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DEVELOPMENT OF E-LAPD LEARNING MEDIA TO IMPROVE STUDENTS' METACOGNITIVE SKILLS ON THE MATERIAL ON REACTION RATE FACTORS

PENGEMBANGAN MEDIA PEMBELAJARAN E-LAPD UNTUK MENINGKATKAN KETERAMPILAN METAKOGNITIF PESERTA DIDIK PADA MATERI FAKTOR LAJU REAKSI

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Abstract

This study aims to determine the metacognitive skills of students after using E-LAPD learning media on the material of reaction rate factors. The subjects of this study were students of class XI-2 SMAN 1 Sidayu Gresik. This study used the R&D (Research and Development) research method with the ADDIE model which was limited to the development stage. Data collection in this study used pretest-posttest test instruments and a questionnaire in the form of a metacognitive inventory questionnaire. The results showed that the value of students' metacognitive skills based on metacognitive skills-based tests for the planning indicator was 90.91%; the monitoring indicator was 80.68%; and the evaluation indicator was 86.36%. These results were supported by the acquisition of the metacognitive inventory given at the end of the meeting for the planning indicator of 93.18%; the monitoring indicator was 88.64%; and the evaluation indicator was 89.02%. Overall, students' metacognitive skills increased significantly.

Keywords : Metacognitive Skills, E-LAPD, Reaction Rate

Abstrak

Penelitian ini bertujuan untuk mengetahui keterampilan metakognitif peserta didik setelah menggunakan media pembelajaran E-LAPD pada materi faktor laju reaksi. subjek penelitian ini adalah peserta didik kelas XI-2 SMAN 1 Sidayu Gresik. Penelitian ini menggunakan metode penelitian R&D (*Research ang Development*) dengan model ADDIE yang dibatasi pada tahap *development*. Pengumpulan data pada penelitian ini menggunakan instrumen tes *pretest-posttest* dan angket berupa angket inventori metakognitif. Hasil penelitian menunjukkan bahwa nilai keterampilan metakognitif peserta didik berdasarkan tes berbasis keterampilan metakognitif untuk indikator perencanaan sebesar 90,91%; indikator pemantauan sebesar 80,68%; dan indikator evaluasi sebesar 86,36%. Hasil tersebut didukung oleh perolehan inventori metakognitif yang diberikan pada akhir pertemuan untuk indikator perencanaan sebesar 93,18%; indikator pemantauan sebesar 88,64%; dan indikator evaluasi sebesar 89,02%. Secara keseluruhan, keterampilan metakognitif peserta didik meningkat secara signifikan.

Kata Kunci : Keterampilan Metakognitif, E-LAPD, Laju Reaksi

1. INTRODUCTION

Education is a crucial pillar in developing quality human resources. In science learning, particularly chemistry, developing higher-order thinking skills is a key goal, aimed at producing critical, creative, and innovative students. Education in the 21st century demands that students possess higher-order thinking skills, one of which is metacognitive skills (Maullidyawati et al., 2022). These skills are crucial not only for academic success but also for facing the increasingly complex challenges of everyday life. Metacognition refers to the awareness and control of thought processes, including the ability to plan, monitor, and evaluate learning activities (Flavell, 1979).

Students' metacognitive skills are crucial to developing in the education system, as they can empower their thinking and contribute to academic improvement. Metacognitive skills involve mental activities and cognitive structures that consciously regulate, control, and examine one's thought processes (Muhali, 2013). Students with strong metacognitive knowledge will easily understand their strengths and weaknesses during learning, enabling them to readily identify mistakes and strive to improve (Andini & Azizah, 2021). The learning process in educational units in Indonesia is held interactively, inspiringly, challengingly, motivatingly, fun, student-centered, creatively, and builds student independence according to the physical and psychological development of students (Putri et al., 2024). To achieve the objectives of the learning process, skills, activeness, ability in investigation, and the ability to carry out reasoning to solve various problems and issues are needed (Nafilah & Azizah, 2019). However, the learning process that occurs has not been as desired. Based on a questionnaire distributed to class XII of SMA Negeri 1 Sidayu Gresik, it was found that 80.6% of students considered chemistry learning difficult, especially the material on reaction rates. This material is considered difficult by students because there are many concepts that must be understood. Basic competencies in the material on reaction rates include describing the concept of reaction rates through experiments regarding the factors that influence them (Triana et al., 2021). Therefore, students are required to carry out practicums in order to understand the factors that influence reaction rates and calculate reaction orders well (Aditia & Azizah, 2016). Thus, these results indicate that many students experience difficulties in learning chemistry, particularly in connecting theoretical concepts with their applications in everyday life.

Based on the results of a pre-research questionnaire distributed to 31 students at SMAN 1 Sidayu Gresik, the results indicated that students' metacognitive skills were still relatively low, with 14.5% achieving planning skills, 25.8% achieving monitoring skills, and 33.8% achieving evaluation skills. This indicates that students are not yet accustomed to using their metacognitive skills during learning. Therefore, an appropriate learning model is needed to train metacognitive skills in the topic of reaction rates.

Metacognitive skills require metacognitive strategies to teach. Metacognitive strategies can be described as routines that represent specific mental processing actions that are part of a complex process and are carried out in order to achieve goals such as understanding what has been read (Fitriana & Haryani, 2016). One learning model that involves active student participation and aligns with the characteristics of metacognitive strategies is the guided inquiry learning model (Maullidyawati & Hidayah, 2022). This requires an approach that can support the development of metacognitive skills. Therefore, guided inquiry is a learning model that directly involves students in the learning process, where students are trained to discover a concept based on questions and existing facts (Wandani et al., 2022).

The guided inquiry learning approach has been widely recognized as an effective method for improving students' metacognitive skills. This method provides students with the opportunity to actively explore concepts and solve problems with minimal guidance from educators (Afriani et al., 2025). Guided inquiry allows students to design experiments, analyze data, and draw conclusions, ultimately supporting the development of their critical thinking and metacognitive skills (Aprilia & Sugiarto, 2013). Overall, the guided inquiry approach has proven effective in improving students' metacognitive skills, which in turn can improve their learning outcomes and independence (Alfahinsa & Fauziah, 2025).

The lack of interactive learning media to support guided inquiry-based learning is also a barrier. E-LAPD (Electronic Student Worksheets) based on digital technology can be an innovative solution to this problem addresses this issue (Rahmawati & Wulandari, 2020). With its interactive design, e-LAPD facilitates the process of exploring concepts through a guided inquiry approach, which has been proven effective in improving metacognitive skills (Wardhana et al., 2022). With the advancement of technology, LKPD can be developed and integrated into interactive digital media (e-LKPD), which is considered more effective and efficient. Electronic teaching materials can be optimally utilized through various visualization innovations (Cholifah & Novita, 2022). Therefore, the development of a guided inquiry-oriented e-LAPD is an urgent need for implementation in chemistry learning, specifically on Reaction Rate Factors (Cholifah & Novita, 2022). With this medium, it is hoped that students will not only understand concepts in depth but also improve metacognitive skills, which will be beneficial in the ongoing learning process (Widyawati & Nasrudin, 2019).

This development also aligns with the needs of modern education, which emphasizes the use of technology as an effective learning tool. With the introduction of guided inquiry-based e-LAPD, it is hoped that a more meaningful and in-depth learning experience will be created for students.

2. RESEARCH METHOD

The type of research applied in this study is research and development (R&D). According to Sugiyono (2015), Research and Development (R&D) is a research method used to produce a product. This study will focus on the development of learning media in the form of guided inquiry-oriented e-LAPD to improve metacognitive skills, referring to the ADDIE development model (analysis, design, development, implementation, and evaluation). However, the ADDIE research stage in this study is limited to the development stage. The ADDIE development model provides a clear, step-by-step approach to developing learning materials. Each ADDIE stage has a specific objective, thus ensuring that the final result is in accordance with needs. In addition, the ADDIE development model is iterative, meaning that if there are deficiencies or changes in needs during the development process, it is possible to return to the previous stage without disrupting the entire process.

The data collection method in this study used test and questionnaire methods. The test method was used to determine the value of students' metacognitive skills based on metacognitive skill-based tests, while the questionnaire method was used as supporting data for students' metacognitive skills through metacognitive inventory questionnaires. Metacognitive skill data based on metacognitive skill-based tests were assessed with a score of 1-4. Furthermore, the score was converted into student metacognitive skill scores which included planning, monitoring, and evaluation indicators. Data obtained from the Metacognitive Awareness Inventory (MAI) questionnaire sheet were analyzed descriptively quantitatively. The criteria for assessing the Metacognitive Awareness Inventory (MAI) questionnaire data were in the form of positive and negative statements, based on the Likert scale in table 1.

Table 1. MAI Questionnaire Assessment Criteria

Assessment Criteria		Score
Positive statement	**Negative statement**	
Always	Never	4
Often	Rarely	3
Rarely	Often	2
Never	Always	1

(Riduwan, 2015)

The average value of metacognitive skills in each student's metacognitive skills activity can be determined using the following formula:

$$average\ value = \frac{the\ sum\ of\ all\ students'\ metacognitive\ scores}{number\ of\ students}$$

The data resulting from the average metacognitive skills scores can be categorized as follows:

Table 2. Conversion of metacognitive skill activity values

Percentage (%)	Category
0-20	Not good
21-40	Less good
41-60	Quite good
61-80	Good
81-100	Very good

(Riduwan, 2015)

The data from the Metacognitive Awareness Inventory (MAI) questionnaire is said to support the effectiveness of E-LAPD if the value obtained is ≥ 61% with good or very good criteria (Riduwan, 2015).

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3. RESULTS AND DISCUSSION

Prior to conducting the limited trial, the media to be used was first developed. This process was carried out after selecting the media and format to be used. The learning media presented is the initial result of the development of an electronic student activity sheet (e-LAPD) that focuses on reaction rate factors. This media is designed to help students understand chemical concepts more interactively and contextually through engaging activities that are easily accessible digitally. The media cover page features photos of practical activities depicting real-life laboratory activities directly related to each reaction rate factor (Nuraini & Hidayah, 2023).

The e-LAPD media presented is designed by integrating visual and interactive features to support learning on the topic of reaction rate factors in a more engaging and meaningful way. The main page features arrow-shaped navigation buttons, each representing factors that influence reaction rate. These buttons not only serve as guides to the next section of the material but are also designed to stimulate students' independent exploration in understanding each factor in depth. By utilizing a combination of interactive buttons and visual representations of experiments, this media encourages active student engagement, supports differentiated learning, and enables the integration of digital technology into the chemistry learning process. These features are an important part of a learning strategy that not only delivers material but also creates a reflective, independent, and contextual learning experience in accordance with the principles of the Merdeka curriculum (Nuraini & Hidayah, 2023). The following is an overview of e-LAPD:

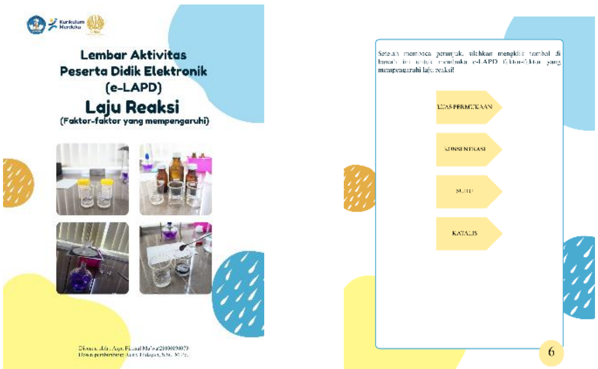

Figure 1. some e-LAPD views

Students' metacognitive skills were obtained based on the results of metacognitive skills-based tests and metacognitive inventory questionnaires given at the end of two meetings implemented with a guided inquiry learning model on the reaction rate material. Data on students' metacognitive skills scores obtained through metacognitive skills-based tests including planning, monitoring, and evaluation are presented in the bar chart in Figure 2.

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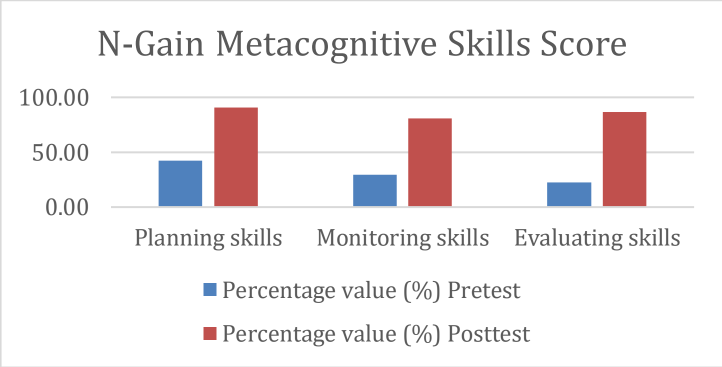
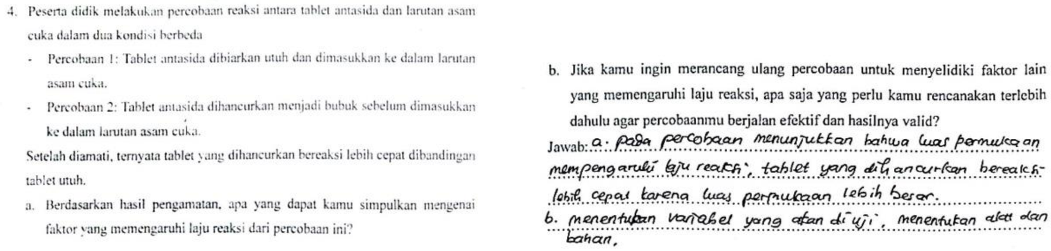


Figure 2. N-Gain scores of metacognitive skills test

Based on the graph above, the metacognitive skill indicator for monitoring shows a slightly lower N-Gain score compared to the planning and evaluation indicators. The low results in the monitoring indicator are likely due to the demand to actively recognize and control the thinking process during learning, which requires higher self-awareness. Furthermore, some students still experience difficulties in continuously observing and evaluating their learning progress, for example in assessing whether the strategies used are effective or need improvement, especially when understanding the concept of reaction rate factors and their relationship to existing theories.

This planning indicator reflects students' ability to design logical, relevant, and contextually appropriate procedures for the given problem. Figure 1 shows that the average pretest score for the planning indicator was 42.05, while the average posttest score increased to 90.91. The N-Gain score of 0.84 is considered high, indicating a significant improvement in metacognitive planning skills. The following presents students' answers to the planning indicator.



4. Peserta didik melakukan percobaan reaksi antara tablet antasida dan larutan asam cuka dalam dua kondisi berbeda
   - Percobaan 1: Tablet antasida dibiarkan utuh dan dimasukkan ke dalam larutan asam cuka.
   - Percobaan 2: Tablet antasida dihancurkan menjadi bubuk sebelum dimasukkan ke dalam larutan asam cuka.

Setelah diamati, ternyata tablet yang dihancurkan bereaksi lebih cepat dibandingan tablet utuh.

a. Berdasarkan hasil pengamatan, apa yang dapat kamu simpulkan mengenai faktor yang memengaruhi laju reaksi dari percobaan ini?

b. Jika kamu ingin merancang ulang percobaan untuk menyelidiki faktor lain yang memengaruhi laju reaksi, apa saja yang perlu kamu rencanakan terlebih dahulu agar percobaanmu berjalan efektif dan hasilnya valid?

Jawab: a. pada percobaan menunjukkan bahwa luas permukaan mempengaruhi laju reaksi, tablet yang dihancurkan bereaksi lebih cepat karena luas permukaan lebih besar.
b. menentukan variabel yang akan di uji, menentukan alat dan bahan.

Figure 3. Answers at the planning stage

This monitoring skill indicator reflects students' ability to assess the effectiveness of the strategies used and review their understanding of the concepts learned. Based on Figure 1, the average pretest score for the monitoring indicator was 29.55, while the average posttest score increased to 80.68. The N-Gain value obtained was 0.73, which is included in the high category, indicating a significant increase in metacognitive monitoring skills. The following is an example of student answers to this indicator.

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2.

Gambar 1. Buah apel membusuk

Dalam sebuah eksperimen sederhana, beberapa buah apel ditempatkan dalam dua kondisi yang berbeda untuk diamati laju pembusukannya. Apel pertama dibiarkan di luar ruangan pada suhu kamar, sedangkan apel kedua disimpan di dalam kulkas pada suhu rendah. Setiap hari, kamu mencatat perubahan yang terjadi pada kedua apel, seperti perubahan warna, tekstur, dan aroma. Berdasarkan hasil pengamatan tersebut:

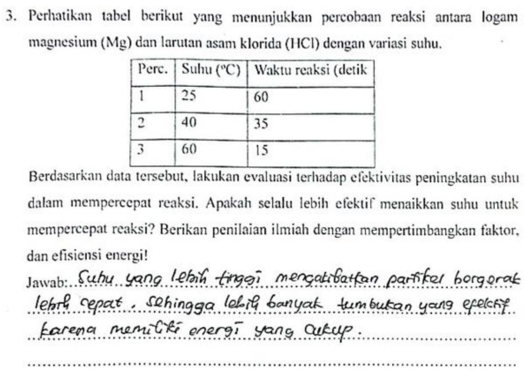
a. Jelaskan mengapa apel yang disimpan di luar ruangan membusuk lebih cepat dibandingkan dengan apel yang disimpan di dalam kulkas!

b. Dari pengamatan yang telah kamu lakukan, bagaimana kamu bisa memastikan bahwa hasil pengamatanmu akurat dan dapat dipercaya?

Jawab: a. apel membusuk dikarenakan suhu tinggi yang mempercepat mikroorganisme dan reaksi kimia.
b. pengamatan dilakukan secara konsisten. dan memastikan data dicatat dan dibandingkan dengan teratur.

Figure 4. Monitoring stage answers

This evaluation indicator reflects students' ability to reflect on their understanding, assess the validity of the approach used, and determine necessary corrective actions. Figure 1 shows that the average pretest score for the evaluation indicator was 22.73, while the average posttest score increased to 86.36. The N-Gain score of 0.82 is considered high, indicating a significant improvement in metacognitive evaluation skills. The following is an example of a student's answer reflecting this indicator.



3. Perhatikan tabel berikut yang menunjukkan percobaan reaksi antara logam magnesium (Mg) dan larutan asam klorida (HCl) dengan variasi suhu.

Perc.	Suhu (°C)	Waktu reaksi (detik
1	25	60
2	40	35
3	60	15

Berdasarkan data tersebut, lakukan evaluasi terhadap efektivitas peningkatan suhu dalam mempercepat reaksi. Apakah selalu lebih efektif menaikkan suhu untuk mempercepat reaksi? Berikan penilaian ilmiah dengan mempertimbangkan faktor, dan efisiensi energi!

Jawab: Suhu yang lebih tinggi mengakibatkan partikel bergerak lebih cepat, sehingga lebih banyak tumbukan yang efektif karena memiliki energi yang cukup.

Figure 5. Evaluation stage answers

The metacognitive skills data was supported by a metacognitive inventory questionnaire administered at the end of each meeting. The results of the students' metacognitive inventory questionnaire at each meeting are presented in the diagram in Figure 6:

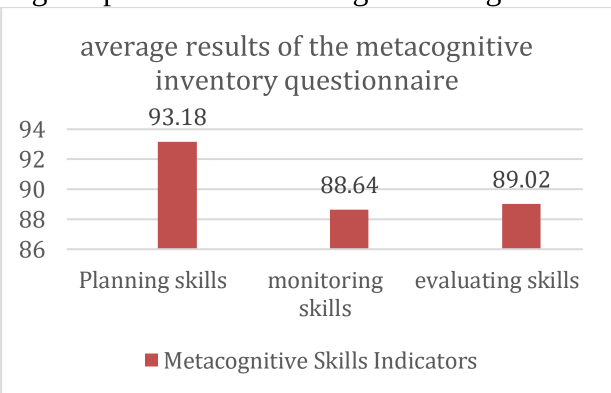


Figure 6. Average Metacognitive Inventory Questionnaire Score

Figure 6 shows that the percentage of students' Metacognitive Awareness Inventory (MAI) scores during the trial was limited to each metacognitive skill indicator. Specifically, the planning skills indicator achieved 93.18%, the monitoring skills indicator achieved 88.64%, and the evaluating skills indicator achieved 89.02%. Overall, the student's Metacognitive

Awareness Inventory (MAI) score was 90.28%. This indicates that the overall score was ≥ 61%, categorized as very good.

Therefore, the Metacognitive Awareness Inventory (MAI) questionnaire supports the development of the learning media.

4. CONCLUSION

From the results of the research that has been conducted, the suggestion that can be recommended is that this research be carried out in 2 meetings, even though the improvement of students' metacognitive skills should be improved continuously so that students are accustomed to controlling their way of thinking, including planning what will be done, monitoring their work process and checking how well the method is carried out.

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