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Development of Socio-Scientific Issue-Based E-LKPD Flipbook to Improve Elementary School Students' Critical Thinking Skills

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ABSTRACT

The Merdeka Curriculum promotes contextual learning and the development of 21st-century competencies, particularly critical thinking. This study aimed to develop an electronic student worksheet (E-LKPD) in flipbook format based on socio-scientific issues (SSI) and to examine its validity, practicality, and potential to support fifth-grade students' critical thinking skills. This Research and Development study used the ADDIE model. Participants included two expert validators, one classroom teacher, and 13 fifth-grade students selected through purposive sampling. Data were collected through expert validation, teacher and student response questionnaires, and a one-group pretest-posttest design. The E-LKPD was rated highly feasible by material and media experts, with validity scores of 88.89% and 90.00%, respectively. Teacher and student responses indicated high practicality, with scores of 88% and 95.38%. Students' mean critical thinking score increased from 46.54 on the pretest to 77.69 on the posttest. A paired-samples t-test showed a statistically significant difference between the scores ($p < .001$). These findings suggest that the developed SSI-based E-LKPD in flipbook format is valid, practical, and has the potential to support fifth-grade students' critical thinking skills in science learning.

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1. INTRODUCTION

Education is a fundamental pillar of human development because it not only transfers knowledge but also equips learners with the competencies needed to address future challenges [1]. Rapid global development has increased the demand for 21st-century competencies, particularly the 4Cs: critical thinking, creativity, collaboration, and communication [2]. Among these competencies, critical thinking is considered essential because it enables students to analyze information, solve problems, evaluate evidence, and make reasoned decisions. In this study, critical thinking is defined based on Facione's

framework, which comprises six indicators: interpretation (understanding the problem), analysis (identifying relationships), evaluation (assessing solutions), inference (drawing conclusions), explanation (explaining results), and self-regulation (monitoring and reflecting on one's reasoning) [3]. Strengthening these competencies aligns with Indonesia's deep learning implementation and the eight dimensions of the Graduate Profile promoted by the Ministry of Education, Culture, Research, and Technology [4]. This policy responds to students' relatively weak higher-order thinking skills, as reflected in the 2022 Programme for International Student Assessment (PISA), where Indonesia's science literacy score (383) remained below the OECD average of 485 [5], [6]. Since elementary education provides the foundation for later learning, fostering critical thinking skills should begin at this level.

The rapid advancement of digital technology has transformed educational practices from conventional instruction to technology-enhanced learning environments [7]. Consequently, digital learning resources have become increasingly important in supporting student-centered learning. One such resource is the electronic student worksheet (E-LKPD), which enables students to engage in independent and interactive learning activities [8]. Among various digital formats, flipbooks provide multimedia features and interactive navigation that can increase students' motivation, engagement, and learning achievement while supporting independent learning [9], [10], [11], [12], [13]. Nevertheless, digital media alone are insufficient to develop critical thinking unless they provide meaningful, contextual learning experiences.

Socio-Scientific Issues (SSI) provide an effective context by engaging students with authentic, controversial issues related to science. Through SSI, students are encouraged to apply scientific knowledge, evaluate evidence, construct arguments, consider ethical perspectives, and make informed decisions [14]. Previous studies have shown that SSI improves students' conceptual understanding while increasing their awareness of social and environmental issues [15], [16]. Because SSI naturally promotes discussion, argumentation, and evidence-based reasoning, it can be effectively integrated into student worksheets (LKPD) [17]. In Grade V elementary science, the topic *Getting to Know Our Earth* offers authentic SSI contexts, including deforestation, soil pollution, and climate change [18].

Despite these educational demands, the integration of contextual digital learning media into elementary science instruction remains limited. Preliminary observations conducted in December 2025 at SDN 1 Temengeng revealed that fifth-grade students demonstrated low critical thinking skills. Learning relied primarily on printed textbooks, with limited use of digital and contextual learning resources. Classroom assessment focused mainly on lower-order cognitive skills (C1–C2), while higher-order thinking skills (C3–C6) were rarely assessed. In addition, teachers had not implemented E-LKPD, specifically designed to foster critical thinking. Consequently, students had limited opportunities to practice interpreting problems, analyzing relationships, evaluating evidence, drawing conclusions, explaining their reasoning, and monitoring their own thinking. These classroom findings illustrate broader challenges in implementing learning environments that effectively integrate digital technology, contextual issues, and critical thinking instruction in elementary schools.

Several previous studies have demonstrated the potential of flipbook-based learning media. Yusmar et al. [10] developed a flipbook-based electronic module integrated with external features that was found to be highly valid (91.09%) and practical (90.14%), supporting students' independent learning. Rahmawati et al. [11] reported that responsibility-integrated flipbook media achieved high feasibility scores (75%–94.90%) while promoting active and interactive learning. Similarly, Yusuf [12] found that an integrated flipbook textbook improved students' creative thinking and academic resilience. Although these studies confirmed the educational benefits of flipbook media, they did not incorporate Socio-Scientific Issues (SSI) to promote elementary students' critical thinking skills.

Other studies have integrated Socio-Scientific Issues (SSI) into various learning resources. Khasanah et al. [19] reported that an SSI-based e-book demonstrated high feasibility, as confirmed by expert validation. Similarly, Ulliva and Prodjosantoso [17] found that SSI-based printed student worksheets were valid and practical and supported improvements in students' chemistry literacy, although no significant improvement in scientific attitudes was observed. Alya and Purwaningsih [15] also developed an SSI-based interactive e-module integrated with micro-projects, which showed high validity and supported students' conceptual understanding and science process skills. Despite these promising findings, the studies focused on e-books, printed worksheets, or e-modules rather than flipbook-based E-LKPD, involved secondary school students, and did not specifically address elementary students' critical thinking skills.

Based on the literature and the classroom findings, a clear research gap remains. Previous studies have developed SSI-based e-books or flipbooks separately, but few have integrated socio-scientific issues, electronic student worksheets (E-LKPD), the flipbook format, and elementary students' critical thinking into a single learning product. Therefore, this study aims to develop an SSI-based E-LKPD in flipbook format on the topic of Getting to Know Our Earth and to evaluate its validity, practicality, and potential to support the critical thinking skills of fifth-grade elementary school students.

2. METHOD

2.1. Research Designs

The development process followed the ADDIE instructional design model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation [20], [21]. During the analysis stage, a needs assessment was conducted at SDN 1 Temengeng through classroom observations, interviews, and needs analysis questionnaires to identify learning problems and the need for digital learning media. The design stage involved determining learning objectives, selecting science content, designing SSI-based learning activities, developing critical thinking tasks and assessment instruments, and preparing the flipbook interface. During the development stage, the E-LKPD was produced, validated by material and media experts, and revised based on their recommendations. The implementation stage consisted of a limited classroom trial involving one fifth-grade teacher and 13 fifth-grade students, followed by practicality evaluation using teacher and student response questionnaires. Finally, the evaluation stage comprised formative evaluation through expert feedback and summative evaluation to assess the validity, practicality, and

preliminary effectiveness of the developed E-LKPD. The product's effectiveness was evaluated using a one-group pretest-posttest design, in which the same students completed a pretest before and a posttest after the intervention to examine changes in their critical thinking skills. The overall research procedure is presented in Figure 1.

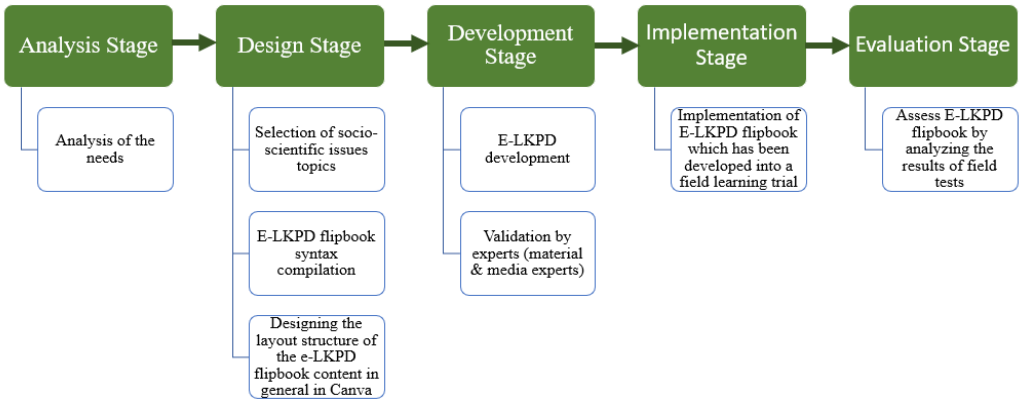


Figure 1. Flowchart according to the ADDIE Model

2.2. Research Participants

The study involved two expert validators, one fifth-grade teacher, and 13 fifth-grade students from SDN 1 Temengeng, Blora Regency, Central Java, Indonesia. Participants were selected through purposive sampling based on their roles in the development and evaluation of the SSI-based E-LKPD. The expert validators, consisting of one material expert and one media expert, evaluated the content, language, instructional design, usability, and technical quality of the product and provided recommendations for revision. The classroom teacher evaluated the practicality of the E-LKPD, while the students, as the target users, participated in both the practicality evaluation and the effectiveness test using a one-group pretest-posttest design. The sample was limited to one class (13 students), consistent with the implementation stage of R&D studies that emphasize preliminary product evaluation rather than statistical generalization. Therefore, the findings should be interpreted within the context of this study.

2.3. Data Collection Techniques and Instruments

Data were collected through observations, interviews, questionnaires, expert validation sheets, and essay tests. Different instruments were used at each stage of the ADDIE model to support the development and evaluation of the SSI-based E-LKPD in flipbook format. During the analysis stage, classroom observations, semi-structured interviews, and needs analysis questionnaires were administered to the fifth-grade teacher and students to identify learning problems, learner characteristics, instructional practices, the use of digital learning media, and the need for an SSI-based E-LKPD for the topic *Getting to Know Our Earth*. During the development stage, the E-LKPD was evaluated using expert validation sheets completed by one material expert and one media expert. The material expert assessed curriculum alignment, content, presentation, and language, whereas the media expert evaluated usability, visual design, multimedia integration, navigation, and

instructional benefits. The experts' recommendations were used to revise the product before implementation.

Product practicality was evaluated through teacher and student response questionnaires after implementation. The teacher questionnaire assessed media design, instructional benefits, and language, while the student questionnaire evaluated support for critical thinking, learning motivation, ease of use, media attractiveness, and media operation. The effectiveness of the developed E-LKPD was measured using a pretest and posttest consisting of 10 essay questions based on Facione's six critical thinking indicators: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Student responses were scored using a four-point analytic rubric (1–4). The test's content validity was established through expert judgment by the material and media experts.

2.4. Data Analysis Techniques

The collected data were analyzed to evaluate the needs, validity, practicality, and effectiveness of the developed SSI-based E-LKPD in flipbook format. The needs analysis was conducted using data from classroom observations, semi-structured interviews, and teacher- and student-focused needs analysis questionnaires during the analysis stage. Observation and interview data were analyzed descriptively to identify learning problems, instructional practices, learner characteristics, the use of digital learning media, and the need for developing an SSI-based E-LKPD. Questionnaire responses were summarized descriptively to support the findings from the observations and interviews.

The validity analysis was based on expert validation sheets completed by one material expert and one media expert. The material expert evaluated curriculum alignment, content accuracy, presentation, and language, whereas the media expert assessed usability, visual design, multimedia integration, and instructional benefits. The experts' suggestions were used to revise and improve the E-LKPD before classroom implementation. The grid for the validation sheet is as follows:

Table 1. Grid for Expert Assessment Validation Sheet

No	Aspect	Indicator
Material Expert		
1	Curriculum alignment	Relevance to the curriculum, difficulty level, and concept connections
2	Content accuracy and presentation	Presentation structure, media variety, and interactivity
3	Language	Clarity of language, consistency of terms, and appropriateness of writing style
Media Expert		
1	Usability	Easy navigation process, clear usage instructions, and media responsiveness
2	Visual design	Interesting visual design, color composition suitability, and the use of graphics and animation
3	Multimedia integration	Multimedia integration, curriculum compatibility, and ease of use
4	Instructional benefits	Training critical thinking skills, supporting learning styles, and improving understanding

The practicality analysis was conducted using teacher and student response questionnaires administered after the implementation of the developed E-LKPD. The teacher

questionnaire assessed media design, instructional benefits, and language, while the student questionnaire evaluated support for critical thinking, learning motivation, ease of use, media attractiveness, and media operation. The grids of the teacher and student response questionnaires are presented in Table 2 as follows:

Table 2. Grid of Teacher and Student Response Questionnaire

No	Aspect	Indicator
Teacher's Response		
1	Media Design	Visual integration, interactivity, and accessibility
2	Instructional benefits	Improving critical thinking skills, understanding the material, and supporting learning styles
3	Language	Clarity of language, precision of language, and appeal of language
Student Response		
1	Support critical thinking skills	Improving critical thinking skills
2	Learning motivation	The joy of learning
3	Ease of use	Ease of use, easy to understand, self-learning, and learning anytime
4	Media attractiveness	Visual attractiveness and design attractiveness
5	Media operation	Ease of operation and clear instructions

The percentage scores for the validity and practicality analyses were calculated using the following formula:

$$P = \frac{x}{x_i} \times 100\% \quad 1)$$

Where P is the percentage score, x is the total score obtained, and x_i is the maximum possible score. he results were interpreted using the following criteria: (81% - 100%) = very feasible/very practical; (61% - 80%) = feasible/practical; (41% - 60%) = fairly feasible/fairly practical; (21% - 40%) = less feasible/less practical; and (0% - 20%) = not feasible/not practical.

The effectiveness analysis was conducted using students' pretest and posttest scores obtained from a one-group pretest-posttest design. The assessment instrument consisted of 10 essay questions. Students' responses to the essay test were assessed using an analytic scoring rubric adapted from Facione's critical thinking framework. The rubric evaluated six critical thinking indicators: interpretation, analysis, evaluation, inference, explanation, and self-regulation, using a four-point scale ranging from 1 (lowest performance) to 4 (highest performance). The scoring rubric is presented in Table 3.

Descriptive statistics were first used to summarize students' pretest and posttest scores. Before hypothesis testing, the normality of the score differences was examined using the Shapiro–Wilk test, as the sample consisted of fewer than 50 participants. The paired-samples *t*-test was subsequently performed using IBM SPSS Statistics after the normality assumption was satisfied. This test was selected because it compares the mean scores of the same participants measured before and after the intervention. Statistical significance was determined at $\alpha = .05$. A statistically significant improvement in posttest scores indicated the

preliminary effectiveness of the developed E-LKPD in supporting students' critical thinking skills.

Table 3. Analytic Scoring Rubric for Students' Critical Thinking Skills

Critical Thinking Indicator	Score 4	Score 3	Score 2	Score 1
Interpretation (Understanding the problem)	Correctly identifies the problem and provides a clear and accurate explanation.	Correctly identifies the problem but provides a less detailed explanation.	Correctly identifies the problem but provides a less detailed explanation.	Correctly identifies the problem but provides a less detailed explanation.
Analysis (Identifying relationships)	Clearly explains logical relationships and cause-and-effect among concepts.	Identifies relationships with minor gaps in reasoning.	Identifies related concepts without explaining their relationships.	Fails to identify logical relationships among concepts.
Evaluation (Assessing solutions)	Provides a well-supported judgment with strong scientific reasoning.	Provides an appropriate judgment with one relevant reason.	Provides a judgment with weak or insufficient justification.	Provides a judgment without justification or with incorrect reasoning.
Inference (Drawing conclusions)	Draws logical conclusions and predictions based on the available evidence.	Draws reasonable conclusions but with limited use of evidence.	Provides simple conclusions with limited logical support.	Draws incorrect or unsupported conclusions.
Explanation (Explaining results)	Clearly and systematically explains the relationships among concepts using appropriate scientific reasoning.	Explains the relationships, but with incomplete details.	Provides partial explanations without demonstrating conceptual relationships.	Provides unclear or incorrect explanations.
Self-regulation (Reflection)	Proposes a concrete action supported by thoughtful self-reflection.	Proposes an appropriate action with limited reflection.	States a general intention without a concrete action.	Shows little or no evidence of self-reflection.

2.5. Ethical Considerations

Prior to data collection, permission to conduct the study was obtained from the principal of SDN 1 Temengeng. Participation was voluntary, and all data collected from students were used solely for research purposes. Participants' identities were kept confidential, and the data were reported in aggregate form to ensure anonymity.

3. RESULTS AND DISCUSSION

This study produced a socio-scientific issues-based E-LKPD flipbook to enhance the critical thinking skills of fifth-grade elementary school students. This development study covers the five stages of the ADDIE model. The ADDIE model is a systematic approach designed to produce effective instructional products. Its diverse use spans various aspects of education, from media development and curriculum to the transformation of digital systems, as well as improving teacher competence through structured training [21]. Here are the details of E-LKPD development:

3.1. Analysis Stage

The analysis stage identified instructional needs that formed the basis for developing the Socio-Scientific Issues (SSI)-based electronic student worksheet (E-LKPD) in flipbook format. Data were collected through classroom observations, interviews with the fifth-grade teacher and students, and needs analysis questionnaires at SDN 1 Temengeng.

The findings showed that science learning remained textbook-oriented, with limited use of digital media and contextual learning activities. Classroom instruction emphasized lower-order cognitive skills (C1–C2), providing few opportunities for students to develop critical thinking skills, including interpretation, analysis, evaluation, inference, explanation, and self-regulation. Although digital facilities were available, E-LKPD had not been implemented, and both teachers and students expressed the need for interactive digital learning media that integrate authentic socio-scientific issues into science learning. Therefore, *Getting to Know Our Earth* was selected as the learning topic because it incorporates local environmental issues, such as deforestation, oil mining, and waste from chicken farming, that are relevant to students' daily lives.

These findings demonstrate a gap between the learning demands of the Merdeka Curriculum and current classroom practices. While the curriculum emphasizes contextual learning and the development of higher-order thinking skills, existing instructional resources had not yet adequately facilitated students' engagement with authentic scientific issues or supported systematic critical thinking. Similar needs have been reported by Mentari et al. [16], who found that integrating SSI into digital worksheets promotes contextual learning by encouraging students to connect scientific concepts with real-world problems. Likewise, Samawati and Rahayu [3] reported that flipbook-based E-LKPD provides interactive learning experiences that support students' critical thinking through structured learning activities. Yusmar et al.[10] further demonstrated that flipbook learning resources integrated with interactive features facilitate students' independent learning, while Abshor et al. [22] emphasized that digital E-LKPD can effectively support the development of critical thinking skills through contextual and technology-enhanced learning.

The findings also support previous studies highlighting the role of Socio-Scientific Issues in elementary science education. SSI-based learning improves elementary students' critical thinking by engaging them in analyzing controversial scientific issues and evaluating alternative solutions [23]. Similarly, Saputri and Wulandari [8] showed that integrating environmental issues into digital E-LKPD encourages students to develop evidence-based reasoning while strengthening their critical thinking skills.

Based on these findings, the analysis stage provided a strong empirical basis for developing the SSI-based E-LKPD in flipbook format. The identified instructional needs guided the selection of local socio-scientific issues, the integration of interactive multimedia features, and the design of learning activities that specifically target the six critical thinking indicators proposed by Facione. Therefore, the subsequent stages of the ADDIE model were designed not only to produce a feasible digital learning medium but also to provide contextual learning experiences with the potential to support elementary students' critical thinking skills.

3.2. Design Stage

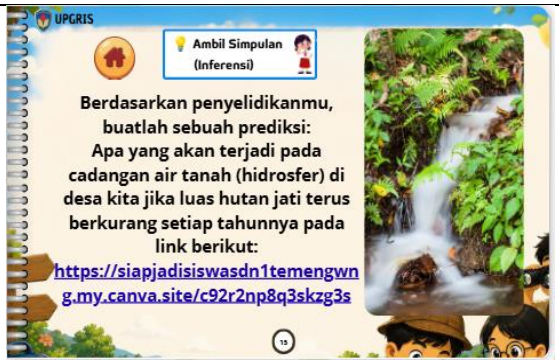
Based on the needs identified during the analysis stage, the SSI-based E-LKPD in flipbook format was designed to provide contextual, interactive, and student-centered science learning. The design focused on integrating authentic socio-scientific issues with multimedia features and structured learning activities to support the development of students' critical thinking skills. The E-LKPD was developed for the Grade V science topic *Getting to Know Our Earth*. Local environmental issues, including deforestation, oil mining, and waste from chicken farming, were selected as the learning context to help students relate scientific concepts to real-life situations. The learning activities were then organized according to the learning objectives and critical thinking indicators proposed by Facione, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation.

The flipbook interface was designed to enhance students' engagement through multimedia elements, including images, videos, hyperlinks, and interactive navigation. In addition, learning activities included contextual problem scenarios, discussion questions, virtual experiments, evaluation tasks, and reflection pages. These features were intentionally designed to encourage students to identify problems, analyze scientific information, evaluate alternative solutions, draw evidence-based conclusions, explain their reasoning, and reflect on their own learning process. The design decisions were supported by previous studies demonstrating that learning media plays an important role in ensuring the effectiveness of the learning process [24]. Using media can also increase engagement, spark motivation, and positively affect students' psychological readiness to learn [25]. Interactive flipbook media promote student engagement and independent learning [10], [11]. The development of E-LKPD should be tailored to students' characteristics, level of understanding, and an easy-to-understand language [26]. Therefore, the design stage translated the instructional needs identified during the analysis phase into a learning product specifically intended to support elementary students' critical thinking through contextual and interactive science learning.

3.3. Development Stage

During the development stage, the initial design was transformed into an SSI-based E-LKPD in flipbook format by integrating science content, interactive multimedia, and learning activities aligned with the six critical thinking indicators proposed by Facione. The product was developed for the Grade V science topic *Getting to Know Our Earth* and included contextual socio-scientific issues, instructional videos, interactive navigation, learning missions, student worksheets, evaluation questions, and reflection activities. The complete product is presented in Table 4.

Table 4. Development Results of Socio-Scientific Issues-Based Flipbook E-LKPD

No	E-LKPD Feature	Learning Purpose	Critical Thinking Indicator
1		Identify contextual problems	Interpretation
2		Identifying relationships among scientific concepts and phenomena	Analysis
3		Evaluating alternative solutions based on evidence	Evaluation
4		Drawing evidence-based conclusions	Inference

No	E-LKPD Feature	Learning Purpose	Critical Thinking Indicator
5		Communicating and justifying conclusions using scientific evidence	Explanation
6		Reflecting on learning and self-monitoring	Self-regulation

After the product was completed, it was evaluated by one material expert and one media expert to determine its feasibility before classroom implementation. The material expert assessed curriculum alignment, content accuracy, presentation, and language, whereas the media expert evaluated usability, interface design, multimedia integration, and instructional benefits. Suggestions from both experts were used to revise and improve the E-LKPD before it was implemented in the classroom. The results of the material expert validation are presented in Table 5.

Table 5. Results of Material Expert Validation

Aspect	Number of indicators	Score	Percentage	Category
Curriculum alignment	3	14	93.33%	Very feasible
Content accuracy and presentation	3	14	93.33%	Very feasible
Language	3	12	80.00%	Very feasible
Total score	9	40	88.89%	Very feasible

The material expert evaluation produced an average validity score of 88.89%, indicating that the developed E-LKPD is very feasible for classroom use. High scores across all assessment aspects suggest that the learning objectives, science content, presentation, and language were appropriate for fifth-grade students and aligned with the Merdeka Curriculum. Nevertheless, the expert also provided several recommendations regarding wording consistency, visual presentation, and minor revisions to instructional content, all of which were incorporated into the final version of the product. The media expert validation results are presented in Table 6.

Table 6. Result of Media Expert Validation

Aspect	Number of indicators	Score	Percentage	Category
Usability	3	14	93.33%	Very feasible
Visual design	3	11	73.33%	Feasible
Multimedia integration	3	15	100%	Very feasible
Instructional benefits	3	14	93.33%	Very feasible
Total score	12	54	90.00%	Very feasible

The media expert evaluation yielded an overall validity score of 90.00%, which also falls within the very feasible category. The results indicate that the developed flipbook provides an attractive interface, clear navigation, effective multimedia integration, and appropriate instructional support for elementary science learning. Recommendations on layout consistency, visual refinement, and user navigation were implemented to further improve the product's quality and usability before classroom implementation.

The expert validation results demonstrate that the developed E-LKPD meets the required standards for content quality, instructional design, language, and media presentation. These findings indicate that the product is suitable for classroom implementation; however, expert validation alone does not demonstrate instructional effectiveness. Therefore, the effectiveness of the developed E-LKPD was evaluated separately during the implementation and evaluation stages.

The high feasibility scores obtained in this study are consistent with previous research reporting that socio-scientific issues-based learning requires students to weigh evidence, consider various perspectives, and justify their decisions [27]. This approach emphasizes critical thinking, in which students examine biased attitudes, beliefs, and values [28]. The learning media features a flipbook format, with integrated videos, animations, and interactive quizzes providing a multimodal learning experience that suits various student learning styles, whether visual, auditory, or kinesthetic [29]. Flipbook-based learning media provide interactive and user-friendly learning experiences for students [10], [11]. However, unlike previous studies that developed either SSI-based e-books or flipbook media separately, the present study integrates SSI, an electronic student worksheet (E-LKPD), flipbook technology, and elementary students' critical thinking within a single learning product. This integration represents the primary contribution of the developed E-LKPD and provides a foundation for examining its practicality and preliminary effectiveness in the subsequent stages of the study.

3.4. Implementation Stage

Following expert validation and product revision, the developed SSI-based E-LKPD in flipbook format was implemented in a fifth-grade science class at SDN 1 Temengeng. The implementation involved one classroom teacher and 13 fifth-grade students during the topic *Getting to Know Our Earth*. The classroom activities followed the learning sequence designed in the E-LKPD, beginning with the presentation of contextual socio-scientific issues, followed by observation and discussion activities, completion of learning missions, evaluation tasks, and reflection.

During implementation, students interacted with the flipbook through multimedia features, including images, videos, hyperlinks, and interactive worksheets. The SSI-based learning activities encouraged students to discuss authentic environmental issues, analyze problems, evaluate solutions, explain their reasoning, and reflect on their learning, while the teacher facilitated classroom discussions and problem-solving activities. The implementation documentation is presented in Figure 2.

Figure 2. Documentation of the E-LKPD Flipbook Implementation Stage

The practicality of the developed E-LKPD was evaluated through teacher and student response questionnaires administered after the implementation. The teacher response questionnaire assessed media design, instructional benefits, and language quality, whereas the student questionnaire evaluated perceived support for critical thinking, learning motivation, ease of use, media attractiveness, and media operation.

The teacher's response yielded an overall practicality score of 88%, placing it in the very practical category. This result indicates that the teacher perceived the E-LKPD as easy to use, visually attractive, and supportive of science learning. However, this finding should be interpreted with caution because the practicality evaluation was based on the response of only one classroom teacher. Consequently, the teacher's evaluation primarily reflects the practicality of the product within the context of this study rather than representing broader teacher perceptions.

The student response questionnaire produced an average practicality score of 95.38%, indicating that students considered the developed E-LKPD to be very practical. Overall, students responded positively to the interactive design, multimedia features, and contextual learning activities. The detailed results of the student response questionnaire are presented in Table 7.

Table 7. Student Response Questionnaire Results

Aspect	Number of indicators	Score	Percentage	Category
Support critical thinking skills	1	13	100%	Very practical
Learning motivation	2	13	100%	Very practical
Ease of use	3-6	49	94.23%	Very practical
Media attractiveness	7-8	26	100%	Very practical
Media operation	9-10	23	88.46%	Very practical
Total score	10	124	95.38%	Very practical

The high level of student practicality suggests that the developed E-LKPD was well accepted by its target users. Interactive multimedia, contextual SSI scenarios, and structured learning missions appeared to increase students' engagement throughout the learning activities. The positive practicality results also suggest that the developed E-LKPD can be implemented effectively in elementary science classrooms from both teacher and student perspectives. Nevertheless, practicality does not necessarily indicate instructional effectiveness. Therefore, further evaluation through students' learning outcomes was conducted during the evaluation stage to examine the product's potential to support critical thinking skills.

3.5. Evaluation Stage

The evaluation stage examined the validity, practicality, and preliminary effectiveness of the developed SSI-based E-LKPD in flipbook format. Formative evaluation was conducted throughout the development process through expert validation and product revision, whereas summative evaluation focused on students' critical thinking skills after classroom implementation.

The effectiveness of the developed E-LKPD was evaluated using a one-group pretest-posttest design involving 13 fifth-grade students. Before conducting the hypothesis test, the pretest and posttest scores were examined for normality using the Shapiro–Wilk test. As shown in Table 8, both datasets were normally distributed ($p > 0.05$), indicating that the normality assumption was met and that the paired-samples *t*-test could be applied.

Table 8. Shapiro–Wilk Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Critical Thinking Skills Pretest	.137	13	.200*	.928	13	.325
Critical Thinking Skills Posttest	.177	13	.200*	.908	13	.173

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Students' critical thinking skills increased after using the developed E-LKPD. The mean pretest score increased from 46.54 to 77.69 in the posttest, indicating substantial improvement in students' performance. The normalized gain (N-gain) was .5927, which was categorized as moderate, suggesting a meaningful improvement in students' critical thinking skills following the implementation of the developed learning media. Therefore, a Paired Sample T-Test was conducted. The paired-sample *t*-test results are presented in Table 9.

Table 9. Paired-Sample t-Test

	Paired Differences							Significance	
				95% Confidence Interval of the Difference					
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	One-Sided p	Two-Sided p
Pretest – Posttest	-31.15385	8.20413	2.27542	-36.11155	-26.19614	-13.691	12	<,001	<,001

The paired-sample *t*-test showed a statistically significant difference between the pretest and posttest scores ($p < .001$, df = 12). These findings indicate that students demonstrated higher critical thinking scores after participating in learning activities using the SSI-based E-LKPD in flipbook format. However, because this study employed a one-group pretest-posttest design without a control group, the observed improvement should be interpreted as preliminary evidence rather than definitive proof of a causal effect. Other factors, including maturation, repeated testing, classroom interaction, and teacher facilitation, may also have contributed to the improvement.

The improvement in students' critical thinking can be interpreted in relation to the instructional features embedded within the developed E-LKPD. Contextual socio-scientific issue scenarios encouraged students to interpret authentic environmental problems, while observation and investigation activities required them to analyze relationships among scientific concepts and real-world phenomena. Discussion activities guided students to evaluate alternative solutions using scientific evidence, whereas evaluation tasks required students to draw inferences and formulate evidence-based conclusions. Students were also encouraged to explain and justify their answers during discussions and written activities, while the reflection pages promoted self-regulation by prompting them to monitor and evaluate their reasoning. These integrated learning experiences align with Facione's critical thinking framework and offer a pedagogical explanation for the observed improvement in students' performance.

The findings support previous studies demonstrating that contextual learning also allows students to be actively involved in the learning process because the material they study is directly relevant to their social and cultural environment [30]. SSI-based learning promotes evidence-based reasoning and critical thinking by engaging students in authentic scientific issues [23], [31]. Studies on flipbook-based learning media have also shown that interactive multimedia enhances student engagement, independent learning, and conceptual understanding [10], [11]. Unlike these previous studies, however, the present study integrates SSI, an electronic student worksheet (E-LKPD), flipbook technology, and explicit critical thinking indicators within a single instructional product for elementary science learning. This integration represents the study's primary contribution and extends previous research by providing a more comprehensive learning resource specifically designed for fifth-grade students.

Although the results indicate that the developed E-LKPD is valid, practical, and has the potential to support students' critical thinking skills, several limitations should be

acknowledged. First, the effectiveness evaluation involved only 13 students from a single elementary school, limiting the generalizability of the findings and reducing the statistical power of the analysis. Second, the absence of a control group means that improvements in students' scores cannot be attributed solely to the developed E-LKPD. Third, the implementation was conducted over a relatively short period and within a single school context, which may not fully represent broader classroom conditions. Furthermore, the successful implementation of digital learning media depends on adequate technological infrastructure, including internet connectivity, device availability, students' digital literacy, and teachers' readiness to integrate digital learning resources into classroom practice.

Therefore, the findings should be interpreted as preliminary evidence supporting the feasibility, practicality, and potential effectiveness of the developed SSI-based E-LKPD in flipbook format. Future studies are recommended to involve larger and more diverse samples, employ experimental or quasi-experimental designs with control groups, and examine the long-term impact of the developed learning media on elementary students' critical thinking skills.

3.6. Limitations and Implications

The findings indicate that the SSI-based E-LKPD in flipbook format has the potential to support elementary students' critical thinking by engaging them in interpreting problems, analyzing information, evaluating alternatives, drawing conclusions, explaining reasoning, and reflecting on learning. These findings are consistent with previous studies reporting the benefits of flipbook media and SSI-based learning in promoting active, contextual, and higher-order learning [10], [15], [19]. Unlike previous studies, however, this research integrates SSI, an electronic student worksheet (E-LKPD), flipbook technology, and critical thinking activities into a single learning product for elementary science.

The findings should be interpreted with caution because the effectiveness test employed a one-group pretest-posttest design without a control group. Consequently, external factors such as maturation, repeated testing, and teacher influence cannot be fully controlled. In addition, the study involved only 13 students from one elementary school and a short implementation period, limiting statistical power and the generalizability of the findings. Practical implementation may also depend on device availability, internet access, students' digital literacy, and teachers' readiness to use digital learning media.

Future research is recommended to evaluate the developed E-LKPD using larger samples across different school contexts and a quasi-experimental design with a control group to provide stronger evidence of its effectiveness. Longitudinal studies are also needed to examine the sustainability of its impact on students' critical thinking skills

4. CONCLUSION

This study developed an electronic student worksheet (E-LKPD) in flipbook format based on Socio-Scientific Issues (SSI) for Grade V science learning using the ADDIE model. The findings indicate that the developed E-LKPD is valid and practical, and has the potential to support students' critical thinking skills, as evidenced by the one-group pretest-posttest evaluation. The study contributes to elementary science learning by integrating SSI, flipbook

technology, and critical thinking activities into a contextual and interactive digital learning resource.

This study is limited by the small sample size, implementation in a single school, short intervention period, and the absence of a control group. Therefore, future studies are recommended to evaluate the developed E-LKPD using larger, more diverse samples across different school contexts and to compare its effectiveness with conventional LKPD using quasi-experimental or experimental designs.

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