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Development of an Electronic Worksheet Oriented to Problem-Based Learning to Improve Metacognitive Skills on Reaction Rate Material

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Abstract: Metacognitive skills are cognitive controls directly related to higher-order thinking processes, which are the demands of the Merdeka Curriculum. One of the efforts that can be used to improve metacognitive skills is to use learning media, namely Electronic Worksheets (E-Worksheets), oriented to Problem-Based Learning (PBL). This study aims to develop a feasible PBL-oriented E-Worksheet with valid, practical, and effective criteria to improve metacognitive skills on reaction rate material. This research model is guided by a 4D model (Define, Design, Develop, and Disseminate), which is limited to the development stage (Develop) with a limited trial to 30 SMA Negeri 21 Surabaya students. The research data showed that the validity of the E-Worksheet was declared valid in terms of the construct validity mode score of 4 with a suitable category, content validity of 4 with a good category, and graphics of 4 with a good category. The practicality of the E-Worksheet is stated to be practical based on the results of the students' response questionnaire, which obtained an average percentage of 96.17% in the very good. The effectiveness of the E-Worksheet is reviewed from the Pretest-Posttest N-gain value of metacognitive skills in the planning skills component, monitoring which successively gets a value of 0.84, 0.76, and 0.74 with high criteria. Based on this, it can be concluded that the developed E-Worksheet is feasible based on valid, practical, and effective criteria for improving metacognitive skills on reaction rate material.

Keywords: E-Worksheet; Metacognitive Skills; Problem-Based Learning; Reaction Rate.

Introduction

Education is one of the keys to improving the quality of human resources [1]. Through education, each individual can develop themselves so that they experience development in creative thinking, critical thinking, analysis and other forms of behaviour to respond to any changes in their environment. Education has a role in creating an intelligent generation and encouraging generations to improve. Education is also expected to give birth to innovative, creative things and produce generations that can bring about much better changes. To achieve optimal educational goals, good curriculum development is critical. In Indonesia, the Merdeka Curriculum has been introduced to improve the quality of education. Merdeka Curriculum has diverse intracurricular learning where content will be optimized so learners have enough time to explore concepts and strengthen competencies [2].

The Merdeka Curriculum seeks to strengthen learner independence and facilitate learner-centred learning by emphasizing empowerment and developing 21st-century skills [3]. The Merdeka Curriculum aims to free learners from an overly theoretical curriculum and prioritize learning more contextual and relevant to real life [4]. The Merdeka Curriculum focuses on a more contextual, inclusive, and learner-centered educational paradigm [5]. This approach emphasizes learning that accommodates students' individual needs and potential and provides space for creativity and active participation of students in the learning process.

The Merdeka Curriculum is applied to learning in schools, one of which is in chemistry. Chemistry is part of Natural Sciences (IPA), which studies the nature, structure of matter, composition of matter, changes, and energy accompanying changes in matter. The chemistry learning process emphasizes providing direct experience to develop skills and attitudes so students can scientifically explore and understand the surrounding environment [6]. One of the critical chemistry materials to learn is reaction rate material [7]. This is because the reaction rate material links to everyday life and can improve students' thinking ability [8].

Reaction rate is one of the chemical studies that demands the study of macroscopic, microscopic, and symbolic aspects. Reaction rate theory contains abstract concepts mathematical calculations, and involves multiple representations. Sometimes, students identify the actual concept with the object that is used to describe the concept [9]. Abstract concepts are not obtained directly through the experience of the five human senses but through imagination or logical relationships inherent in the mind. Therefore, a clear understanding of the material concept is needed to learn the reaction rate.

Based on the results of pre-research conducted at SMA Negeri 21 Surabaya, 58% of students have expressed displeasure with learning chemistry. Students answered that they did not like studying chemistry because they thought chemistry lessons were difficult to understand or understood, had too many formulas, and were boring. Meanwhile, 42% of students stated they were happy with learning chemistry because chemistry lessons were

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enjoyable. In addition, 31% of students noted that the reaction rate lesson was material that was relatively easy to understand, especially for the sub-material of the reaction rate equation, collision theory, and factors that affect the reaction rate.

To help students better understand the reaction rate material well, the accuracy of the learning model is needed so that students actively use their thinking skills and get explicit knowledge about the concepts in the material provided [10]. One of the appropriate learning models to be applied is the Problem-Based Learning model. This Problem-based Learning model is also a government recommendation that should be used for independent curriculum learning. This Problem-Based Learning model is suitable if applied to reaction rate material because, in this learning model, students are asked to solve a real problem [11]. In addition, the syntax of the model can also measure and fulfil the demands of the reaction rate learning outcomes to involve students in applying material concepts and following the independent curriculum, namely student-centred learning. There are stages of solving problems in the learning process. These demands can be met by PBL syntax, namely organizing students to learn or research and assisting independent or group investigations [12].

Problem-based learning is a learning model that exposes students to problems. Through Problem-based Learning, a learner will have skills in solving problems that can be applied when facing real societal issues. The teacher becomes the director in the Problem-Based Learning model. Another role of the teacher in the Problem-Based Learning model is to propose problems, propose investigations, and dialogue. The teacher also provides scaffolding or a supportive framework that enhances learners' inquiry and intellectual growth [12]. Problem-based learning is student-centred learning where students must be more active and independent to improve classroom learning quality. The learning process is also directed to train students to think analytically when making decisions and to work together and collaborate when solving problems.

In reality, some learners often find it challenging to solve problems because the characteristics of one problem with another are different. This shows that problem-solving also requires monitoring the solution's effectiveness and modifications to the chosen strategy so that the problem can be resolved. In this case, metacognition plays a role in reducing obstacles in solving problems. Metacognition in problem-solving refers to the knowledge and processes that guide successful problem-solving thinking processes. This shows the importance of metacognition for learners in solving problems.

Metacognitive skills refer to planning skills, monitoring skills, and evaluation skills. Good learning conditions can be seen in students trying to complete tasks correctly by identifying learning objectives (planning skills), explaining learning outcomes (monitoring skills), students double-checking the results of work (monitoring skills), students are encouraged to double-check the writing of goals and reflect on the learning strategies used (evaluating skills) [13]. Metacognition is a cognitive control directly related to the higher order thinking process, which demands an independent curriculum. The existence of an independent learning curriculum is expected to improve the quality of students in various fields, not only academic but also non-academic [14]. In terms of academics, students are not only required to think at a low level but also a high level so that they have critical thinking power, which continues to be developed by students [15].

Based on pre-research conducted at SMA Negeri 21 Surabaya, the results showed that the average planning skills of students reached 48.61% with sufficient criteria, the average monitoring skills of students reached 48.74% with sufficient criteria, and the average evaluating skills of students reached 16.20% with very poor criteria. Although two skills are classified as enough, improving students' metacognitive skills is necessary to help them in various learning processes. The results of the pre-research show that students are not accustomed to using their metacognitive skills during learning. Previous research shows that applying the Problem-Based Learning model can positively influence students' metacognitive abilities [16]. Problem-based learning activities can help develop students' higher-order thinking skills, including metacognitive skills [12]. The research proposed by Saputri also states that the Problem-Based Learning model can improve students' metacognitive skills [17].

Good learning also requires innovation to increase students' excitement and interest. For this reason, more attractive media is needed to make students like learning chemistry, especially reaction rate material. Based on the results of pre-research that have been conducted, 61% of students stated that the printed books they have used in learning have not been able to make it easier for them to learn chemistry, especially reaction rate material. Therefore, other engaging media, such as Learner Activity Sheets, can be used. Learning by using Learner Activity Sheets effectively improves students' learning outcomes, knowledge, attitudes and skills [18]. Learner Activity Sheets can make it easier for students to understand the material and practice experiments inside and outside the classroom and at home.

Worksheets are teaching materials in the form of worksheets or learning activities for students [19]. The function of the Worksheet is to make students more independent in understanding the material, which is one of the dimensions of the Pancasila Learner Profile in the Merdeka Curriculum [20]. In addition, worksheets can also train students in discovering and developing their skills. The learner Activity Sheet is one type of teaching material that can be used by teachers and students so that learning activities become more effective and efficient. To increase students' interest in the learning process, a worksheet is made in electronic form or can be called an e-Worksheet.

E-Worksheet is a worksheet designed in digital form. Users need facilities such as computers, netbooks/laptops, smartphones, or tabs to read these electronic products [21]. E-Worksheet is necessary considering that E-Worksheet teaching materials are very suitable for the current generation, nicknamed the internet generation. The Internet generation was born between 1995 and 2012, known as the Net Generation or Generation Z [22]. The Internet generation is a generation that has been exposed to technology and the Internet as early as possible, or in other words, a generation that is thirsty for technology. Electronic teaching materials can include sound elements and dynamic images such as videos [23]. E-worksheets can also provide an opportunity to increase understanding related to the material because students are not only motivated by text. In addition, a Worksheet can make learners more active and independent in learning. Therefore, it is suitable to collaborate E- Worksheets with learning models such as Problem-Based Learning to improve students' metacognitive skills. Research conducted by Putri states that an E-Worksheet based on Problem-Based Learning on reaction rate material is feasible and effective to use [24]. E-Worksheet is also said to be effective and practical in improving students' metacognitive skills based on research conducted by Suarningtyas & Hidayah [25].

Digital features in E-Worksheets can also help teachers deliver material, such as video, animation, and sound. Combining these features will help students visualize abstract material, especially when learning chemistry. This E-Worksheet will help students more easily understand chemistry concepts, especially reaction rate material. The E- Worksheet that will be developed differs from the existing One. In addition to features such as images, videos, and animations, E-Worksheet has template designs such as backgrounds, control buttons, navigation bars, hyperlinks, and backgrounds that make the display more attractive.

Based on the orientation results included in the descriptions above, it is necessary to develop a Problem-Based Learning-oriented E-Worksheet that can improve students' metacognitive skills and become an innovation in learning tools. Therefore, the title used in this research is "Development of E-Worksheet Oriented to Problem-Based Learning (PBL) to Improve Metacognitive Skills on Reaction Rate Material".

Research Methods

The type of research used is research and development (Research and Development) based on the 4D model by Thiagarajan. This model has four stages: the define stage, design stage, develop stage, and disseminated stage. However, this research was only carried out until the development stage, considering the research's time, situation, and location. In the development stage, a limited trial was conducted on 30 students of class XI-1 at SMAN 21 Surabaya. The data collection techniques used were questionnaire and test methods, so the data collection instruments used were validation questionnaire sheets, response questionnaire sheets, and test question sheets. The results obtained from this study come from quantitative data on the validity, practicality, and effectiveness of the E-Worksheet developed.

The validity of the E-Worksheet was measured using a validation sheet filled out by three expert validators. Data from the validation results were then measured descriptively and quantitatively. Scoring is based on a Likert scale, as shown in Table 1 below [26].

Based on the table above, ordinal data is obtained and analyzed by finding the mode. E-worksheet is valid if the mode of assessment obtained is at least 4 with good or very good categories.

The practicality of the E-Worksheet can be known through the students' response questionnaire results. Data on the results of students' responses were analyzed descriptively and quantitatively. The response questionnaire is in the form of positive and negative statements. Scoring is based on the Guttman scale, as shown in Table 2 below [26].

Table 1. Likert Scale Score

Value/Scores	Statement
1	Very Less
2	Less
3	Simply
4	Good
5	Very good

Table 2. Guttman Scale Scores

Statement	Answer	Value/Score
Positive	Yes	1
	No	0
Negative	Yes	0
	No	1

Students' positive response to the E-Worksheet developed can be seen based on the percentage of students answering "Yes" to positive statements and "No" to negative statements. Data from the response questionnaire is then analyzed using the following formula [27].

$$\%\text{Percentage} = \frac{\text{sum of scores obtained}}{\text{maximum score}} \times 100\%$$

The results of the response questionnaire will then be converted using the score interpretation shown in Table 3 below [26].

Table 3. Response Questionnaire Percentage Criteria

Percentage (%)	Criteria
0 – 20	Not Practical
21 – 40	Less Practical
41 – 60	Practical Enough
61 – 80	Practical
81 – 100	Very Practical

The results of the response questionnaire analysis were used to determine the practicality of the developed E-Worksheet. E-worksheets are said to be practical if a percentage of ≥61% is obtained, namely, with functional or very practical criteria.

The effectiveness of the E-Worksheet is measured using pretest and posttest results of metacognitive skills. Learners will get a score after working on the pretest and posttest items. Furthermore, the scores obtained by students will be converted into metacognitive skill values in each dimension of students' metacognitive skills, which include planning skills, monitoring skills, and evaluating skills, using the following formula [27].

$$\text{Value} = \frac{\text{sum of scores obtained}}{\text{maximum score}} \times 100\%$$

The scores obtained by students are then classified based on the criteria for assessing students' metacognitive skills, which can be seen using the values in Table 4 below [26].

Table 4. Metacognitive Skills Score Criteria

Nilai	Keterangan
1-20	Very Less
21-40	Less
41-60	Simply
61-80	Good
81-100	Very good

Students' metacognitive skills are considered good if they get a minimum score of 61.

The increase in students' metacognitive skills before and after learning using PBL-oriented E-Worksheet is then calculated using N-gain. The N-gain formula, according to Hake [28], is as follows:

$$\text{N-gain} = \frac{\text{Pretest Score} - \text{Posttets Svore}}{\text{Maximum Score Ideal} - \text{Pretest Score}}$$

The criteria for the N-gain score are as follows:

Table 5. N-Gain Value Criteria

N-Gain Value	Criteria
N-gain > 0.7	High
0.7 > N grain > 0.3	Medium
N-gain < 0.3	Low

Results and Discussion

This section describes the research results on developing a Problem-Based Learning-oriented E-Worksheet to improve students' metacognitive skills on reaction rate material. This e-Worksheet consists of a cover, preface, table of contents, list of figures, list of tables, instructions for using the E-Worksheet, Problem-Based Learning syntax, indicators of metacognitive skills, instructions for using buttons, concept maps, learning outcomes and learning objectives, LAPD equipped with images, animations, and videos, material descriptions, summaries, interactive quizzes, and a bibliography. Here's what the E-Worksheet developed looks like.

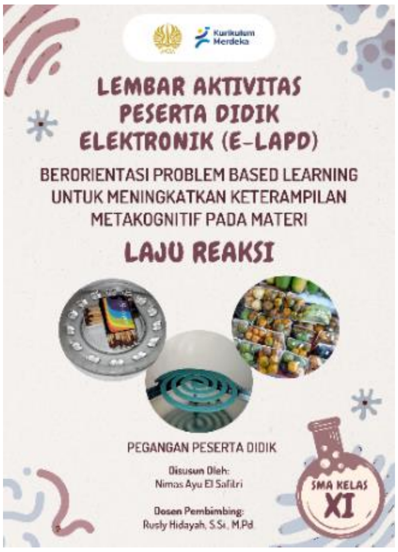

Figure 1. E-Worksheet Cover

Learning activities contain problems that students can solve, in addition to containing PBL model phases and metacognitive skills in each activity. In the developed e-LAPD, a brief description of the material is also given, which can provide insight for students. The design of learner activities and material descriptions can be seen in Figure 2 below.

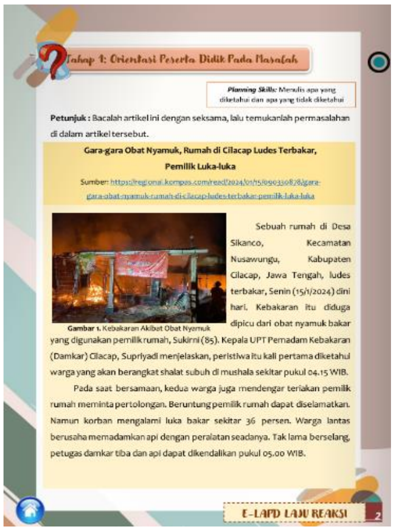

Figure 2. Learning Activities

E-worksheets developed by researchers are equipped with learning videos as learning media. This video contains a reaction rate experiment. The following is a display of the experiment video presented.

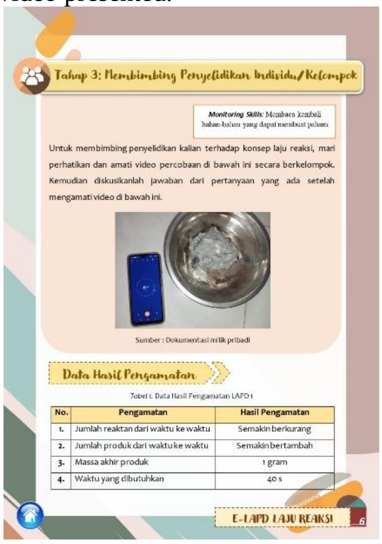

Figure 3. Experiment Video

This interactive quiz contains questions about reaction rate material. This quiz uses Wordwall to attract students' interest in chemistry, especially reaction rates. This quiz is a complementary feature of e-LAPD, where students can do it anytime and anywhere. The display of the interactive quiz on e-LAPD can be seen in Figure 4 below.

The results include the validity, practicality, and effectiveness of the developed E- Worksheet. Validity is assessed using a validation sheet given to the validator. This validation stage will produce a score from the validator on the E-Worksheet that has been developed. The scores given by the validators range from 1 to 5 on each statement. Then, the scores of the three validators will be analyzed using the mode on each statement. The E-Worksheet media developed is valid if it scores≥4, with good to very good criteria. The validation of the developed media is calculated based on construct validity, content validity, and graphics.

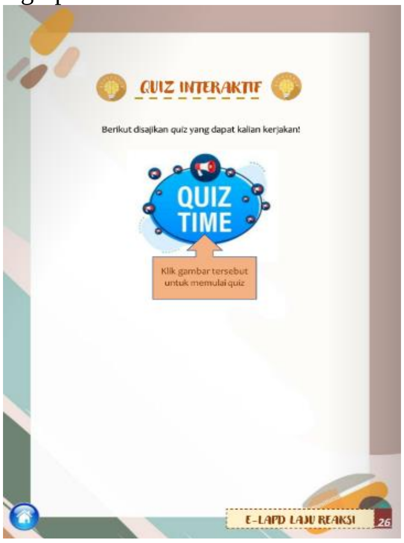

Figure 4. Interactive Quiz

Construct validity is used to assess the suitability of the developed E-Worksheet media. Construct validity can describe the extent to which the measured elements show results by the theory. The results of construct validity can be seen in Table 6 below.

Table 6. Construct Validity Results

No.	Assessed Aspect	Validator Score			
		V1	V2	V3	Mode
1.	Conformity of learning outcomes with the Merdeka curriculum	5	4	5	5
2.	Suitability of reaction rate material with learning outcomes and objectives	4	5	4	4
3.	The suitability of the problem used with the reaction rate material	3	4	4	4
4.	Suitability of e-Worksheetwith metacognitive skills to be improved	4	4	5	4

Table 7. Content Validity Results

No.	Assessed Aspect	Validator Score			
		V1	V2	V3	Mode
1.	Correctness of facts, concepts, principles, and theories contained in the E-Worksheet.	4	4	4	4
2.	The content/topic contained in the e-Workheet has relevance to the metacognitive skills to be improved.	4	4	5	4

Table 8. Graphics Validation Results

No.	Assessed Aspect	Validator Score			
		V1	V2	V3	Mode
1.	The selection of image colours used is appropriate	4	4	4	4
2.	The harmony of colour, type, and size of appropriate	4	4	5	4
3.	Animations are exciting and fit the theme	4	4	4	4
4.	Images and videos arevisible	4	5	5	5
5.	E-Worksheet has a balanced display	4	4	4	4
6.	Present illustrations that are appropriate to the given problem.	4	5	5	5
7.	The use of language that is easy to understand and spelling that follows the General Guidelines for Indonesian Spelling (PUEBI).	5	4	5	5

Content validity is used to assess the correctness of the content or concept of the e-Worksheet media developed. Content validity focuses on providing evidence of the elements measured and the process with rational analysis. The validation results of content validity can be seen in Table 7 below.

Graphics are used as a test to assess the visualization or presentation aspect of the developed e-Worksheet. Graphics focus on the display quality so that e-worksheets can be more attractive. The results of the graphical assessment can be seen in Table 8 below.

Based on the table of results of construct validity, content validity, and graphics, the average score of mode 4 for each validity is obtained with good criteria. This shows that the PBL-oriented E-Worksheet is valid for improving students' metacognitive skills on reaction rate material. The following research conducted by Mitasari & Hidayah (2022) states that the PBL-based e-LKPD developed is valid for improving students' metacognitive abilities [29].

The practicality of the developed E-Worksheet is assessed based on the results of the learner response questionnaire. The developed E-Worksheet is said to be practical in improving students' metacognitive skills if it gets a percentage of ≥61% in a practical or very practical category. The students' response questionnaire results can be seen in Table 9 as follows.

Table 9. Results of the Learner Response Questionnaire

No.	Statement	Percentage
1.	E-Worksheet is very easy for me to access.	100%
2.	The instructions for use in the e-Worksheet are unclear, making it	96.67%

No.	Statement	Percentage
	difficult for me to use this e-Worksheet.	
3.	The E-Worksheet allows me to study more often because it can be used anywhere and anytime.	96.67%
4.	I find it easier to understand the reaction rate material with this E-Worksheet.	100%
5.	This learning activity using an E-Worksheet helps me apply the reaction rate concept.	100%
6.	This e-LAPD makes it difficult for me to solve reaction rate problems given by the teacher.	93.33%
7.	I feel that the material developed in the E-Worksheet is structured.	96.67%
8.	I have difficulty understanding the sentences contained in the developed E-Worksheet.	93.33%
9.	The appearance of this E-Worksheet is very attractive	100%
10.	Learning with E-Worksheet makes me more enthusiastic and more active in learning chemistry.	100%
11.	Using this E-Worksheet motivates me to learn chemistry, especially reaction rate material.	96.67%
12.	The problems presented can encourage my curiosity about reaction rate material.	100%
13.	Problem-based learning-oriented E-Worksheet makes me more interested in learning reaction rates.	96.67%
14.	Problem-based learning-oriented E-Worksheet is a new thing done in schools	86.67%
15.	Problem-based learning-oriented E-Worksheet cannot help me link chemistry learning with daily life.	83.33%
16.	Problem-based learning-oriented E-Worksheet can strengthen my understanding of reaction rate material.	100%
17.	The Problem-Based Learning oriented E-Worksheet challenged me to work on more difficult reaction rate problems until I could solve the problem.	83.33%
18.	The activities in the developed E-Worksheet can encourage me to plan my thinking process.	100%
19.	The activities in the developed E-Worksheet can encourage me to consider several alternatives to a problem before I answer.	100%
20.	The activities in the developed E-Worksheet can encourage me to evaluate my learning outcomes.	100%
Average		96.17%

The students' response questionnaire in this study is divided into five different objectives, namely to determine the ease of use of the developed e-LAPD, to assess the practicality of using the developed e-LAPD, to determine the student's interest in using the developed e-LAPD, to determine the practicality of learning using the PBL model, and to assess the practicality of e-LAPD to improve metacognitive skills for students. Each objective contains several statements that represent that objective.

The average percentage of practicality was 96.17%, with a very practical category. This shows that the e-LAPD developed is practical for improving students' metacognitive skills on reaction rate material. Annisa, Putra, & Dharmono stated that the media is practical if users have no difficulty using the press [30]. Purnama and Suparman stated that e-LAPD can also make it easier for students to understand learning materials in electronic form, which are applied through computers and smartphones [31].

The effectiveness of e-LAPD is calculated based on the increase in students' pretest and posttest scores. Before learning using the developed e-LAPD, students are given pretest questions adjusted to metacognitive skills to determine their initial ability before treatment. Students will then be given treatment through learning using the developed e-LAPD. The developed E-LAPD has been adapted to the phases of Problem-Based learning and uses metacognitive components. The e-LAPD developed has contained the phases of the PBL learning model and its metacognitive skills. Phases 1 to 2 of the PBL model can improve students' planning skills, phases 3 to 4 can improve students' monitoring skills, and phase 5 can improve students' evaluating skills.

After that, students are asked to do a posttest of metacognitive skills to determine their final ability after treatment. Students' metacognitive skills increase if the N-gain value is obtained> 0.3 with moderate or high criteria [28], so the developed e-LAPD can be said to be effective.

The average results of the Pretest and Posttest and N-gain for each component of metacognitive skills can be seen in Table 10 below.

Table 10. Average Results of Pretest and Posttest Values

Metacognitive Skills	Pretest	Postest	N-Gain
Planning Skills	54.44	92.78	0.84
Monitoring Skills	40	85.46	0.76
Evaluating Skills	44.58	85.41	0.74

It was found that students' evaluating skills had a lower percentage than planning and monitoring skills. This shows that students have difficulty in re-evaluating the investigation they have done. Therefore, the evaluating and metacognitive skills obtained the lowest percentage compared to the others. For this reason, the teacher helps students by explaining the purpose of re-evaluating the investigation results. This follows the theory of constructivism, namely scaffolding, where assistance comes from teachers for students.

The graph of the average pretest and posttest scores
of students for each component of metacognitive skills can be seen in Figure 5 below.

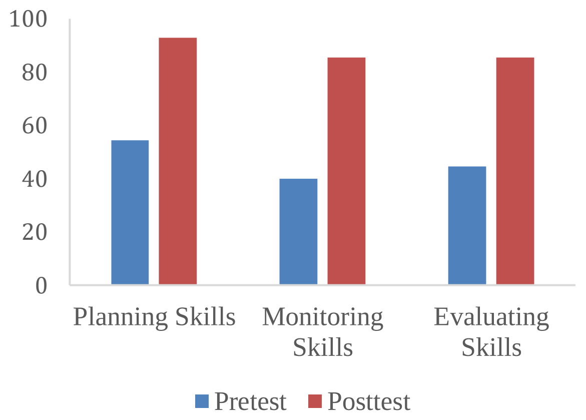

Figure 5. Graph of Average Results of Pretest and Posttest

Based on the data above, each component of metacognitive skills has an N-gain value >0.3, indicating that students' metacognitive skills increase after treatment by learning using PBL-oriented e-LAPD on reaction rate material. Therefore, the developed Problem-Based Learning-oriented e-LAPD improves students' metacognitive skills on reaction rate material. This result is relevant to research, which states that PBL-based e-LAPD is effective for practising students' metacognitive skills [25]. In addition, these results are also supported by research conducted by Irmawati, Muis, & Kurniawan, which states that the Problem-Based Learning model can shape students to be responsible for planning, monitoring, and evaluating their learning so that it helps students improve their metacognitive skills [32].

Conclusion

Based on the results and discussion from the research that has been carried out, it is concluded that E-LAPD oriented to Problem-Based Learning (PBL) to improve metacognitive skills is declared feasible to use. The developed PBL-oriented E-LAPD is declared valid in terms of the construct validity mode score of 4 with a good category, content validity of 4 with a good category, and graphics of 4 with a good category. The developed PBL-oriented E-LAPD is declared practical in terms of the results of the student response questionnaire, which obtained an average percentage of 96.17% in the very practical category. The developed PBL-oriented E-LAPD is declared effective in terms of the Pretest-Posttest N-gain value of metacognitive skills in the components of planning skills, monitoring skills, and evaluating skills which respectively get a value of 0.84; 0.76; and 0.74 with high criteria. This shows that the metacognitive skills of students increase significantly.

References

[1] Jufriadi, A., Huda, C., Aji, S.D., Pratiwi, H.Y., & Ayu, H. D. (2022). Analisis Keterampilan Abad 21 Melalui Implementasi Kurikulum Merdeka Belajar Kampus Merdeka. *Jurnal Pendidikan dan Kebudayaan, 7*(1), 39-35.

[2] Kemendikbudristek. (2022). *Buku Saku: Tanya Jawab Kurikulum Meredeka.* Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi: Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi.

[3] Darmawan, D., & Winataputra, U.S. (2020). Analisis dan Perancangan Kurikulum Merdeka. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, 4*(2), 182-197.

[4] Riyanto, Y. (2019). Kurikulum Merdeka: Tantangan dan Peluang Membangun Pendidikan di Era Digital. *Prosiding Seminar Nasional Pendidikan, 2*(1), 30-36.

[5] Agustina, R. (2018). Model of Learning Empowerment-Based Curriculum 2013 in Elementary School. *Educational Review: International Journal, 15*(2), 176-193.

[6] Mulyasa, E. (2005). *Menjadi Guru Profesional.* Bandung: PT Remaja Rosda Karya.

[7] Ramadhanti, A., & Agustini, R. (2021). Analisis Keterampilan Berpikir Kritis Peserta Didik Melalui Model Inkuiri Terbimbing Pada Materi Laju Reaksi. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, 7(2): 385.

[8] Dewi, C., Utami, L., & Octarya, Z. (2020). Pengaruh Model Pembelajaran Inkuiri Terbimbing Integrasi Peer Instruction Terhadap Kemampuan Berpikir Kritis Siswa SMA Pada Materi Laju Reaksi. *JNSI: Journal of Natural Science and Integration*, 3(2): 196.

[9] Ibnu. (1989). *Kesalahan Atas Konsep- Konsep IPA Karena Ketidaktepatan Pendekatan yang Digunakan.* Malang.

[10] Umar, I., Tikollah, R.M., & Sato. (2022). Prestasi Belajar Akuntansi Keuangan Melalui Model Pembelajaran Problem Based Learning Pada Siswa Kelas XI Akuntansi SMK Negeri 1 Wanggarasi Kab. Pohuwato Gorontalo. *Jurnal Pemikiran Dan Pengembangan Pembelajaran, 4*(1), 124-134.

[11] Basit, D.A., Muslim, B., & Saridewi, N. (2023). Pengaruh Model Problem Based Learning Berbasis Etnosains terhadap Hasil Belajar Peserta Didik pada Materi Laju Reaksi. *SPIN: Jurnal Kimia & Pendidikan Kimia, 5*(1), 75-90.

[12] Arends, R.I. (2012). *Learning to Teach, Ninth Edition.* New York: McGraw-Hill.

[13] Sugiyono, & Harianto. (2011). *Belajar dan Pembelajaran.* Bandung: PT. Rosdakarya.

[14] Vhalery, R., Setyastanto, A., & Leksono, A. (2022). Kurikulum Merdeka Belajar Kampus Merdeka: Sebuah Kajian Literatur. *Research and Development Journal of Education, 8*(1), 185.

[15] Suryaman, M. (2020). Orientasi Pengembangan Kurikulum Merdeka Belajar. *Seminar Nasional Pendidikan Bahasa dan Sastra*, 13-28.

[16] Sembiring, M.B., Octariani, D., & Rambe, I.H. (2021). Pengaruh Model Pembelajaran Problem Based Learning. *Jurnal Ilmiah Mahasiswa Pendidikan Fisika*, 36-41.

[17] Saputri, V. (2021). Pengaruh Model Pembelajaran Problem Based Learning (PBL) Terhadap Keterampilan Metakognitif Dan Kemandirian Belajar Peserta Didik Di Sma Negeri 01 Bumi Agung. *Skripsi*, Universitas Islam Negeri Raden Intan.

[18] Ariani, D., & Meutiawati, I. (2020). Pengembangan Lembar Kerja Peserta Didik (Lkpd) Berbasis Discovery Learning Pada Materi Kalor Di SMP.

Jurnal Phi; Jurnal Pendidikan Fisika Dan Fisika Terapan, *1*(1), 13.
[19] Kosasih, E. (2020). *Pengembangan Bahan Ajar.* Jakarta: Bumi Aksara.
[20] Prastowo. (2014). *Panduan Kreatif Membuat Bahan Ajar Inovatif.* Yogyakarta: Diva Press.
[21] Waryanto, N. (2017). Pelatihan Pembuatan Buku Elektronik Interaktif. *Jurnal Pengabdian Masyarakat MIPA dan Pendidikan MIPA*, 33-40.
[22] Stillman. (2018). *Generasi Z: Memahami Karakter Generasi Baru yang Akan Mengubah Dunia Kerja.* Jakarta: Gramedia Pustaka.
[23] Christianto, J., & Dwiyogo, W. (2020). Pengembangan Media Pembelajaran Cricket Berbasis Mobile Learning Pada Tim Olahraga Cricket Universitas Negeri Malang. *Gelanggang Pendidikan Jasmani Indonesia*, 168-174.
[24] Putri, F. (2023). Pengembangan E-LKPD Materi Laju Reaksi Berbasis Problem Based Learning pada Kelas XI SMA/MA Sederajar. *Jurnal Pendidikan Kimia*, 130-137.
[25] Suarningtyas, S., & Hidayah, R. (2022). Development of Student E-Worksheet Based on PBL (Problem Based Learning) to Practice Metacognitive Abilities of Highshool Student on Reaction Rate Material. *International Journal of Current Science Reasearch and Review*, 2(5), 1680-1687.
[26] Riduwan. (2015). *Dasar-Dasar Statistika.* Bandung: Alfabeta.
[27] Bulilingo, M. R., Paramata, D. D., Latjompoh, M., Lamangantjo, C. J., Pikoli, M., & Nurhayati, N. (2024). Development of a Science Teaching Module Based on SSCS in the Living Things Classification Concept. *Jurnal Pijar Mipa*, 19(4), 663–667
[28] Hake, R. (1999). *Analyzing Change/Gain Score.* USA: American Educational Research Association.
[29] Mitasari,R.A., & Hidayah, R. (2022). Development E-Worksheet Based On Problem Based Learning To Improve Student's Metacognitive Ability. *Journal of Science Education Research*, 6(2), 66-74.
[30] Annisa, A., Putra, A., & Dharmono, D. (2020). Kepraktisan Media Pembelajaran Daya Antibakteri Ekstrak Buah Sawo Berbasis Macromedia Flash. *Quantum: Jurnal Inovasi Pendidikan Sains*, 11(1), 72.
[31] Purnama, A., & Suparman, S. (2020). Studi Pendahuluan: E-LKPD Berbasis PBL untuk Meningkatkan Kemampuan Literasi Matematis Peserta Didik. *JKPM (Jurnal Kajian Pendidikan Matematika*, 6(1), 131.
[32] Irmawati, H., Muis, A., & Kurniawan. (2023). Penerapan Problem Based Learning untuk Meningkatkan Keterampilan Metekognitif dan Hasil Belajar Siswa Kelas VII SMP Negeri 7 Polewali. *Jurnal Pemikiran dan Pengembangan Pembelajaran*, 5 (2), 115-123.