by the lower score (B). An instrument is considered reliable if the percentage of agreement is 75% or higher. If it is less than 75%, the instrument must be tested for clarity and agreement among the observers (Borich, 1994).

Practicality Testing

The practicality of the learning tools is analyzed using the following formula for the questionnaires on the implementation of learning, teacher responses, and student responses:

$$P_{(k)} = \frac{S}{N} \times 100\ \% \quad \dots (3)$$

Descriptions:

$P_{(k)}$	=	Component Percentage
S	=	Total Score Obtained
N	=	Maximum Possible Score

After analysis, the results of the practicality questionnaires, including teacher responses and student responses, are interpreted based on the practicality criteria in Table 2.

Table 2. Practicality Criteria

Practicality Percentage (%)	Practicality Level
75.01 – 100	Practical
50.01 – 75.00	Fairly Practical
25.01 – 50.00	Less Practical
≤ 25.00	Not Practical

(Marisa et al., 2020)

Result and Discussion

Results of the Define Stage

In the define stage, which consists of 5 steps: (a) front-end analysis identified issues related to the limitations of learning resources and learning tools that integrate local wisdom and socio-scientific issues through the learning process; (b) learner analysis found that 75.76% of students showed interest in learning based on local wisdom, and 81.08% showed interest in learning that addresses socio-scientific issues; (c) task analysis assessed the alignment of the assignments given with the learning objectives to be achieved; (d) concept analysis detailed the criteria for achieving the learning objectives according to the learning goals and developed the content concepts to be included in the learning tools; and (e) specification of learning objectives provided the basis for developing the learning tools, including the learning objective flow (ATP), teaching modules (Modul Ajar), E-modules, LKPD, scientific argumentation test instruments and scientific attitude questionnaires.

Results of the Design Stage

In the design stage, there are four steps: (a) Developing test standards to measure students' scientific argumentation and scientific attitudes; (b) Selecting media, including virtual aquatic mini-ecosystem media and LKPD media, to maximize the learning process; (c) Choosing the format; and (d) Creating the initial design of learning tools, including the learning objective flow (ATP), teaching modules, e-modules, LKPD, argumentation test instruments, and scientific attitude questionnaires.

Results of the Develop Stage

1. Validity Testing Results

In the development stage, validity testing, or expert appraisal was conducted to produce valid and reliable products based on the evaluations of experts and practitioners before field testing. The validation process was performed twice to achieve optimal results. The validity testing at this stage includes content validity and construct validity, covering the suitability of presentation and language. Criticisms and suggestions from experts regarding the weaknesses and shortcomings of the tools were used as the basis for further refinement, ensuring the tools are valid for use in teaching. The learning tools evaluated include the learning objective flow (ATP), teaching modules, LKPD, scientific argumentation test instruments, and scientific attitude questionnaires. Below is a summary of the validation results:

a. Results of Content Validity

Content validity measures how well the developed learning instruments cover all aspects of the concept being measured, such as the alignment of e-modules and learning tools with the CRTT model syntax with the SSI approach, as well as their suitability with indicators of scientific argumentation and scientific attitudes.

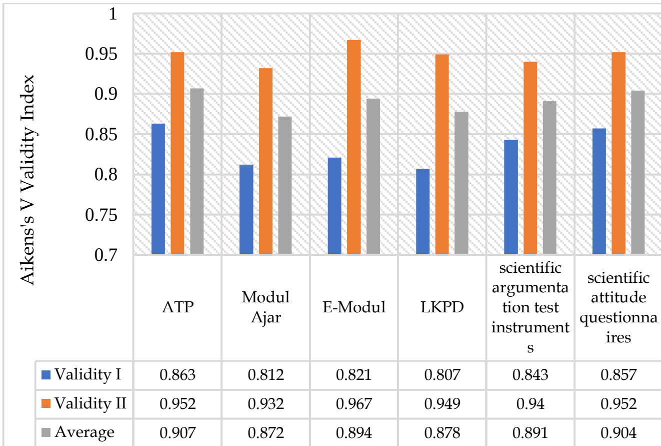

Figure 2. Validation Results of Learning Tools in Terms of Content Validity

Figure 2 shows that the average content validity index for all components of the learning tools, including the learning objective flow (ATP), teaching modules, e-modules, Student Worksheets (LKPD), scientific argumentation test instruments, and scientific attitude questionnaires, is greater than 0.8. This indicates that the developed learning tools are categorized as highly valid.

The content validity results for all components of the teaching materials were rated as highly valid, with validation indices > 0.8. The content validation assessed several aspects, specifically ensuring that the integration of the Culturally Responsive Transformative Teaching (CRTT) model with the Socio-Scientific Issues (SSI) approach was clearly evident in the learning activities and measured variables of argumentation and scientific attitudes. The assessment of ATP and teaching modules includes the relevance between learning objectives and learning outcomes, alignment of model methods, content, media, learning activity descriptions, assessment, and time allocation. The average content validation result for ATP was 0.907, categorized as highly valid. The average content validation result for the teaching module was 0.872, also categorized as highly valid.

For e-modules and LKPD, content validation assessed the relevance of the CRTT-based e-modules with the SSI approach, the e-module's effectiveness in enhancing argumentation and scientific attitudes, accuracy and alignment with biological sciences, and the appropriateness of the presentation for student-centered learning. The average content validation result for the e-module was 0.894, categorized as highly valid. The average content validation result for LKPD was 0.878, also categorized as highly valid.

For the scientific argumentation test instruments and scientific attitude questionnaires, validation assessed their relevance to learning objectives, indicators of scientific argumentation skills and scientific attitudes, alignment with CRTT and SSI aspects, and the proportion of difficulty levels and accuracy of assessment rubrics. The average content validation result for the scientific argumentation test was 0.891, categorized as highly valid. The average content validation result for the scientific attitude questionnaire was 0.904, also categorized as highly valid. Overall, the content validation results indicate that the teaching materials meet the content validity standards, as they have validation indices > 0.4. According to Purnami & Suarni (2021), content validation indices can be considered valid if the validation results are in the range of 0.4–0.8. Additionally, Dzikro & Dwiningsih (2021), state that teaching materials can be deemed valid if they have a minimum percentage of 41-61% or a scale of 0.41-0.61, categorized as sufficiently valid and usable. Furthermore, it is crucial to focus on the integration of the CRTT model with the SSI approach, which must be clearly visible in the developed teaching materials.

Integrating culture and socio-scientific issues through the CRTT model with the SSI approach is important in education because it creates contextual learning, as students are already familiar with the cultural and socio-scientific issues in their daily lives (Dwipayana et al., 2020; Rahmawati et al., 2020b). This aligns with the validation results, which show that the teaching materials are rated as highly valid by validators, concluding that the developed materials are consistent with the CRTT learning model combined with the SSI approach.

b. Result of *Construct Validity*

Construct validity reflects a construction in terms of structure, framework, language, and graphical elements. The results of the construct validity for the ATP, Teaching Module, E-Module, LKPD, Scientific Argumentation Test Instrument, and Scientific Attitude Questionnaire Instrument. Figures 2 and 3 show the average results of construct validity for the aspects of presentation feasibility and language feasibility. For both aspects, the learning tools, including ATP, teaching module, e-module, student worksheets (LKPD), scientific argumentation test instrument, and scientific attitude questionnaire instrument, have construct validity indices greater than 0.8, indicating that they are categorized as highly valid.

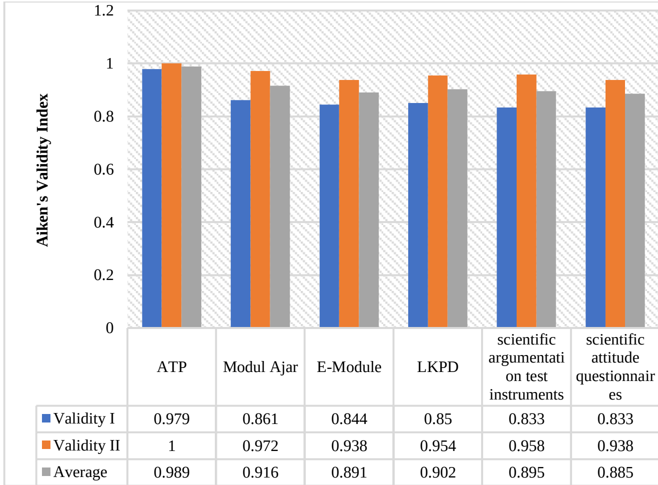

Figure 3. Validation Results of Learning Tools in Terms of Presentation Feasibility in Construct Validity

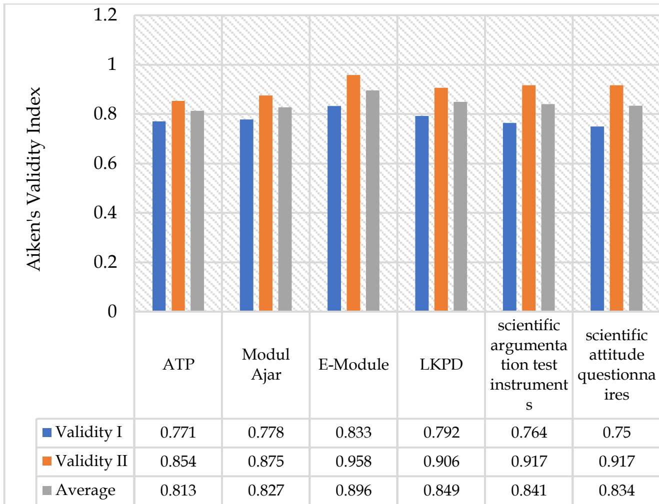

Figure 4. Validation Results of Learning Tools in Terms of Language Feasibility in Construct Validity

Construct validity reflects a construction in terms of organization, framework, language, and graphical presentation (Nengsih et al., 2019). The organization and framework of the developed instruments must be logically and systematically arranged so that each part is interconnected in supporting the measurement of the intended concept. Clear, accurate, and developmentally appropriate language is essential to avoid ambiguity and misinterpretation of items. Additionally, graphical aspects such as the use of images, diagrams, and layout should support the understanding of concepts and not distract from the main measurement objectives (Flake et al., 2017).

The construct validity results for the e-modules and instructional materials concerning presentation feasibility were overall assessed as very valid. The construct validity for presentation feasibility evaluates several aspects that must be present. The evaluation aspects for the ATP and Teaching Module include the systematic arrangement, components of the Teaching

Module containing general information related to module identity, initial competencies, Pancasila student profiles, facilities and infrastructure, the learning model used, learning outcomes, learning objectives, meaningful understanding, triggering questions, and learning activities. The average validity result for the presentation aspect of ATP is 0.989, categorized as very valid. The average validity result for the Teaching Module is 0.916, categorized as very valid.

The construct validity assessment for the e-module and LKPD presentation feasibility evaluates the relevance and consistency of the arrangement, systematic presentation including module identity, table of contents, list of images, list of videos, module description, usage instructions, introduction, appearance of the e-module including cover and content, composition and proportional size of the e-module, appropriateness of font type and size, and ease of operation. The average validity result for the e-module is 0.891, categorized as very valid. The average validity result for the LKPD is 0.902, categorized as very valid.

The construct validity assessment for the scientific argumentation test instruments and scientific attitude questionnaire evaluates the systematic arrangement of the argumentation skills test instrument and scientific attitude questionnaire, and the clarity of the instructions. The average validity result for the scientific argumentation test instrument is 0.895, categorized as very valid. The average validity result for the scientific attitude questionnaire is 0.885, categorized as very valid. Overall, the construct validity results for the presentation aspect indicate that the CRTT-based SSI approach learning materials meet the construct validity standards for presentation feasibility because they have a validity index > 0.4 (Purnami & Suarni, 2021).

The construct validity results for the e-module and instructional materials concerning language feasibility for each component have been assessed as very valid by the validators. The validation results show that the ATP received an index of 0.813, the Teaching Module received an index of 0.827, the E-Module 0.896, the LKPD 0.849, the argumentation test instrument 0.841, and the scientific attitude questionnaire 0.834. Overall, the results for the language feasibility aspect by validators are categorized as very valid because the validity index > 0.8. The construct validity assessment for language feasibility includes aspects of readability, communicativeness, appropriate sentence structure, ease of understanding by students, and avoiding multiple interpretations.

Readability refers to the ease of reading and understanding instructions or questions in instructional materials (Ernica & Hardeli, 2019). Communicativeness assesses the extent to which the language used clearly conveys instructional or question objectives to students (Haspen et al., 2021). The use of precise and clear sentence structures is necessary to reduce ambiguity and ensure accurate interpretation by students. Questions that could lead to multiple interpretations need special attention, particularly in test instrument components (Afrita & Darussyamsu, 2021).

c. Validator Suggestions and Revision Results

After the CRTT-based learning tools with an SSI approach were developed, a validation process was carried out by validators who are experts in their field. The validators provided various inputs and suggestions aimed at improving the quality and suitability of the developed learning tools. Their suggestions included not only technical aspects such as layout, language, and format but also emphasized the refinement of content to ensure greater relevance to cultural contexts and socio-scientific issues. Several suggestions were made for improvements, including revisions to the ATP, teaching module, e-module, Student Worksheets (LKPD), scientific argumentation test instruments, and scientific attitude questionnaires, based on the validators' feedback. The validator suggestions and revision results are presented in the following table:

Table 3. Validator Suggestions and Revision Results for ATP

Suggestion	Improvement
Replace the word "understand" in the learning objectives with a more operational verb	The word "understand" has been replaced with the verb "describe"
Correct the typo in the word "mengindentifikasi" in the learning objectives	The typo "mengindentifikasi" has been corrected to "mengidentifikasi"
Specify the project to be created in the learning objectives for each learning activity	The project to be created has been added to the learning objectives
Adjust the learning objectives to align with the ABCD aspects, especially in terms of C (Condition) and D (Degree)	The learning objectives have been adjusted to meet all ABCD aspects

Table 3 shows validator suggestions and revision results for ATP. Revisions have been made according to validator suggestions to ensure the ATP is clearer, more measurable, and aligned with assessment standards. These changes include replacing vague terms with more precise verbs, correcting typographical errors, specifying expected outputs, and adjusting learning objectives to the ABCD model. Additionally, these improvements are intended to enhance the overall quality and effectiveness of the ATP in guiding the learning process.

Table 4. Validator Suggestions and Revision Results for teaching module (Modul Ajar)

Suggestion	Improvement
Add a cover to the module	The cover has been added
Specify the use of video links to support the material in the media section under facilities and infrastructure	The video link used to support the material has been added in the media section of the teaching module
Align the process skill elements with the designed learning activities	The process skill elements have been aligned with the designed learning activities
Differentiate the wording of learning objectives from the criteria for achieving learning objectives	The wording of the learning objectives and the criteria for achieving them have been revised
Specify the method used in the learning model section	The method has been added according to what is used in the learning activities
Add the benefits for students in learning the material in the meaningful understanding section	The benefits for students in learning the material have been added at the end of the meaningful understanding paragraph

Table 4 shows validator suggestions and revision results for the teaching module (Modul Ajar). The revisions have been implemented to enhance the module's completeness and clarity. Changes include adding a cover page, incorporating video links to support the material, aligning process skills with learning activities, distinguishing between learning objectives and their criteria, specifying the methods used, and adding student benefits to the meaningful understanding section. These updates ensure the module is more structured, supportive, and effective in achieving its educational goals.

Table 5. Validator Suggestions and Revision Results for E-Module and LKPD

Suggestion	Improvement
Add other customs/ cultural practices in the e-module and worksheets to support CRTT-based learning. Each learning activity should incorporate a different cultural aspect	CRTT aspects have been added, specifically the practices of farmers in Selat Village, Narmada District, West Lombok, in caring for rice plants after planting, known as *Ngome* and *Bebonto*. *Ngome* involves removing weeds, snails, and other pests that can interfere with rice growth to ensure optimal plant development. *Bebonto*, or scarecrows, are used to scare away birds and other animals, such as rats, to prevent them from eating the rice.
Add a video related to gold mining in Sekotong	Each SSI aspect has been supplemented with a video, including videos related to deforestation, burning of straw waste, and gold mining in Sekotong.

Table 5 shows validator suggestions and revision results for the e-module and LKPD. Revisions have been made to enrich the content and enhance its relevance. CRTT aspects have been integrated, incorporating local cultural practices such as Ngome and Bebonto from Selat Village, Narmada District, to support rice plant care. Additionally, videos related to various SSI aspects, including gold mining in Sekotong, have been added to provide a comprehensive understanding of the topics covered.

Table 6. Validator Suggestions and Revision Results for scientific argumentation test instruments, and scientific attitude questionnaires

Suggestion	Improvement
Incorporate cultural aspects into the items of the scientific argumentation test	Cultural aspects have been added to the items in the scientific argumentation test instrument
Revise the wording of statements in the scientific attitude questionnaire to be shorter and simpler	The wording of statements in the scientific attitude questionnaire has been revised to be shorter and simpler
Add a more specific scoring guide for each sub-indicator in the scientific attitude questionnaire	The scoring guide for the scientific attitude questionnaire has been added with more specificity for each sub-indicator

Table 6 shows Validator Suggestions and Revision Results for the scientific argumentation test instruments and scientific attitude questionnaires. Revisions include the addition of cultural aspects to the argumentation test items to enhance relevance, simplification of the wording on the scientific attitude questionnaire for better clarity, and the inclusion of more specific scoring guidelines for each sub-indicator to improve assessment accuracy. These updates aim to ensure that the instruments provide valid, reliable measures of students' argumentation skills and scientific attitudes.

d. Reliability Test Results

The purpose of conducting a reliability analysis using the Borich method, known as the Percentage of Agreement (PA), is to assess the consistency of evaluations or the agreement between multiple assessors (validators). This method measures the extent to which two or more assessors agree in their evaluations of components of the e-module and teaching materials, including aspects of content feasibility, presentation feasibility, and language feasibility.

In this study, six validators were used, so the analysis involved combining the evaluations from all six, resulting in 15 validator pairs for which the percentage of agreement needed to be calculated. An instrument is considered reliable if its percentage of agreement is 75% or higher. If it is less than 75%, further clarification and approval from the observers are required. The results of the validator agreement analysis on content feasibility, presentation feasibility, and language feasibility are presented in the following figure:

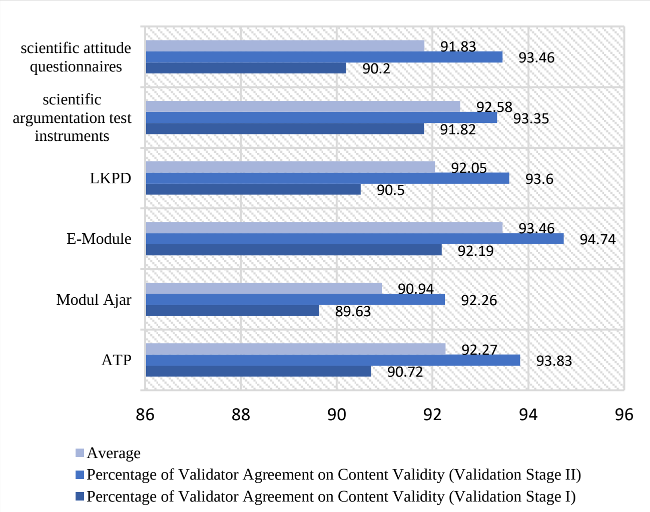

Figure 5. Percentage of Agreement among Validators on Content Validity

Figure 5 shows the results of the reliability test using the Percentage of Agreement method for Content Validity. The results indicate that the average percentage of agreement across all components of the teaching materials is greater than 75%. Therefore, it can be concluded that the validators' assessments are reliable in terms of content.

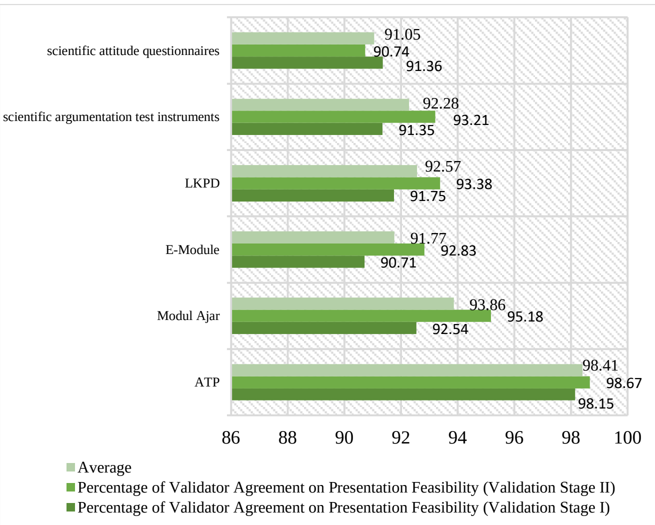

Figure 6. Percentage of Agreement among Validators on Construct Validity (Presentation Feasibility)

Figure 6 shows the results of the reliability test using the Percentage of Agreement method for Construct Validity on presentation feasibility. The results indicate that the average percentage of agreement across all components of the teaching materials is greater than 75%. Therefore, it can be concluded that the validators' assessments are reliable in terms of construct validity for presentation feasibility.

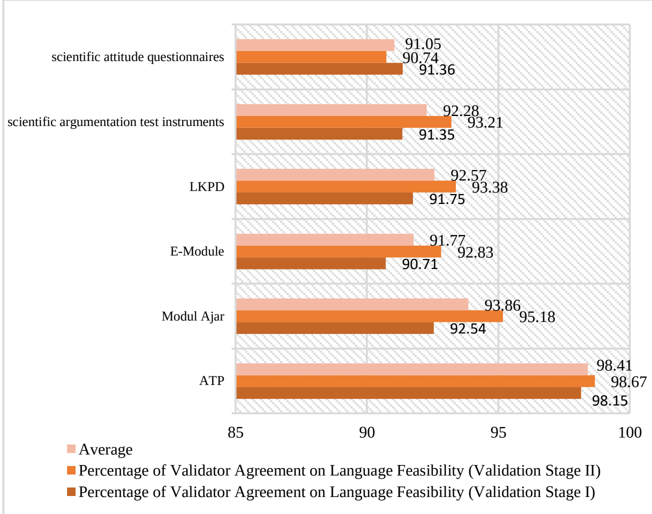

Figure 7. Percentage of Agreement among Validators on Construct Validity (Language Feasibility)

Reliability testing using the Percentage of Agreement method aims to assess the extent to which different raters or validators provide similar evaluations of the same object. One of the primary goals is to evaluate the consistency of the assessments given by different raters for the same components or indicators (Januarti et al., 2023). A level of agreement > 75% indicates that the assessment instrument yields consistent results and can be considered reliable. Reliability analysis using the Percentage of Agreement method can help enhance the validity of research results because the obtained results are credible (Astuti et al., 2021).

In this study, six validators were used, so the analysis involved combining all six validators, resulting in 15 validator pairs whose agreement percentage needed to be calculated. The validator pairs included (V1,2), (V1,3), (V1,4), (V1,5), (V1,6), (V2,3), (V2,4), (V2,5), (V2,6), (V3,4), (V3,5), (V3,6), (V4,5), (V4,6), and (V5,6). The Percentage of Agreement (PA) was then calculated for these 15 validator pairs. The results are considered reliable if the percentage of agreement is greater than or equal to 75%. If it is less than 75%, the instrument must be re-evaluated for clarity and validator approval.

Based on the reliability test results conducted using the Percentage of Agreement method, each validated item had an average percentage > 75%. This result indicates that the validators had consistency in assessing the components of the e-modules and instructional materials, including content feasibility (Figure 5), presentation feasibility (Figure 6), and language feasibility (Figure 7), as the reliability test showed a percentage > 75%. Therefore, it can be concluded that developed instruments are considered reliable because the validator agreement percentage is > 75%.

If the percentage of agreement is less than 75%, the developed instrument needs to be evaluated and adjusted to improve clarity and minimize interpretive differences among raters, ultimately enhancing the quality and effectiveness of the instrument in the assessment process (Makhrus, 2018). Thus, reliability testing using this method is a crucial step to ensure the credibility of data and support more accurate decision-making in determining the reliability of the developed e-modules and instructional materials.

2. *Practicality Test Results*

The practicality test was conducted after the developed e-module and teaching materials were deemed valid and reliable. This test aims to obtain direct feedback from students and teachers regarding the practicality of the e-module and teaching materials. The practicality criteria are based on percentages, with the level of practicality categorized into four groups: practical, fairly practical, less practical, and not practical.

a. *Results of Student Feedback*

The results of student feedback on the learning conducted using CRTT-based teaching materials with the SSI approach show varying percentages across five assessed aspects of practicality. These aspects include learning activities, teaching materials, CRTT-based e-modules and LKPD with the SSI approach, argumentation, and scientific attitudes. The results for all aspects are presented in the following Figure 7.

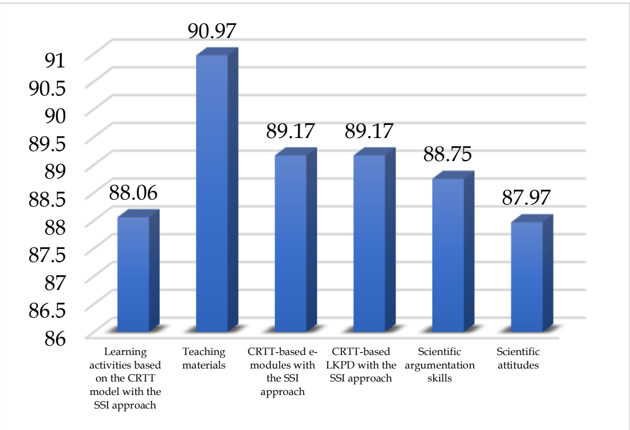

Figure 8. Results of Student Feedback

Based on Figure 8, all aspects show a high level of practicality, with an overall average of 89.02%. The practicality percentages for the various aspects are as follows: learning activities based on the CRTT model with the SSI approach at 88.06%, teaching materials at 90.97%, e-modules and LKPD at 89.17%, scientific argumentation skills at 88.75%, and scientific attitudes at 87.97%. Thus, all aspects are rated as "Practical," indicating that the developed teaching materials are suitable for effectiveness testing.

Students completed a response questionnaire based on their opinions and experiences related to the learning activities conducted using an e-module based on the CRTT model with the SSI approach. The e-module is designed to enhance students' argumentation skills and scientific attitudes. Therefore, students' responses reflect the extent to which the e-module facilitates argumentation and the development of scientific attitudes during the learning process.

The results of the students' response questionnaire across all aspects show a practicality level with an overall average of 89.02%. The aspect of learning activities based on the CRTT model with the SSI approach has an average percentage of 88.06%, learning materials 90.97%, e-modules and LKPD 89.17%, scientific argumentation skills 88.75%, and scientific attitudes 87.97%. Thus, based on the overall average of all aspects, the e-module and teaching tools developed are assessed as practical, indicating that the e-module and learning tools are practical for use in teaching.

Specifically, the component of learning activities based on the CRTT model with the SSI approach assesses students' responses from several aspects. The first aspect relates to enthusiasm in participating in learning activities that cover cultural aspects such as Pedak Api, Ngome, Bebonto, and Awik-Awik, which received a practicality score of 92.22%. The aspect of socio-scientific issues in society, such as deforestation, rice straw burning, and gold mining, received a score of 82.78%. These results indicate that culturally based and socio-scientific issue approaches are practical in engaging students' interest and involvement in the learning process.

Additionally, the learning activities received practical responses as they were easy for students to understand, with a practicality percentage of 85.00%, indicating that the material presented was well understood. Furthermore, learning that combines cultural aspects and socio-scientific issues was rated as providing meaningful learning experiences for students, with a practicality score of 92.22%. This suggests that the CRTT model combined with the SSI approach is relevant in creating contextual learning.

Specifically, the e-module and LKPD components assess students' responses from several aspects. The first aspect is related to the presentation of the e-module and LKPD, which was considered attractive by students with a practicality percentage of 88.89%. Additionally, the e-module and LKPD were found to be easy to understand with a practicality percentage of 86.67%. Cultural aspects included in the e-module and LKPD, such as the Pedak Api, Ngome, Bebonto, and Awik-Awik traditions, also had a positive impact, with 91.67% of students expressing satisfaction with learning using the e-module. Moreover, the integration of socio-scientific issues in the e-module was also favored by students, with a practicality percentage of 89.44%. Overall, the average practicality of the e-module and LKPD based on students' responses is 89.17%, indicating that the e-module is practical for use in teaching.

In line with this, Dwipayana et al., (2020) and Rahmawati et al., (2020b) state that incorporating cultural aspects into teaching can create contextual learning because students are already familiar with their own culture. Besides incorporating cultural aspects, integrating socio-scientific issues present in society into science education also holds significant potential as it can bridge the connection between scientific concepts and real-world situations, making the learning process more meaningful (Rostikawati & Permanasari, 2016).

b. Results of Teacher Feedback

The results of teacher feedback on the CRTT-based learning materials with the SSI approach show varying percentages across five aspects of practicality. These aspects include the teaching module, learning materials, e-module, LKPD, scientific argumentation test instruments, and scientific attitude questionnaires, all based on the CRTT model with the SSI approach. The teacher feedback for each aspect is presented in the following Figure 8.

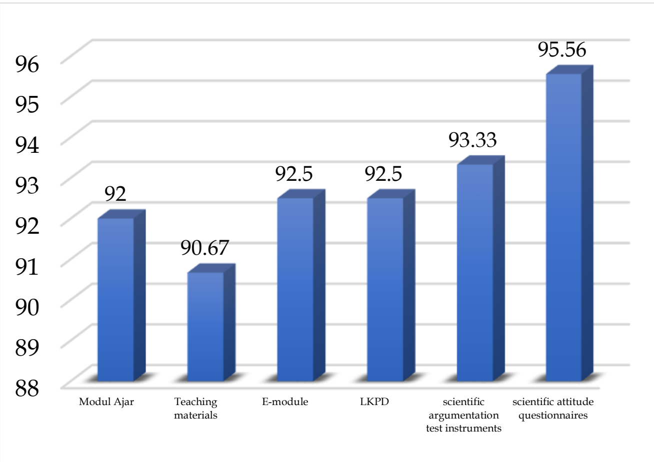

Figure 9. Results of Teacher Feedback

Figure 9 shows the results of teacher feedback on the five aspects of the CRTT-based learning materials with the SSI approach. These aspects include the teaching module, learning materials, e-module, LKPD, scientific argumentation test instruments, and scientific attitude questionnaires. The teaching module received a practicality percentage of 92%, learning materials were rated at 90.67%, e-modules and LKPD at 92.5%, scientific argumentation test instruments at 93.33%, and scientific attitude questionnaires received the highest percentage of 95.56%. Based on these values, all aspects are categorized as Practical, indicating that the CRTT-based materials with the SSI approach are considered easy to implement and practical for use in teaching activities, particularly in enhancing students' scientific argumentation skills and scientific attitudes.

The practicality test also involved three Biology teachers who assessed five aspects related to the e-module and the developed teaching tools. These aspects include the teaching module, learning materials, e-module, LKPD, scientific argumentation skills test instrument, and scientific attitude questionnaire instrument. The teaching module received a practicality percentage of 92%, learning materials were rated at 90.67%, e-modules and LKPD at 92.5%, the scientific argumentation skills test instrument received 93.33%, and the scientific attitude questionnaire recorded the highest percentage of 95.56%. Overall, all aspects were rated in the practical category, indicating that the e-module and CRTT-based tools with the SSI approach are considered easy to apply and practical for use in teaching activities.

Specifically, the CRTT model-based teaching module with the SSI approach assesses teachers' responses from several aspects, including general information, core competencies, assessment, and the suitability of the CRTT and SSI-based learning steps to facilitate argumentation skills and scientific attitudes. The highest scores were achieved in components related to the implementation of CRTT and SSI-based learning steps, as well as activities that train scientific argumentation skills and instill scientific attitudes in students, each with a practicality percentage of 100%.

The e-module and LKPD components achieved an average practicality of 92.5%. This result indicates a very good level of relevance with the competencies that students must master, in accordance with the CRTT model steps with the SSI approach, and their practicality in facilitating argumentation skills and instilling scientific attitudes, each with a practicality percentage of 100%. However, there are some aspects that could be improved, such as the language used and the e-module's appearance, which received percentages below 90%, suggesting room for enhancing the visual appeal or design of the module to make it more engaging for students.

The results indicate that the developed tools can facilitate learning that is relevant to cultural contexts and engage students in socio-scientific issues, in line with the CRTT concept and SSI approach. The Kurikulum Merdeka provides flexibility for educators to develop learning materials relevant to local contexts, including through the integration of culture and socio-scientific issues. Integrating culture allows students to learn in contexts close to their daily lives, which can enhance engagement and understanding of the learning material (Rahmawati et al., 2020b).

Cultural integration aligns with the principles of Kurikulum Merdeka, which promotes student-centered learning and allows for the exploration of local values in the learning process (Sutrisno & Rofi'ah, 2023). The SSI approach, on the other hand, emphasizes the importance of connecting science with relevant social issues (Sadler et al., 2017) such as deforestation, rice straw burning, and gold mining, which impact climate change. Additionally, the application of teaching modules combining cultural aspects and SSI is also consistent with the goals of Kurikulum Merdeka, which focuses on shaping the Pancasila Student profile. Previous research shows that integrating cultural aspects and SSI in science education can enhance scientific argumentation (Lestari et al., 2023) and students' scientific attitudes (Adawiyah et al., 2022).

c. Results of Learning Implementation

Observations of the implementation of learning aim to assess how effectively the CRTT-based e-module with the SSI approach has been applied. This observation is used to evaluate the teacher's activities in carrying out the lessons according to the prepared teaching module. The results of the observation of the learning implementation for the three conducted learning activities are presented in the following Figure 10.

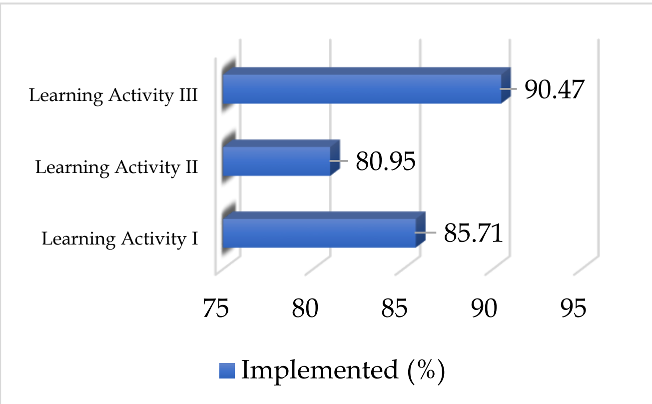

Figure 10. Results of Learning Implementation

The observation results on the implementation of learning across three learning activities showed varying outcomes. In Learning Activity I, implementation reached 85.72%, with most learning activities proceeding as planned. However, some stages of the SSI approach, particularly in stages 3 and 4, were modified to be completed at home. These stages, which involve examining the impact of socio-scientific issues and making solution-oriented decisions, were initially intended to take place in class but were modified to be done at home due to the school's OSIS election activities.

In Learning Activity II, implementation was at 80.95%, mainly affected by a marching exercise event, which reduced the effectiveness of classroom learning. Once again, stages 3 and 4 of the SSI approach, focusing on analyzing the impact of socio-scientific issues and developing solutions, were completed through home-based group work. This modification allowed students to carry out each critical phase of the SSI approach despite limited class time and promoted independent learning, which is a key aspect of the Kurikulum Merdeka (Minarti et al., 2023).

Learning Activity III recorded an increased implementation rate of 90.47%, with stages 3 and 4 of the SSI approach completed similarly, through modification. Although interruptions from school activities were fewer, some parts of the lesson were still more effectively carried out at home, such as stage three of the SSI, which involves examining the local, national, and global impact of the issue presented, and stage four, where students make solution-based decisions based on the assessed impacts. Overall, these results indicate that, although certain stages of learning could not be fully implemented in class due to various disruptions, all steps were completed through modifications outside of class. This was done to ensure that learning objectives could still be achieved to the fullest extent.

The main factor affecting learning implementation, based on the results, was time allocation, as several learning activities were hindered by concurrent school events. Consistent with this, Jariah & Aminatun (2022) noted that insufficient time allocation can impact learning implementation. Additionally, the implementation of the CRTT model integrated with the SSI approach was being trialed for the first time at this site, meaning that students needed time to adjust, which could influence activity implementation (Sutrisno & Rofi'ah, 2023). Another factor was the quality of the available network, as network support is essential for electronic module-based learning (Widianto, 2021).

Conclusion

Based on the objectives, research results, and discussion, the conclusion is that the CRTT model-based teaching tools with the SSI approach are valid and practical for use in the learning process.

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Author Contributions

In this study, the contributions of the authors are divided into several key areas. The first author was responsible for designing teaching tools and collecting field data. The second author was involved in data analysis. The third author contributed to writing the research report, drafting the article, and reviewing the literature related to the CRTT model and SSI approach. All authors participated in discussing the research results and revising the manuscript up to the publication stage.

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Conflicts of Interest

The authors' interest in publishing this article is to fulfill the publication requirements for their thesis examination in the master's program in Science Education at Universitas Mataram.

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