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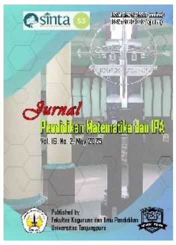

DEVELOPMENT OF AN SCIENCE LEARNING MODULE BASED ON THE ERP (ENGAGE, RESEARCH, AND PRESENT) LEARNING MODEL TO ENHANCE STUDENTS' METACOGNITIVE SKILLS

Najwa Salsabila Rondias[1], Riva Ismawati[2*], Ahmad Muhlisin[3]
[1,2,3]Department of Science Education, Faculty of Teacher Training and Education, Universitas Tidar, Jl. Kapten Suparman No.39, Potrobangsan, North Magelang District, Magelang City, Central Java, Indonesia 56116
Email Corresponding: rivaismawati@untidar.ac.id

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Abstract

This study aims to develop a valid, effective, and practical science learning module based on the ERP (Engage, Research, and Present) model to improve students' metacognitive skills. The background of the study was the low metacognitive skills of students at SMP Negeri 5 Magelang, the lack of supporting teaching materials, and learning that does not support independent learning. The study used a Research and Development (R&D) method with the ADDIE development model. The subjects were 31 eighth-grade students. The instruments used included an expert validation sheet, a metacognitive skills test, the Metacognitive Awareness Inventory (MAI) questionnaire, and a student response questionnaire. The results of the study showed that: (1) the learning module was declared valid based on expert validation results with an Aiken's V score of 0.85; (2) the module was effective in improving students' metacognitive skills, as indicated by the increase in pretest and posttest scores and an N-Gain score of 0.72, categorized as high; and (3) the module was considered practical based on student response questionnaires, with a practicality score of 84.7%, categorized as very practical. The findings indicate that the science learning module based on the ERP model is valid and feasible to be used as teaching material, and it is effective and practical in improving students' metacognitive skills. The limitations of this study lie in the research design, which did not employ a control group. Therefore, the findings of this study require further investigation.

Keywords: *Science learning module, ERP learning model, Metacognitive skills*

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INTRODUCTION

Education plays a crucial role in enhancing the intellectual capacity of a nation. Along with the passage of time, education is required to produce a generation that is qualified and possesses 21st-century competencies. Learners in 21st-century learning are expected to have higher-order thinking skills, such as critical thinking, creativity, collaboration, communication, as well as metacognitive skills, in order to derive meaningful understanding from their learning processes [19].

In learning, it is essential to develop key 21st-century skills, known as the 4C Skills, one of which is metacognitive skills [16]. Metacognitive skills refer to an individual's ability to be aware of, control, and evaluate their own thinking and learning processes. This ability involves thinking about one's own thought processes, which helps students solve problems independently and master learning through reflection and observation [14, 16]. Metacognitive skills play a crucial role in science education. This aligns with Ermin's perspective, which states that students who can monitor and evaluate their learning processes tend to be more confident and able to identify appropriate strategies for understanding complex science concepts [7]. Research has found that students with high metacognitive skills tend to solve problems correctly using proper strategies and logical reasoning. Conversely, students with low metacognitive skills often face difficulties in understanding problems, selecting appropriate strategies, and finding correct solutions [9].

Metacognitive skills are essential for students to possess; however, evidence indicates that students' metacognitive skills are still relatively low. This assertion is supported by studies conducted by [5] and [7], which found that metacognitive skills among junior high school students remain in the low category. Observations at SMP Negeri 5 Magelang further confirm that students' metacognitive levels are still generally limited. The primary causes of this condition include the lack of learning materials that actively support metacognitive development and the predominance of teacher-centered learning methods. These findings collectively indicate that students' metacognitive characteristics are still underdeveloped [12]. The inadequacy of learning resources often results in students being unaccustomed to exercises that promote metacognitive problem-solving [24]. According to [2], limited availability of learning resources can affect students' ability to learn independently and develop metacognitive skills. In the current science lessons, learning materials are primarily derived from the Kemendikbud Merdeka Curriculum science textbooks, which are considered insufficient in supporting students to practice critical thinking and to manage strategies needed to solve problems. As a result, students have limited opportunities to develop metacognitive skills and to fully grasp the concepts being studied [6]. Metacognitive skills are closely related to an individual's learning independence. A learning module serves as a self-directed learning resource, systematically organized to guide students in achieving learning objectives [20]. The use of a module as

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a teaching tool, which includes content, methods, limitations, and evaluation procedures designed in an engaging manner, can enhance student interest and facilitate easier access to learning materials. Such a module can create a new learning environment and more engaging learning activities, thereby supporting the development of students' metacognitive abilities.

Efforts to enhance students' metacognitive skills can be carried out by using modules based on learning models that support student activity and independence.

The ERP model represents an innovative research-based learning approach designed to prepare students to face various educational challenges through structured research skills [11].

The ERP learning model consists of three main stages: Engage, Research, and Present. This model trains students to solve problems through research activities embedded in the learning process, while simultaneously emphasizing independence and active participation during classroom learning [23].

The use of ERP-based learning modules is expected to encourage students to consciously plan, monitor, and evaluate their learning processes, thereby enhancing their metacognitive skills. For this reason, a study titled "Development of Science Learning Modules Based on the ERP (Engage, Research, and Present) Learning Model to Improve Students' Metacognitive Skills" is proposed. The module will implement content on elements, compounds, and mixtures, which is part of the Grade VIII Science curriculum in junior high school.

The objectives of this study are as follows: (1) to examine the validity of the ERP-based science learning module in improving students' metacognitive skills; (2) to analyze the effectiveness of the ERP-based science learning module in enhancing students' metacognitive skills; (3) to evaluate the practicality of the ERP-based science learning module in supporting the development of students' metacognitive skills.

METHOD

This study uses a Research and Development (R&D) method following the ADDIE model, which includes five stages: Analyze, Design, Develop, Implement, and Evaluate. The product produced in this research and development is a science learning module based on the ERP model for the topics of elements, compounds, and mixtures, aimed at enhancing the metacognitive skills of middle school students.

The subjects of this study were students at SMP Negeri 5 Magelang, with 31 students from class VIII G selected as the research sample using purposive sampling. The validity of the module was assessed through questionnaires filled out by expert validators, consisting of two lecturers and three science teachers. Data on students' metacognitive skills were collected using essay tests and the Metacognitive Awareness Inventory (MAI) adapted from Schraw & Dennison. The research design employed a one-group pretest-posttest approach, where students completed the tests and MAI questionnaire before and after the implementation of the ERP-based science module. Data on the practicality of the module were collected using student response questionnaires to measure the ease of

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use and applicability of the module in learning.

Data on the validity of the module were analyzed through expert validation. In addition, suggestions and feedback from the validators were used as a basis for evaluating and revising the module. The validity score was calculated using Aiken's V formula. A module is considered valid if it obtains an Aiken's V value greater than or equal to 0.8 (≥ 0.8).

The effectiveness of the module in enhancing metacognitive skills was analyzed using hypothesis testing, which included a paired sample t-test and N-Gain analysis.

This corresponds to the implementation phase, during which the developed module was trialed in the class serving as the research subject. Prior to analysis, the data obtained from the pretest and posttest were first subjected to a normality test. The paired sample t-test was conducted to determine whether there was a significant difference in students' test scores before and after the use of the module. The hypotheses in the paired sample t-test for this research and development study were as follows:

H_0: There is no significant difference in students' metacognitive skills before and after using the ERP-based science module.

H_a: There is a significant difference in students' metacognitive skills before and after using the ERP-based science module. Meanwhile, the N-Gain test is conducted to measure the magnitude of improvement in students' metacognitive skills between pretest and posttest. The data obtained from the pretest and posttest will be analyzed using the N-Gain formula. The N-Gain score categories are presented in Table 1.

Table 1. N-Gain score categories

N-Gain Score	Interpretation/Category
.70 ≤ g ≤ 1.00	High
.30 ≤ g ≤ 0.70	Medium
.00 ≤ g ≤ 0.30	Low

The practicality of the module was analyzed based on student response questionnaires regarding the use of the module in learning, calculated using the following formula:

$$Practicality\ Percentage = \frac{Total\ Score\ Obtained}{Maximum\ Possible\ Score} \times 100\%$$

RESULTS AND DISCUSSION

Module Validity

The validity of the science module was determined based on the results of validation conducted by expert validators. In this study, the validators consisted of two lecturers from Universitas Tidar and three science teachers from SMP Negeri 5 Magelang.

Expert validation was conducted to obtain assessments of the developed science module in order to improve its quality before implementation with students. The aspects evaluated

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included content feasibility, presentation, language, and module design. A summary of the validation results is presented in Table 2.

Table 2. Expert validation results of the module

Aspect	V Aiken Score	Category
Content Feasibility	0,83	Valid
Presentation Feasibility	0,85	Valid
Language Feasibility	0,86	Valid
Design Feasibility	0,86	Valid
Average	**0,85**	**Valid**

Based on Table 2, the average V-Aiken score is above 0.8, which can be interpreted as “valid.” Therefore, the ERP-based module is considered suitable for implementation in learning, with improvements made in accordance with the suggestions and feedback provided by the expert validators.

The content feasibility aspect obtained an average score categorized as valid. This result indicates that the material in the module aligns with the basic competencies and learning outcomes [18]. The module aimed at enhancing metacognitive skills demonstrates good content validity because it was developed systematically and is consistent with the learning objectives [15].

The presentation feasibility aspect obtained an average score categorized as valid. [25] states that a well-presented module can enhance students’ interest in reading and facilitate their understanding of the material contained in the module.

The language feasibility aspect obtained an average score categorized as valid. According to [8], the use of proper and communicative language can support instructional materials to be easily understood by students, ensuring that the content of the module is effectively conveyed to its readers.

The design feasibility aspect obtained an average score categorized as valid. According to [21], modules should incorporate principles of visual hierarchy to stimulate student motivation in studying and understanding the material presented. Modules with appropriate design and color selection can effectively motivate students and enhance the appeal of learning.

Module Effectiveness

The effectiveness of the ERP-based science module was tested using a one-group pretest-posttest design. The test instruments and the Metacognitive Awareness Inventory (MAI) questionnaires administered as pretest and posttest to measure students’ metacognitive skills had previously been validated and tested for reliability.

The effectiveness of the module was assessed using prerequisite tests, namely the normality test, followed by hypothesis testing consisting of a paired sample T-test and N-gain analysis. The conducted normality test indicated that both the pretest and posttest data, obtained from the test instruments and MAI questionnaires, were normally distributed. A summary of the normality test, paired sample T-test, and N-gain results is presented in Table 3.

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Table 3. Summary of normality test, paired sample t-test, and n-gain analysis

Test	**Result**	
Normality	Test	
	Pretest	0,230
	Posttest	0,122
	MAI Questionnaire	
	Pretest	0,093
	Posttest	0,094
Paired sample T-test	Tes	0,00
	MAI Questionnaire	0,00
N-Gain	Tes	0,72
	MAI Questionnaire	0,65

Based on the results of the paired sample T-Test, a significance score (2-tailed) of 0.00 < 0.05 was obtained, indicating that H_a is accepted and H_0 is rejected. This means that there is a significant difference in students' metacognitive skill scores before and after using the ERP-based science learning module.

The analysis to determine the effectiveness of the learning module was conducted using the N-gain scores from pretest and posttest data. Based on the N-gain calculation, the test instrument yielded a score of 0.72, indicating a high category, while the MAI questionnaire instrument obtained a score of 0.65, indicating a medium category. This demonstrates that the use of the ERP-based science learning module can enhance students' metacognitive skills. The N-gain scores for each metacognitive skill indicator from the test instrument data are presented in Figure 1.

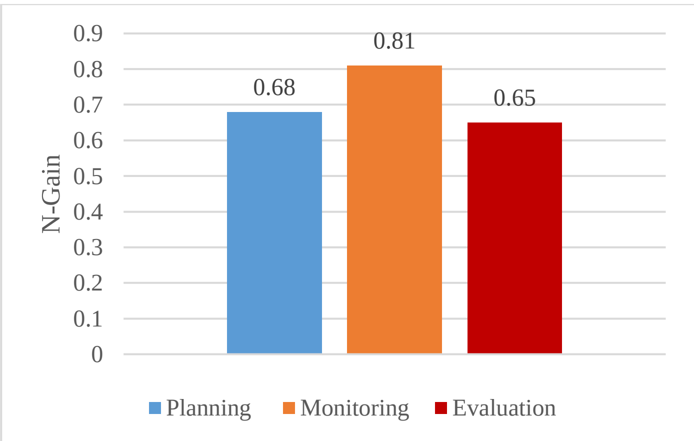

Figure 1. N-Gain scores for each metacognitive skill indicator

Students' metacognitive skills improved across three indicators: planning, monitoring, and evaluation. Based on Figure 1, the N-gain score for the planning indicator is 0.68, categorized as moderate improvement.

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This increase demonstrates that students possess the ability to plan effectively when completing assigned tasks. Students with strong planning skills are capable of developing learning plans to achieve learning objectives [22]. The engage phase in the ERP model corresponds to the planning indicator, as this stage aims to capture students' attention on the topic, stimulate curiosity, and encourage initial planning of learning strategies. The learning module incorporates the engage phase, requiring students to independently analyze presented phenomena so they can identify problems and determine strategies to solve the given tasks. The ability to design learning strategies is a core component of the planning dimension. This aligns with [1], which states that students can acquire and understand relevant information and objectives from the presented problems; with accurate information and clear objectives, students can determine appropriate strategies to solve the problems effectively.

The monitoring indicator achieved an average N-gain score of 0.81, indicating a high level of improvement. This increase demonstrates that students are able to engage in self-questioning to recall necessary information and determine the steps needed to solve problems, thereby effectively monitoring their own learning processes. Students' ability to recognize difficulties and adjust their learning strategies also improved [17]. The research phase in the ERP model corresponds to the monitoring indicator, as students are required at this stage to formulate hypotheses that aid in problem identification. This process trains students to become aware of their level of understanding, enabling them to determine appropriate steps or strategies to solve the problems [13]. Additionally, the research phase requires students to conduct investigations, where experiments are performed in accordance with the content of the module to acquire the knowledge necessary to address the previously posed problems.

The N-gain score for the evaluation indicator is 0.65, indicating a moderate level of improvement. This increase shows that students are beginning to habitually ask themselves how well they have completed the assigned tasks. The present phase in the ERP model is associated with the evaluation indicator. In this phase, students are required to create concept maps and present the results of their investigations, enabling them to assess their learning outcomes and the effectiveness of the strategies applied. This stage demands that students communicate their learning outcomes and reflect on the efficiency of the learning process. Through the present phase, students can evaluate both the process and the results of their learning, determine whether the learning objectives have been achieved, and identify improvement strategies for subsequent learning activities. According to [1], students examine the alignment between the information they know and the methods or steps used to complete the tasks. This indicator plays a critical role in learning to enhance overall learning quality [22].

Module Practicality

This test was conducted to determine the practicality of the

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product. The measurement of the practicality of the learning module was obtained from a questionnaire completed by students as users of the science module in the learning process. The user response questionnaire consisted of 14 statements covering aspects of content, presentation, and language. The results of the analysis of the module practicality percentage by students are presented in Table 4.

Table 4. Practicality test results

Aspect	Percentage	Category
Content	82,4%	Very Practical
Presentation	85,8%	Very Practical
Language	85,8%	Very Practical
Average	**84,7%**	**Very Practical**

The student response questionnaire regarding the practicality of the ERP-based science learning module to enhance students' metacognitive skills yielded a percentage score of 84.7%, indicating that the module falls into the "very practical" category for use in learning activities.

The content aspect received a percentage score of 82.4% and was categorized as very practical. This result is attributed to the presence of clear instructions for using the module, well-explained material that facilitates student understanding, support for independent learning, and assistance in achieving learning objectives. [15] indicates that a learning module based on a metacognitive-oriented instructional model, developed with a logical and structured content framework, can effectively enhance students' understanding and problem-solving skills.

The presentation aspect received a percentage score of 85.8%, categorizing it as very practical. This outcome is due to the learning activities described in the module being perceived as engaging by the students, the sequential and systematic presentation of the material facilitating comprehension, the clear and attractive illustrations aiding understanding, and the use of visually appealing and legible fonts. An engaging module presentation can motivate students to read, facilitate information acquisition, and help maintain the reader's attention without causing boredom [4].

The language aspect received the same percentage as the presentation aspect, 85.8%, classifying it as very practical. This result occurred because students found it easy to understand the language used in the module, the use of simple sentences facilitated comprehension of the module's content, and the terminology or words employed were easy to understand. Communicative language can assist students in grasping the material effectively [4].

The limitation of this study lies in its use of a one-group pretest–posttest design, which means that the improvement in students' metacognitive skills cannot be directly compared with learning without the ERP-based module. Future research could be conducted using a quasi-experimental design with a control group so that the effects of the ERP-

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based module can be compared more objectively.

CONCLUSION

This study produced an ERP-based science learning module that is valid, effective, and practical for enhancing middle school students' metacognitive skills. The developed module was proven to significantly improve students' metacognitive skills, achieving a high level of improvement, and received positive responses from the students. This research provides an innovative ERP-based instructional resource that systematically trains students in planning, monitoring, and evaluating their learning, thereby supporting more independent and meaningful science learning.

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