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Development of Learning Tools Using the ECIRR Model on Colloid Material to Improve Science Process Skills

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ABSTRACT
Objective: *This study aims to develop learning tools based on the ECIRR (Elicit, Confront, Interpret, Resolve, Reinforce) model for colloidal material to enhance students' science process skills.* ***Method:*** *The research employed the ADDIE development model, encompassing Analyze, Design, Development, Implementation, and Evaluation phases. Learning tools were validated by experts using Aiken's V formula, and a limited implementation was carried out among grade XI MIPA students.* ***Results:*** *The validation results yielded an average Aiken's V count of 0.87, indicating high validity. Furthermore, student responses to the developed learning tools showed a positive perception, with an average response rate of 90%, categorized as very good.* ***Novelty:*** *The integration of the ECIRR learning model into science learning tools presents a novel approach that shifts from traditional methods to a student-centered learning paradigm. This development addresses the gap between curriculum expectations and classroom practices by fostering active learning and improving students' engagement and process skills in understanding colloidal concepts.*

INTRODUCTION

The 21st century is referred to as the century of knowledge, the knowledge-based economy, the information technology era, globalization, the fourth industrial revolution, and so on. Curriculum changes have been implemented by the government, and at the secondary and lower levels, the 2013 Curriculum has been applied with various improvements [1], [2]. This curriculum has in fact accommodated 21st-century skills, as seen from the content standards, process standards, and assessment standards.

In the 2013 Curriculum, educators are required to implement learning using a scientific approach. However, several problems are still encountered, among which is that most teaching is still teacher-centered [3]. As a result, students are unable to optimally master 21st-century skills. Therefore, a reform in learning that shifts from teacher-centered to student-centered learning is the answer to developing students' 21st-century skills through the implementation of appropriate learning models [4].

Before teaching, teachers must prepare learning tools that are in accordance with the material they are going to teach. However, in reality, most teachers still find it difficult to develop these learning tools, especially in formulating learning objectives and indicators to be included in the lesson plan (RPP) [5]. Research by Palobo & Tembang shows that one of the difficulties teachers face in developing learning tools is in formulating achievement indicators. This is because the competencies students must achieve based on the Core and Basic Competencies (KI and KD) of the 2013 Curriculum are increasingly complex, encompassing cognitive, affective, and psychomotor domains Kusumaningrum & Djukri. This complexity also affects teachers' difficulties in developing appropriate assessment instruments to measure all student competencies [6].

Student-centered learning models are learning models suited to the 21st century. In the 2013 Curriculum, the scientific approach is mandatory. Students are encouraged to express thoughts, ideas, knowledge, or new information, both verbally and in writing. Additionally, skills to work together effectively and show respect for diverse team members, as well as fluency and willingness in making decisions to achieve shared goals, are emphasized [7].

One model that can be used in chemistry learning is the ECIRR (Elicit, Confront, Identify, Resolve, Reinforce) model. The ECIRR model is a student-centered learning model [8]. It provides opportunities for students to actively predict, construct concepts, and develop problem-solving skills using their existing knowledge [9]. An increase in students' problem-solving abilities has been observed after applying the ECIRR model [10].

Research conducted by Indah Kurniawati titled The Application of the ECIRR Learning Model with Pictorial Riddle Method Supported by Flashcards found a decrease in student misconceptions in the experimental class by 52.04%, and a decrease in misconceptions for each sub-concept in the topic of work and simple machines by 57.89% compared to the control class. Furthermore, research by Wahyu Juli Astuti on remedial learning using the ECIRR model showed a reduction in student misconceptions on redox reactions, with the percentage of concept mastery (TK) increasing in class X IPA 3 from 60% to 97%, in class X IPA 5 from 48% to 96%, and in class X IPA 7 from 64% to 97%.

To optimize learning, teachers need to involve students actively in constructing their knowledge and apply appropriate approaches, strategies, models, or methods according to student needs. Teachers also need to get used to developing quality learning tools to enhance problem-solving skills. One solution is implementing the ECIRR learning model [4].

Studying science as a process is also known as scientific process skills (SPS). SPS is a learning approach in which students are given the opportunity to interact with concrete objects up to the point of concept discovery [11]. Through SPS, students discover concepts instead of merely memorizing them, enabling them to apply SPS in real-world contexts [12]. Good products result from good process skills [13]. The steps of SPS include observing, measuring, predicting, concluding, classifying, and communicating [14].

Chemistry is the study of composition, structure, properties, changes, and the energy involved. Chemistry explores natural phenomena. From these phenomena, concepts, theories, and laws are developed. These concepts, theories, and laws are then used to explain various phenomena in nature. Chemistry explains phenomena through three levels: macroscopic, microscopic, and symbolic [15]. With these characteristics, chemistry is an excellent subject for developing 21st-century skills.

One topic in the chemistry curriculum for 11th-grade high school students is colloids. According to Rohma, Muntholib, & Munzil colloid material is contextual because of its close relation to daily life and its microscopic nature, which leads students to perceive colloids as difficult to understand. The learning process often only involves memorizing and taking notes.

Based on the aforementioned issues, the researcher believes it is necessary to develop learning tools using the ECIRR model for colloid material to enhance scientific process skills. It is expected that these learning tools can be used by teachers and students as teaching materials in the learning process.

RESEARCH METHOD

The research method used is Research and Development (R&D) to produce a product and test its feasibility using the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation) [16]. Designing with the ADDIE model involves a systems approach, which breaks down planning into several steps arranged in a logical sequence [16].

The participants in this study were 10 students from the 11th grade science class (XI IPA) in the second semester. The sampling technique used was purposive sampling, which involves selecting samples based on specific criteria [17].

RESULT AND DISCUSSION

Result

From the research conducted, the resulting data consisted of validation results, N-gain test outcomes, and responses from teachers and students after the learning tools were developed. This research employed the ADDIE model (Analyze, Design, Develop, Implement, and Evaluate). The following is an explanation of each stage:

1. Analyze

The first stage in this study was analyzing the literature review, including the analysis of colloid material and the selected learning model. This phase aimed to understand the problems and challenges in the learning process, especially regarding colloid topics aligned with the school curriculum, including an analysis of Core Competencies (KI), Basic Competencies (KD), and Learning Indicators (IPK). Research conducted by Suwarno indicated that students experienced monotonous learning processes, which were one-directional and lacked training in scientific process skills. This issue can be addressed using the ECIRR learning model, particularly for colloid topics Desriyanti & Lazulva.

2. Design

The design phase involved developing learning tools such as lesson plans (RPP), student worksheets (LKPD), and test questions. These tools were designed in a way that allowed for validation by experts, ensuring the products' feasibility for further development.

The lesson plan (RPP) was the first component prepared and designed for a single class session. It contained the KI, KD, IPK, learning objectives, materials, approaches, models and methods, media, learning resources, steps of instruction, and attachments. The second component was the LKPD, intended for one class meeting and included KD, learning objectives, usage instructions, learning materials, experiment titles and objectives, procedures, observation sheets, questions, and conclusions. These learning tools were aligned with the ECIRR model to improve scientific process skills. The third component was the pretest-posttest, consisting of 11 validated multiple-choice items. After the design of all learning components was completed, they were validated by seven experts. Before validation, the researcher first developed assessment instruments, which included evaluation rubrics for the RPP, LKPD, test items, and student observation sheets used during the learning process.

3. Develop

This third stage in the ADDIE method involved the development of the learning tools. Before being tested in the classroom, these tools were validated by experts to assess their feasibility. Each component was reviewed by seven validators.

4. Implement

The implementation phase aimed to test the feasibility of the learning tools that had been created and validated. A limited trial was conducted at SMAN 1 Cikande with 10 students from the 11th-grade science class (XI MIPA).

5. Evaluate

The final phase in the ADDIE model is evaluation. Each stage of ADDIE requires evaluation, particularly the design phase. In this stage, each learning component was revised based on feedback and suggestions from the experts or validators. The results from instruments validated by seven experts indicated that the 11 test items, LKPD, and RPP were deemed valid and ready for the product trial at SMAN 1 Cikande. Evaluation was also conducted during the implementation stage to determine whether the learning instruments were effective in measuring students' scientific process skills (SPS) on colloid material.

Discussion

From the experiment conducted using the validated learning tools, it can be concluded that a learning tool is considered effective and of good quality if it meets three main criteria: validity, practicality, and effectiveness Jarnawi, 2017. The implementation of the ECIRR learning model (Elicit, Confront, Identify, Resolve, Reinforce) in the topic of colloids to improve science process skills can be described as follows:

1. Validity Test

a. Lesson Plan (RPP)

The lesson plan (RPP) serves as a guide that outlines the steps taken by the teacher throughout the learning activities, structured in a learning scenario. In this study, the RPP was developed by aligning it with the ECIRR learning model using a practicum-based method. It was designed in such a way that students' science process skills could be observed throughout the learning activities.

Table 1. Below presents the results of the validity test of the RPP.

No	Assessed Aspects	Validity	Info
1	Completeness of the Lesson Plan (contains the components of the Lesson Plan: identity, learning objectives, materials, models, learning activities, learning resources, and assessment)	0,89	Valid
2	The competencies to be achieved are formulated clearly and precisely	1	Valid
3	Compliance of competency achievement indicators with basic competencies	0,86	Valid
4	Learning objectives are formulated precisely and measurably according to the competencies to be achieved	0,86	Valid
5	Learning materials are described clearly, explicitly, systematically, and in accordance with the competencies and objectives to be achieved	1	Valid
6	Learning activities are aligned with the stages of the ECIRR learning model	0,89	Valid
7	Learning steps are clearly outlined	1	Valid
8	Completeness of evaluation instruments	1	Valid
9	Language use complies with good and correct Indonesian language rules	1	Valid
10	Language used is concise, clear, and does not give rise to ambiguous meanings	0,86	Valid

Based on Table 1, the results of the lesson plan validity test conducted, the lesson plan, assessed by expert assessment, can be piloted and is considered highly suitable for use in terms of validity.

b. Student Worksheets (LKPD)

LKPD can be defined as sheets containing assignments to be completed by students. The LKPD is intended to serve as a guide or step-by-step guide to completing a task. The assignment is structured according to the ECIRR model and aligned with the lesson plan and the core competency to be achieved, namely KD 4.14: Summarizing the results of experiments on the properties and preparation of colloids. It is designed to achieve learning objectives.

Table 2. Results of the LKPD validity test.

No	Assessed Aspects	Validity	Info
1	Completeness of the Student Worksheet	0,89	Valid
2	Clarity of the Student Worksheet format (font, font size, numbering system)	1	Valid
3	Suitability of the Student Worksheet to the competency achievement indicators	0,93	Valid
4	Suitability of the assignments to the sequence of materials	0,82	Valid
5	Suitability of the assignments to the ECIRR learning model	1	Valid
6	Suitability of learning activities to the stages of the ECIRR learning model	0,86	Valid
7	Issues raised are appropriate to the students' cognitive level	1	Valid
8	Language use is in accordance with good and correct Indonesian language rules	1	Valid
9	Language used is concise, clear, and does not create ambiguity	1	Valid
10	Clarity of instructions or directions	0,86	Valid

Based on the results of the Student Worksheet (LKPD) validity test conducted in Table 2, the LKPD, assessed by expert assessment, can be piloted and is considered highly suitable for use in terms of its validity.

c. Test Questions

Test questions in this study serve as an assessment technique commonly used to measure students' abilities in achieving a specific competency (student cognitive aspects) [5]. The test questions used in this study were multiple-choice questions designed to identify differences in student learning outcomes.

Table 3. Test question validity test results.

Assessment Items	Validity	Info
Item 01	0,86	Valid
Item 02	1	Valid
Item 03	0,90	Valid
Item 04	0,90	Valid

Item 05	1	Valid
Item 06	0,86	Valid
Item 07	1	Valid
Item 08	1	Valid
Item 09	1	Valid
Item 10	0,90	Valid
Item 11	0,90	Valid
Item 12	0,90	Valid
Item 13	1	Valid
Item 14	1	Valid
Item 15	1	Valid
Item 16	0,95	Valid
Item 17	1	Valid
Item 18	0,67	Not Valid
Item 19	0,52	Not Valid
Item 20	0,86	Valid
Item 21	0,95	Valid
Item 22	1	Valid
Item 23	0,86	Valid
Item 24	1	Valid
Item 25	0,95	Valid
Item 26	0,95	Valid
Item 27	0,95	Valid
Item 28	0,95	Valid
Item 29	0,95	Valid
Item 30	0,95	Valid

Based on Table 3, the results of the test item validity test conducted, 28 of the 30 questions were declared valid by experts. The validation results were then revised and empirically validated, and their reliability was assessed. The data obtained after empirical validation, from the 24 validated questions, only 11 items will be used for the pretest and posttest.

1. Practicality

Based on the discussion in the validity stage of the learning tools used, the learning tools were then tested for practicality with a limited number of 10 grade XI Mathematics and Natural Sciences students. In this limited test, each group consisted of 5 students, totaling 10 students. The teacher then distributed worksheets (LKPD).

The first stage of using the ECIRR learning model is for students to formulate hypotheses related to environmental problems based on the questions they have created.

In the second stage, students seek answers to their hypotheses through the LKPD. They compare their answers from the elicit and confront stages. Using the provided LKPD, students conduct experiments on the properties and formation of colloids. The Student Worksheet (LKPD) is created through a practical learning process using several readily available materials to determine the properties of colloids. After obtaining the experimental results, students are asked to discuss the relationship between the concepts of colloid properties and their preparation. They are then asked to write a report on the experimental results.

In this final stage, students are asked to evaluate each stage they have completed previously by drawing conclusions related to the results of the group discussion. The following is a sample of one group's work in the Resolve stage. Based on the students' answers, it can be seen that they were able to relate the experimental results to the principles of colloid properties and their preparation by drawing conclusions.

2. Testing the Feasibility of Learning Tools

The data obtained through the validation process was processed based on Aiken's V calculation with a 5% error rate. Based on the Aiken's V table, with seven validators and five-choice assessments, a statement is considered valid if its V is greater than or equal to 0.75. Based on the data processing results, the lesson plan feasibility test obtained a score of 0.84, the student worksheet feasibility test 0.85, and the test questions feasibility test 0.93. Therefore, it can be concluded that the developed learning device is generally valid.

Table 4. Validation Results for Each Learning Device Component.

No.	Learning Device Components	Average Score Percentage	Information
1	RPP	0,84	Very Valid
2	LKPD	0,85	Very Valid
3	Test Questions	0,93	Very Valid

3. Student Response to Learning Tools

After the validation test of the developed learning tools was completed, the learning tools, consisting of lesson plans (RPP) and student worksheets (LKPD), underwent a limited trial during the implementation phase. The limited trial was conducted at SMAN 1 Cikande with 10 students from grade XI MIPA. During the limited trial, students carried out all the activities and followed the learning stages according to the developed learning tools.

After completing the lesson, students were asked to complete a questionnaire to determine their responses to the learning tools, consisting of lesson plans and student worksheets, used during the lesson. The results of the questionnaire data analysis showed that 90% of the students' responses were in the very good category.

This is in line with Afriani, who stated that student learning experiences are the most important factor in achieving learning objectives. These learning experiences will be more meaningful if the material taught can be connected to real-life situations.

CONCLUSION

Fundamental Finding : The development of learning tools using the ADDIE model has resulted in valid and feasible products, as indicated by the validation scores—RPP (84%), LKPD (85%), and test instruments (93%)—with Aiken’s V values exceeding the minimum threshold (V ≥ 0.75), confirming their validity. **Implication :** These findings suggest that the integration of the ECIRR model into lesson planning and instructional materials can significantly support the implementation of student-centered learning and enhance science process skills. **Limitation :** However, the limited trial was conducted with a small sample of only 10 students from one school, which restricts the generalizability of the results. **Future Research :** Further studies should involve larger and more diverse populations, along with assessments of the long-term impact on students' learning outcomes to strengthen the evidence of effectiveness and scalability of the developed learning tools.

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