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Development of an Inquiry-Based Social Complexity Science Pocketbook to Enhance Elementary Students' Critical Thinking Skills

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Abstract
This research problem begins with the results of a needs analysis of students. The research aims to produce a product in the form of a science pocket book based on Inquiry Social Complexity that is valid, practical and effective in order to improve students' critical thinking skills. The type of research used Research and Development (R&D), following the ADDIE model with five stages: Analysis, Design, Development, Implementation, and Evaluation. The population of this studied consists of fifth-grade students from SD Rayon II, Sidomulyo District. The sample was determined used Cluster Random Sampling, aligned with the research objectives. Data collection tools included valid and reliable test instruments. The validation results of the Inquiry-Based Social Complexity Science pocketbook, developed by the researchers, theoretically confirmed its feasibility, with an Aiken's V analysis yielding an average of 0.87, falling into the "Very Valid" category. Science pocket book product based on Inquiry Social Complexity which was developed to be practical in its application in the classroom. The results of the practicality assessment on educators' responses had a holistic average score of 88.04 with a very practical interpretation and student responses had a holistic average score of 87.77 with a very practical interpretation. The data analysis technique employed an independent t-test. The calculation result was 0.009, which was less than 0.05. It is indicating a significant difference between the pre-test and post-use of the product in the class groups. This shows that the pocket book used is effective in improving students' critical thinking skills.

Keywords: critical thinking, pocket book, inquiry social complexity

INTRODUCTION

The implementation of science education in elementary schools requires teachers to encourage students to utilize nature as a learning resource. Science offers numerous benefits for students, including familiarizing them with their surroundings and providing hands-on experiences through various environmental experiments (Djamaluddin & Wardana, 2019). Science is the study of natural objects and their contents. Science education in elementary schools should give students the opportunity to experience and discover the meaning of the material taught through critical thinking, making it easier for students to understand science subjects. Therefore, elementary science education emphasizes providing direct learning experiences to achieve learning objectives effectively. Current science learning activities in elementary schools focus on student-centered learning, which can be developed through the implementation of science literacy education. Successful learning is demonstrated when students understand what they have learned and can apply it to solve various real-life problems (Irsan, 2021). The complexities of the skills and knowledge required by today's students necessitate a shift in emphasis from old teaching paradigms to new learning paradigms. As the emphasis of education shifts from teacher to student, the teacher's job shifts from being the sole provider of knowledge to that of a facilitator (Cahyaningtyas & Desstya, 2024).

Learning objectives can be achieved through active, innovative, and creative student engagement. Teaching and learning activities should implement active, innovative, and creative learning models. Educators must select teaching models that align with students' characteristics and the material being taught to maximize learning outcomes. Current education demands the enhancement of 4C skills: Critical Thinking, Communication, Collaboration, and Creativity (Partono et al., 2021). One essential skill to develop in the learning process is critical thinking. Critical thinking skills are crucial for solving problems and collaborating, which are competencies needed for the 21st century (Jannah & Atmojo, 2022). Thus, students should be given opportunities to experiment with physical objects, supported by peer interactions and insightful questions from teachers (Wahyuni et al., 2023). For improve critical thinking skills students in studying science. Teachers need to get involved students in learning activities. Teacher-managed science learning must be effective and efficient to achieve goals desired learning is achieved. Likewise with science learning whose implementation must be centralized to students (Iman et al., 2022).

Baron & Sternberg (1987) state that critical thinking involves making decisions about what to believe or do. This definition combines five fundamenstal aspects of critical thinking: practical, reflective, reasonable, belief, and action. According to (Ennis, 1991), critical thinking is reasonable and reflective thinking that emphasizes decision-making about what to believe or do. The indicators of critical thinking derived from Ennis, (1991), critical activities are: (1) the ability to formulate main issues; (2) the ability to reveal necessary facts to solve a problem; (3) the ability to choose logical, relevant, and accurate arguments; (4) the ability to detect bias from different perspectives; and (5) the ability to determine the consequences of a statement taken as a decision. Critical thinking is essential for everyone to solve real-life problems. Competencies in the world of education in the 21st century, which must be prioritized for achievement by the world of education today, can be said to be based on one of the most dominant main competencies, namely critical thinking. Critical thinking is the main competency and can be analogous to the parent of other competencies (Halim, 2022).

According to interviews with educators in SD Rayon II, Sidomulyo District, another factor contributing to low critical thinking skills is the limited learning resources, which include only teacher's books, student textbooks, and bupena books. The insufficient number of books means students must take turns using a single book. The learning resources used by educators are less interesting, monotonous, and do not adequately consider the students' characteristics. The material in these teaching materials has not been able to bring out students' critical thinking abilities. As a result, students feel bored and bored, lack high curiosity, are less active in asking and answering questions, so that students' thinking abilities do not develop well in the process of finding learning concepts because students tend to only memorize and record the information in the material. Open without understanding the meaning and interpreting it in everyday life, as a result students' critical thinking abilities become low. Apart from that, the ongoing learning process uses textual language book references which are difficult for students to understand.

One of the skills that needs to be developed in the learning process is the ability to think critically. The ability to think critically in solving problems and collaborating is a competency in entering 21st century life (Jannah & Atmojo, 2022).To overcome the problem of low critical thinking skills, innovative learning models are needed. One learning model that can improve critical thinking skills in science learning is the Inquiry Social Complexity model. The application of the Inquiry Social Complexity (ISC) model shows that there has been an increase in students' critical thinking skills and student learning outcomes (Rika, 2022). In this case, the science pocket book was developed on the basis of Inquiry Social Complexity (ISC) as accompanying teaching material used to help improve students' abilities in critical thinking. It is important for educators to develop teaching materials, one of which is a pocket book that can later be used to create a student learning atmosphere and students' creative thinking which can help develop students in their ability to understand the meaning of a text.

Rika's research (2022) entitled Implementation of "Inquiry Social Complexity to Improve Critical Thinking Skills and Student Learning Outcomes in social Learning" states that the application of the Inquiry Social Complexity (ISC) model shows that there has been an increase in students' critical thinking skills and student learning outcomes. The success of implementing the Inquiry Social Complexity (ISC) learning model can be seen by changes in the attitude of students who are enthusiastic in learning to find and solve their own problems. This is also in line with Paradigma's research entitled "Effectiveness of Inquiry Social Complexity (ISC) Based Learning Using Interactive Multimedia to Improve Students' Critical Thinking Abilities (Paradigma, 2022).

In Inquiry Social Complexity (ISC) learning, students will face problems that must be observed, studied, and scrutinized, thus requiring teaching materials to support it. The reality in the field of education shows that many educators still use conventional teaching materials ready-made, ready-to-buy, and instant without the effort to plan, prepare, and develop their own. This poses a risk if the teaching materials used remain conventional, unappealing, monotonous, and less suited to students' needs.

Educators need to develop teaching materials, one of which is a pocketbook that can be used to create a conducive learning environment and stimulate students' creative thinking, helping them to better understand the meaning of a text. It is hoped that the pocketbook developed by the researchers can assist students in learning. Specifically, the science pocketbook developed with an Inquiry Social Complexity (ISC) approach will serve as supplementary teaching material to enhance students' critical thinking skills. In

the learning process, teachers need to employ appropriate strategies to ensure that the learning objectives are effectively achieved. One way to do this is by selecting a learning model that fits the material (Andriani et al., 2022).

The constructivist theory emphasizes that students must discover and transform complex information, match new information with old rules, and adjust when those rules no longer apply (Kusumawati et al., 2022). Mastering and implementing learning models will facilitate teachers in transferring knowledge, attitudes, and skills to students (Widiantoro, 2022). Learning models can also serve as alternatives and strategies for teachers to facilitate science learning in elementary schools, thereby enhancing students' critical thinking skills (Maimunah, 2022). Positive collaboration between students and teachers in applying constructivist theory in learning has been indicated to improve critical thinking skills, student comprehension, and the learning quality (Subarjo et al., 2023). Learning based on constructivist theory will condition learning such that knowledge cannot be transferred merely theoretically; this process is aided by interaction with the environment and focuses on student-centered learning (Prabawati et al., 2024). In the learning process, students actively construct their own knowledge and reality based on their experiences. Constructivist theory utilizes and stimulates students' curiosity about the world and its workings (Muzakki, 2021).

Materials packaged appealingly are excellent for supporting learning activities and will impact critical thinking skills. Pocketbooks are printed in a small size to be more efficient, practical, and easy to use. A pocketbook is a small-sized book containing information and serving as a learning resource in schools. It can be kept in a pocket, making it easy to carry anywhere (Hermawan et al., 2020). Lestari & Aman (2018) defines a pocketbook as a small-sized book that can be carried in a pocket and easily taken anywhere. A pocketbook is also described as a small, light book that can be stored in a pocket, making it practical to carry and read anytime. Sanusi et al. (2020) explains that a pocketbook is small and light, making it easy to store and carry. This pocketbook features many pictures and colors, providing an attractive appearance.

Researchers need to develop teaching materials that can improve critical thinking skills, specifically a product in the form of a science pocket book based on Social Complexity Inquiry. The pocket books should be arranged more concisely and easily understood by students, in addition to making them interesting so that students are motivated to read and study them. Therefore, this pocket book based on Inquiry Social Complexity (ISC) is expected to have a positive impact on students' critical thinking abilities. The results of its development are expected to produce a pocket book that is valid, effective, and practical.

METHOD

The type of research conducted was Research and Development (R&D), aimed at producing a product and testing the effectiveness or feasibility of the product (Sugiyono, 2017).The development model in this research utilized the ADDIE model. According to Branch (2009), the ADDIE development model is one of the most effective tools for producing a product because it serves as a framework guideline for highly complex situations, making it suitable for educational product development. The stages of the ADDIE model include analysis, design, development, implementation, and evaluation. The flowchart of the development procedure for the Inquiry Social Complexity-based Science Pocketbookuses the ADDIE development model consisting of analysis, design, development, implementation, and evaluation.

The population in this study consisted of fifth-grade students in Rayon II, Sidomulyo Sub-district, South Lampung. The sampling technique employed in this study was cluster random sampling. This technique is used when the population consists of groups of individuals or clusters rather than individual units (Sugiyono, 2017). In this technique, each group in the population has an equal chance of being selected as a sample in the research. Since the population consisted of 3 class groups, namely class V of SDN Kotadalam, SDN Sukamarga, and SDN Sukamaju, the researcher used drawing lots to select two groups for the study. After sampling by drawing lots, the selected groups became the samples in the study, with class V of SDN Kotadalam as the experimental group and class V of SDN Sukamaju as the control group.

This research consisted of independent and dependent variables. The independent variable was the Inquiry Social Complexity (ISC)-based Science Pocketbook(X), and the dependent variable was critical thinking skills (Y). The instruments used in this research are needs analysis instruments for students and educators, feasibility and practicality instruments for pocket books (validation by expert lecturers and product users, in this case fifth grade students at SDN Kotadalam, and SDN Sukamaju. Data regarding needs in preliminary research obtained using a questionnaire instrument. The needs analysis questionnaire is used to obtain information about the needs of schools, educators and students in the learning process. Questionnaires are given to students and educators in class V of SD Rayon II, Sidomulyo subdistrict product attractiveness. Data on the applicability of the Inquiry Social Complexity (ISC)-based pocket book were collected through validation by material expert lecturers. Meanwhile, media experts will validate the format for creating the science pocket book (writing structure and visuals), and a linguist will validate the suitability of the language employed.

FINDINGS AND DISCUSSION

Findings

This study was conducted with the fifth-grade class at SDN Kotadalam serving as the experimental group, while the control group consisted of fifth-grade students at SDN Sukamaju. The findings of this research indicated that the product developed was an Inquiry Social Complexity-based pocketbook designed to enhance students' critical thinking skills. The subject matter covered in this study was the science topic "Ecosystem" during the odd semester. The following outlines the stages of the ADDIE model implementation carried out in this research.

1. **Analysis**

   During this stage, preliminary research was conducted to gather data and analyze the students' needs according to the issues encountered in the field. The analysis aimed to obtain initial information through field studies using observations, teacher interviews, and distributing questionnaires to students to assess their critical thinking skills via a pretest.

   Based on the problem analysis, it was found that many fifth-grade students in SD Rayon II, Sidomulyo Sub-district had not yet achieved the criteria or indicators for critical thinking skills, with less than 50% reaching the expected level.

2. Design

Several steps were undertaken in the product design phase for developing the pocketbook based on local wisdom. The following outlines the steps taken by the researchers in designing the product:

a. Product Planning
The researchers began planning the development process. Based on the needs analysis, the study aimed to develop an Inquiry Social Complexity-based pocketbook to enhance critical thinking skills in the science topic "Ecosystem."

b. Draft Product Development
The developed product is a pocketbook based Inquiry Social Complexity. The development involved discussions with the first supervisor, Dr. Dwi Yulianti, M. Pd., and the second supervisor, Dr. Muhammad Nurwahidin, M.Ag., M.Si. The content was adjusted and accompanied by images with clarity and brightness, facilitating the learning process for both educators and students. The outcome of this activity was a prototype of the Inquiry Social Complexity-based pocketbook intended to enhance critical thinking skills in the science topic "Ecosystem." The initial steps in designing this product included:
1) Preparing the title of the product, which is an Inquiry Social Complexity-based science pocketbook on the ecosystem topic.
2) Preparing the ecosystem material for fifth-grade students in the first (odd) semester.
3) Structuring the design starting with the cover, user guide, core competencies, basic competencies and indicators, learning objectives, and concept maps.
4) Designing the lesson plan by incorporating it into the Lesson Plan (RPP) as a guide so that educators can use the science pocketbook effectively during the teaching of the ecosystem topic.

3. Development

a. PocketbookValidation
In the development phase, the Inquiry Social Complexity-based science pocketbook was initially designed to be more engaging for students. The pocketbook aimed to be simple yet attractive. Below are the steps before and after validation by validators. Validation testing was conducted to validate the Inquiry Social Complexity-based science pocketbook. The product validation involved subject matter experts, media experts, language experts, and field testing by students to ensure suitability with real-world conditions. The detailed results of the expert validation are as follows:

1) Cover

Before After

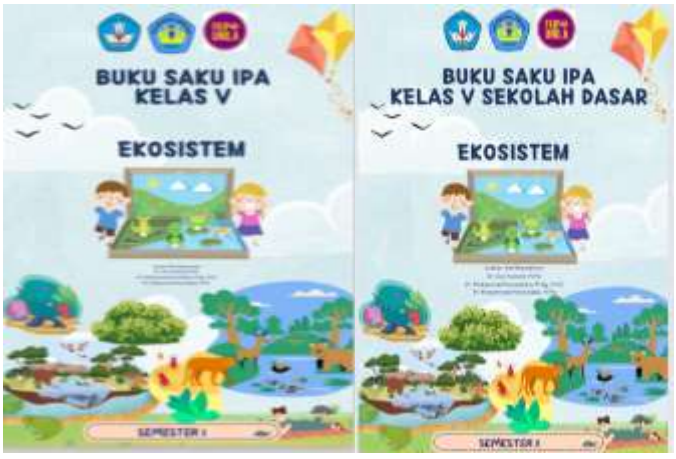

Figure 1. Cover Revision

Description:
The photos change in that the cover now includes the text “elementary school” as a clarifier, and the author’s name has been increased by a few sizes to avoid appearing too small.

2) User Guide

Before After

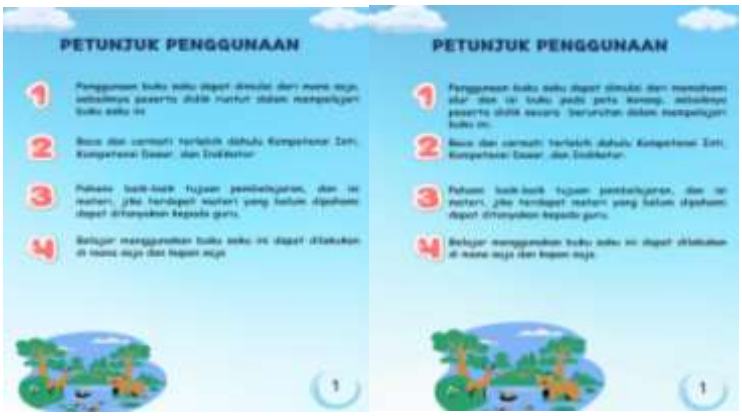

Figure 2. User Guide Revision

Description:
The difference in the images is that in the user guide, point no. 1 has been clarified by removing the phrase “from anywhere” and replacing it with “starting from understanding the flow and content of the book in the concept map.”

Expert Validation Testing

After the assessment by expert validators (material, media, and language), nine validators provided their evaluations on the instruments proposed by the researcher. The data analysis from the expert validation, including media experts, language experts, and material experts, as well as the assessment and validation instrument sheets, was conducted using the following Aiken’s V index formula:

$$V = \frac{\sum_{i=1}^{n} s_n}{n(c-1)}$$

To interpret the analysis of the value categories, the categories used are presented in Table 1 below:

Table 1. Aiken’s V Validity Levels

Value	Category
V > 0.84	Very Valid
V > 0.68-0.84	Valid
V > 0.52 – 0.68	Quite Valid
V > 0.36 – 0.52	Less Valid
V ≤ 0.36	Not Valid

Based on the obtained results, the data was processed through Aiken’s V, and the results are as follows:

Table 2. ISC PocketbookAssessment Results

No	Assessment Aspect	Validation	Category
1	Material Feasibility	0.86	Very Valid
2	Media Feasibility	0.88	Very Valid
3	Language Feasibility	0.87	Very Valid
	Aiken's V Holistic		0.87

Source: Research Results 2024

4. Implementation

Practicality Validation by Users

The practicality test aims to assess the use of the Inquiry Social Complexity-based Science pocketbook. The trial involved 2 educators and 15 students.

1) Practicality Test Results by Educators

The educator response questionnaire results from the initial field test aimed to determine the practicality of the Inquiry Social Complexity-based Science pocketbook. Each statement item on the educator response questionnaire had a maximum score of 4 and a minimum score of 1. The results of the educator response questionnaire are shown in Table 3.

Table 3. Practicality Test Results by Educators

No	Assessed Aspect	Percentage (%)	Category
1	Instructional Design	89.5	Very Practical
2	Operational	87.5	Very Practical
3	Visual Communication	89.28	Very Practical
4	Ease of Implementation	81.25	Very Practical
5	Benefits	90.6	Very Practical
6	Time	87.5	Very Practical
	Average	88.04	
	Category	Very Practical	

Source: Research Results 2024

2) Practicality Validation by Students

The student practicality test aimed to determine the use of the media by students in the learning process. The results of the practicality test analysis can be seen in Table 4.

Table 4. Practicality Test Results by Students

No	Assessed Aspect	Percentage (%)	Category
1	Instructional Design	87.78	Very Practical
2	Operational	85.83	Very Practical
3	Visual Communication	86.67	Very Practical
4	Ease of Implementation	86.67	Very Practical
5	Benefits	85.83	Very Practical
6	Time	86.67	Very Practical
	Average	87.77	
	Category	Very Practical	

Source: Research Results 2024

Evaluation

Field test data was collected from two classes: one class as the experimental group conducted at SDN Kotadalam and one class as the control group conducted at SDN Sukamaju. The test questions used in this study consisted of 8 essay items for both the pretest and posttest, each containing indicators of critical thinking skills: elementary clarification, basic support, inference, advanced clarification, and strategies and tactics.

a) Scores for Each Critical Thinking Indicator in the Experimental Class

The field test data on the critical thinking skills of students in the experimental class are presented in the following table.

Table 5. Percentage Scores for Each Critical Thinking Indicator in the Experimental Class

No	Indicator	Pretest Score	Category	Posttest Score	Category
1	Elementary Clarification	60%	Low	73%	High
2	Basic Support	57%	Low	74%	High
3	Inference	49%	Low	73%	High
4	Advance Clarification	50%	Low	72%	High
5	Strategies and Tactic	49%	Low	72%	High

Source: Research Results 2024

b) Scores for Each Critical Thinking Indicator in the Control Class

The control class did not receive the intervention of using the Inquiry Social Complexity-based Science pocketbook. The critical thinking skills for each indicator in the control class are presented in the following table.

Table 6. Percentage Scores for Each Critical Thinking Indicator in the Control Class

No	Indicator	Pretest Score	Category	Posttest Score	Category
1	Elementary Clarification	58%	Low	62%	Low
2	Basic Support	60%	Low	66%	Medium
3	Inference	58%	Low	63%	Medium
4	Advance Clarification	61%	Low	65%	Medium
5	Strategies and Tactic	55%	Low	63%	Medium

Source: Research Results 2024

Based on the tables above, it can be observed that the control class had a lower percentage compared to the experimental class. The percentage for each indicator in the control class only increased to a medium category in the post-test phase.

The above information is a comparison between the experimental and control classes from the researcher's perspective, showing that the experimental class using the Inquiry Social Complexity-based Science pocketbook showed a higher percentage increase in critical thinking skills compared to the control class using conventional teaching materials.

Decisions are made based on the significance value (p) > 0.05 where Ha is accepted and H1 is rejected. However, if the significance value (p) < 0.05, Ha is rejected and H1 is accepted. The results of the t-test for student learning outcomes are shown in Table 7.

Table 7. Independent Sample T-Test Results

Class	Mean	Significance Value	Category
Experimental Class	72.6786	0.009	H0 rejected
Control Class	63.5577		

Source: Research Results 2024

Based on the independent sample t-test results presented in Table 8, it can be concluded that the independent sample t-test for the learning outcomes in the experimental and control classes resulted in a value of 0.009, which is less than 0.05. Therefore, it can be concluded that Ha is accepted and H0 is rejected, indicating a significant improvement in critical thinking skills with the use of the Inquiry Social Complexity-based Science pocketbook.

Discussion

The science pocket book based on Inquiry Social Complexity, the material in which is developed, relates it to the real lives of students. This pocket book is a companion teaching material that has been validated by several validators to make it suitable for use. Pocket books as supporting teaching materials to support understanding of the material so that it is easier for students to understand and comprehend. Pocket books have a practical, innovative nature so they can attract students' attention to be more active during learning (Setiyaningrum & Suratman 2020). The pocket books as accompanying teaching materials should be used as well as possible to support innovative and unconventional learning.

Improving students' critical thinking skills on ecosystem material using a science pocket book based on Inquiry Social Complexity cannot be separated from students' involvement in the learning process. Student involvement in the learning process is the implementation of student activities in a class. Students can contribute actively by carrying out activities that support the learning process including discussions, reading, and doing assignments that have been given by educators (Indah, 2020).

The combination of the inquiry learning model with social complexity is carried out to minimize the shortcomings of the inquiry learning model. Students will get the results and goals of learning that the teacher wants. After learning using inquiry combined with social complexity, it is hoped that all students can be active in learning activities and get maximum results in critical and creative thinking. Both will have quite a big impact, especially in understanding learning objectives, both for students in the high and low categories (Perdana et al., 2020).

The learning process takes place using the Inquiry Social Complexity learning model. It becomes easier for students to understand the learning material at each meeting

because students are directly involved in actively searching for information and finding their own knowledge. Through this activity, students build their own knowledge concepts. This is in accordance with the constructivist learning theory put forward by (Djamaluddin & Wardana, 2019), constructivist theory is a truly active activity, seeking knowledge and building it on its own, concluding new concepts and ideas with previously owned knowledge. Critical thinking skills really need to be developed for students' successful learning in the 21st century. Critical thinking skills can be developed through learning activities that can raise students' curiosity about a concept so that they are active in seeking information, solving problems and discovering their own knowledge.

CONCLUSION

The Inquiry Social Complexity-based Science pocketbook developed using the ADDIE model is valid in terms of content and construct. The validity of the product is demonstrated by the results of material, media, and language validation tests. Validity is evidenced by the Aiken's index assessment results from media experts, with a holistic average score of 0.88 interpreted as very valid, from language experts with a holistic average score of 0.87 interpreted as very valid, and from material experts with a holistic average score of 0.86 interpreted as very valid. The Inquiry Social Complexity-based Science pocketbook developed is practical in its application in the classroom. The practicality assessment results show that the educator response had a holistic average score of 88.04 interpreted as very practical, and the student response had a holistic average score of 87.77 interpreted as very practical. The results of the Independent Sample T-test on learning outcomes in the experimental and control classes obtained a value of 0.009, which means the value is less than 0.05. Therefore, it can be concluded that H_a is accepted and H_0 is rejected, indicating a significant increase in critical thinking skills by using the Social Complexity Inquiry-based science pocket book. This shows that the pocket book used is effective in improving students' critical thinking skills.

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