INSECTA **Vol. 5 No. 2, 2024, pp. 234 - 248**

Available online at
INSECTA
Integrative Science Education and Teaching Activity Journal
Journal homepage : https://jurnal.iainponorogo.ac.id/index.php/insecta

Article

Design and Implementation of E-LKPD Using the LOK-R Model for Electromagnetic Wave Material in Senior High School

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Article Info
Article history:
Received: September 23, 2024
Accepted: October , 2024
Published: November 30, 2024

Keywords:

E-LKPD;
Electromagnetic Wave;
Fourth keyword;
LOK-R;
Senior High School

ABSTRACT

This research project analyses the creation of an E-LKPD utilising the LOK-R model, based on the principles of scientific literacy, specifically tailored for physics education. This research is intended to: (1) Get to know the development process, (2) Analyze the feasibility, and (3) Determine whether this physics learning material using LOK-R based on science literacy about Electromagnetic Waves is interesting and attractive, and has been integrated with the independent curriculum. The method used is a 4D development method (Define, Design, Development, and Dissemination) created by Thiagarajan, this research methodology. The limitation of this research is only in the development stage. For media experts and material experts, ways to get feasibility test devices and to measure interest from teachers and twelfth-grade students at 3 schools in total. This research was carried out at State High School 01 Bandar Lampung, Private High School Perintis 2 Bandar Lampung, and State High School 10 Bandar Lampung, and here are the research results: E-LKPD Physics Material Using the LOK-R Model Based on Science Literacy on Electromagnetic Waves integrated with the independent curriculum is very suitable and interesting as well as ready to be material for distance learning and can train students to learn independently.

INTRODUCTION

In order to improve the quality of education, the education sector must constantly adapt to technological and knowledge developments (Arifin & Setiawan, 2020). To improve the quality of education, the field must always align itself with advancements in science and technology (Novitasari et al., 2021). The advancement of information technology forces the education sector to keep up with new developments, particularly in terms of integrating technology into the teaching and learning process (Garsinia et al., 2020). Using a learning medium can enable the achievement of that ability. Due to technological advancements, E-LKPD has become one of the learning media available. This E-LKPD is teaching material in digital or electronic form and is flexible to use (Prastika & Masniladevi, 2021). E-LKPD has advantages over printed LKPD, including the fact that E-LKPD makes the learning process more dynamic, whereas printed LKPD only presents materials and images. In addition to imparting knowledge or acting as the sole source of learning that can achieve anything (teacher-centered), educators also play an active role as mediators and facilitators, helping students

realize their full potential. Electronic student worksheets (E-LKPD) serve as one form of visualization. E-LKPD will offer a visual representation of the material under study (Triyani et al., 2024).

Through the use of student worksheets, students have ample opportunities to showcase their cognitive skills and actively participate in the learning process (Ati et al., 2013). Entering the "4.0" era, technical skills are highly expected from educators (Hariri, 2019). By using computer and Android-based learning materials, educators can enhance the quality of teaching thanks to technological advancements. The use of electronic student worksheets (E-LKPD) is one way to achieve this. With E-LKPD, students can work individually or in groups to complete exercises based on the topics they are studying (Latifah et al., 2016). Furthermore, it provides more meaningful learning in terms of content. It aims to enhance student participation in the learning process and improve student performance (Susanti et al., 2021).

The learning that takes place in school does not meet expectations because students still view physics as a topic that is difficult to understand (Muzannur, Latifah, S., Asyhari, A. & Widayanti., 2017; Rubiyanto, E., & Susanto, 2019), improper utilization of educational resources by educators is one of the causes (Agustin et al., 2018), which leads to students struggling to observe the mechanisms occurring during learning activities (Chi et al., 2017). It is essential to improve the previous learning conditions so that students can actively participate in the learning process (Haruehansawasin & Kiattikomol, 2018). This is because educators still rely on traditional media, the physics teaching materials are not yet fully effective for students, and teachers have not maximized the use of electronic resources for physics education. As a result, students become bored and find it difficult to understand the material. According to (Permatasari et al., 2018; Prastika & Masniladevi, 2021), this phenomenon can lead to students becoming bored and struggling to understand the material.

Studies in electromagnetism are difficult, especially in independent curriculum. There are several reasons supporting this decision, namely that electromagnetism is a physics concept that involves everyday phenomena that can be easily identified by students. The integration of LOK-R with science literacy can provide a more tangible context by making it easier for students to understand electromagnetic subjects through practical applications. This can motivate students to grasp physics concepts more deeply. Furthermore, developing E-LKPD using the LOK-R model based on science literacy can actively engage students in exploration and discovery. They can learn about various types of electromagnetic waves. This can encourage students to face challenges in understanding physics concepts, in line with the Merdeka Curriculum policy.

The Merdeka Curriculum emphasizes learning that leads to self-discovery and active student engagement. E-LKPD can help students who previously struggled to understand electromagnetic material in a traditional classroom setting discover a more relevant and engaging approach. This helps create equal learning opportunities for all students, in line with the values of a better curriculum.

The application of physics learning using E-LKPD with the LOK-R model based on scientific literacy requires a learning design that has novelty. The autonomy of educators allows them to independently plan, implement, and evaluate their educational initiatives. One of the keys to achieving learning objectives is the ability to plan or design the process (Suttrisno et al., 2022a). We also interpret Merdeka belajar as granting students the freedom to experience a pleasant learning atmosphere. A pleasant learning atmosphere can certainly influence students' interest and learning outcomes. (Wahyuni & Naim, 2019). Higher-quality learning will also occur when there is an engaging learning environment and a learning process that has clear objectives (Ismail, 2010; Suttrisno et al., 2022b).

Use a learning model that is relevant to the indicators and learning objectives besides media (Skills, 2022) to enhance higher-order thinking skills, particularly in problem-solving. (Paat et al., 2021). One of the learning methods called guided LOK-R has the ability to improve

student learning outcomes and enhance student retention of the subject matter (Andriani et al., 2023). In LOK-R, the instructor guides the class to take a more active role and lead. By thinking, asking questions, and conducting experiments, students can enhance their knowledge. In addition, the appropriate learning model and students' enthusiasm for learning are expected to improve students' learning outcomes (Nasbey et al., 2022).

The aforementioned description necessitates the creation of instructional materials that bolster students' communication abilities. To this end, the researcher crafts E-LKPD Physics by utilizing the LOK-R Model, which integrates Science Literacy in Electromagnetism with the Merdeka Curriculum. Thus, the objective of this development research is to describe the process of developing or designing E-LKPD, as well as the feasibility and attractiveness of the physics E-LKPD using the LOK-R Model based on Science Literacy.

METHODS

Types Of Research

The research presented here creates an E-LKPD product utilising the LOK-R Model, based on Science Literacy and consistent with the Merdeka Curriculum. The E-LKPD was evaluated at SMAN 1 Bandar Lampung, SMA 2 Perintis Bandar Lampung, and SMAN 10 Bandar Lampung via two phases of trials: a small group trial including 10 students and a field trial comprising 20 students.

Research Procedure

The research procedure utilizes the four main steps of the 4-D development paradigm, developed by Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel (Panjaitan et al., 2023; Pratiwi & Yuliani, 2021). According to (Arigiyati et al., 2019; Zunaidah & Amin, 2016). The research procedure adheres to the four main steps of the 4-D development paradigm. During the define stage, we analyze needs, students, tasks, concepts, and formulate objectives. The design stage includes the format selection and initial layout. The development stage includes expert validation testing, media revision, and E-LKPD testing. We did not conduct the dissemination stage, as this research solely focuses on validating the feasibility and attractiveness of E-LKPD. Figure 1 presents the stages of the E-LKPD development procedure for physics learning using the LOK-R Model Based on Science Literacy.

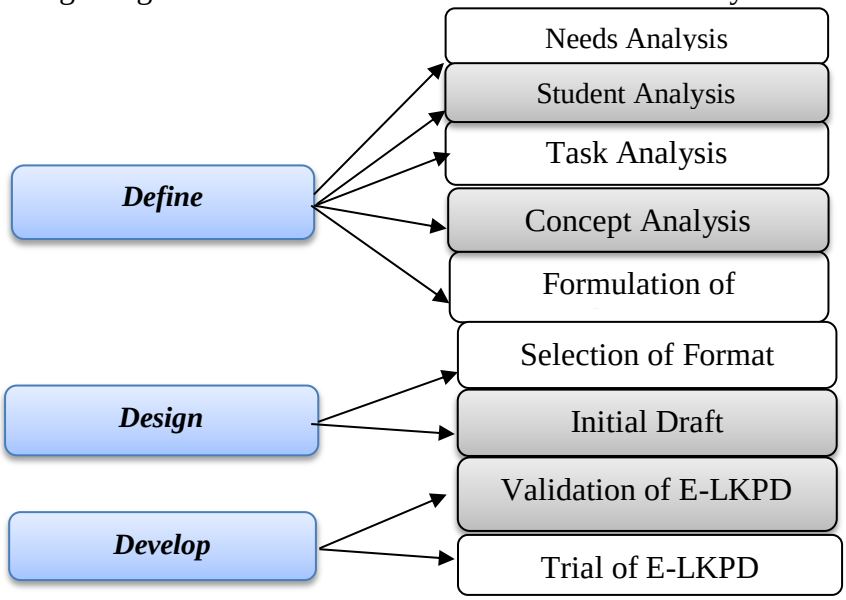


Figure 1. Procedure for Developing E-LKPD

The research procedure in this development begins with the introduction stage (define), which is followed by the design stage, and then the development stage. (develop). The first stage (define) involves conducting a needs analysis to identify the necessary media and the

underlying reasons for its use. Subsequently, we conducted an analysis of the students to ascertain their prior knowledge and experiences, which serve as indicators of their developmental progress. Next, analyze the task to formulate the objectives for creating learning media for the development of E-LKPD in physics education using the LOK-R Model based on science literacy on the material. After that, a concepSubsequently, we carried out a concept analysis, pinpointing the primary concepts within the material and elucidating the developed concepts in detail. n the define stage is the formulation of objectives that must align with physics education's broader goals.

The second stage is the design phase. This stage is the design phase of the development of E-LKPD learning media for physics using the LOK-R Model Based on Science Literacy, utilizing Microsoft Word, Canva, and the Heyzine flip book application on electromagnetic material. At this stage, there are two activities: selecting the format and basic design. We choose the format of the E-LKPD learning media based on the learning objectives. The selected format involves designing the content display and choosing the E-LKPD for learning. The E-LKPD learning media's initial design uses hardware, specifically one laptop, along with the applications Canva and Flip Book Heyzine.

The development stage is the final one. During this stage, we carry out the validation of the E-LKPD, revision of the E-LKPD, and trial of the E-LKPD. This results in a physics learning E-LKPD that utilizes the LOK-R model based on scientific literacy, making it suitable and engaging for use during the physics education process. The initial activity at this stage is the validation of the E-LKPD, conducted by a team of experts consisting of media and content specialists. Following this, the E-LKPD is revised. When the developed product still contains elements that do not align with the desired outcomes, the researcher makes revisions to produce a better product.

Instruments and Techniques for Data Collection

This research project makes use of a questionnaire as the main instrument for data collection, employing a Likert scale and receiving validation from media and content experts (Elwi et al., 2017; Pratiwi & Yuliani, 2021).The evaluations of educators and students utilise a uniform instrument. Data analysis is performed using qualitative methods. The Likert scale ranges from "Very Good" (5) to "Very Insufficient" (1), with scores converted into percentages to assess the eligibility of each aspect according to a formula (Wibawa, 2012).

The results are subsequently converted into qualitative values based on evaluation criteria, as illustrated in two interpretation tables: one for expert validation of media and materials (S.Asprilla et al., 2019), and another for educator and learner responses (Wulandari et al., 2022). The overall percentage of subjects is calculated to facilitate a comprehensive analysis (S.Asprilla et al., 2019).The interpretation scales enable the researcher to assess the efficacy of the electromagnetic E-LKPD for physics education in the XII grade, utilising the LOK-R model with an emphasis on scientific literacy.

Student Response

A student response questionnaire serves as the instrument, incorporating four assessment indicators: (1) attractiveness; (2) material; (3) language; and (4) technical quality. Each indicator in the student response questionnaire contains aspects related to the learning provided, accompanied by answer choices for students to select based on their evaluation of the learning experience.

RESULTS AND DISCUSSION

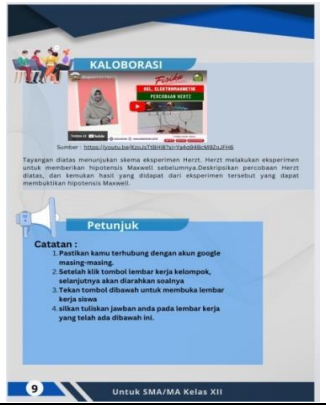
Valid E-LKPD

In the process of creating E-LKPD for physics learning using the LOK-R model based on science literacy, the researcher utilized supporting software, namely the flip book Heyzine. Among the applications for creating E-LKPD, the flip book Heyzine offers greater advantages due to its ease of use, even for beginners without knowledge of HTML programming. Heyzine,

a feature-rich flipbook creator with page editing functions (Khasanah et al., 2024; Pratiwi & Yuliani, 2021; S.Asprilla et al., 2019). Table 4 shows the plan for how students in grade 12 SMA/MA will learn E-LKPD using the LOK-R model and how it will be based on their science literacy when it comes to electromagnetic material.

Tables and Figure

Table 4. Storyboard E-LKPD Using the LOK-R Model based on Science Literacy

Integrasi	Bagian E-LKPD
Model LOK-R	1) Literasi (L) At this stage, an animated video related to the theory of electromagnetic waves is presented, which students must first watch and pay attention to, before they are expected to understand the material presented in that video.  2) Orientasi (O) At this stage, we ask students to observe the existing video. Then, students will answer the provided questions by exploring their basic cognitive knowledge.  3) Kaloborasi (K) At this stage, students must collaborate with their peers to request explanations of their observations through discussion or written communication. 

Integrasi	Bagian E-LKPD
Model LOK-R	4) Refleksi (R) At this stage, the author presents several reviews in the form of questions as a way to evaluate the students' understanding of the material. Present the author's designed questions in the form of test items. 

Medium Validation

The feasibility test of this E-LKPD medium was conducted by three validators to assess three aspects, which consist of the size of the E-LKPD, the cover design of the E-LKPD, and the content design of the E-LKPD. The following images display the E-LKPD's cover design and content, as well as the graph of the results of the feasibility test of the E-LKPD media.

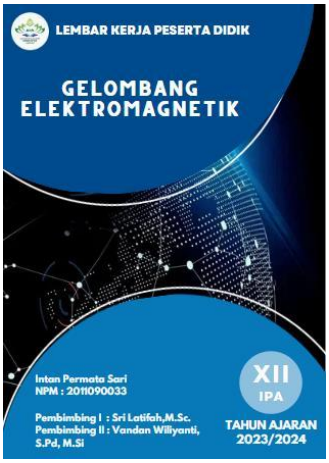


Figure 2. Design of the E-LKPD cover

Figure 3. Instructions for Use and Table of Contents of E-LKPD

Figure 4. Design of the Back Cover of the E-LKPD

Materi Validator

After conducting the media feasibility test, the next step is to conduct the material feasibility test. Three validators carry out the material feasibility test, assessing three aspects: content feasibility, presentation, and language and graphics. The results of the material feasibility test for E-LKPD can be seen in figure 6 below:

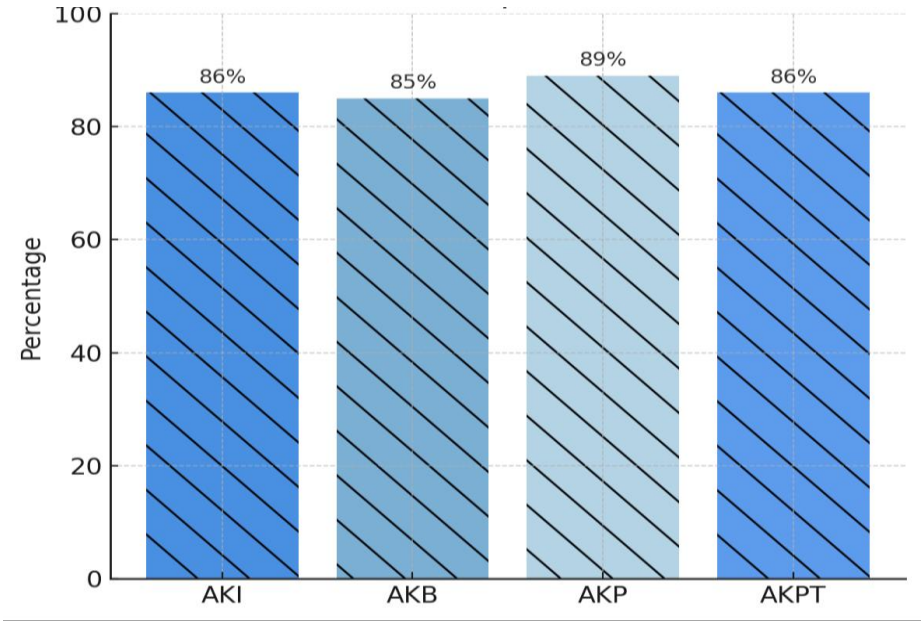


Figure 6. Expert Material Validation Graph

Description:
AKI = Content Feasibility Aspects
APKT = Contextual Assessment Aspects
AKB = Language Feasibility Aspects
AKP = Aspects of Presentation Feasibi

Educator Response

Product trials were conducted in three schools, namely SMAN 1 Bandar Lampung, SMA 2 Perintis Bandar Lampung, and SMAN 10 Bandar Lampung. The results of the attractiveness test by the educators are presented in Table 5 below.

Table 5. Results of the Attractiveness Test by the Educators

Results of the Attractiveness Test by Educators								
No	**Assessment Aspects**	**R1**	**R2**	**R3**	**Σ Score**	**Criteria Rat**	**Score (%)**	**Eligibility Category**
1	Difficulty with the Level of Student Development	4	5	5	14	4.67	93%	VERY INTERESTING
2		4	5	5	14	4.67		
3		5	5	5	15	5.00		
4		5	5	4	14	4.67		
5		5	5	4	14	4.67		
6		4	4	5	13	4.33		
7		5	5	5	15	5.00		
8		4	5	5	14	4.67		
9		4	5	4	13	4.33		
10		5	5	4	14	4.67		
11	Komunikatif	4	5	5	14	4.67	97%	
12		5	5	5	15	5.00		
13	Presentation Techniques	5	5	5	15	5.00	95%	
14		4	5	5	14	4.7		
15		4	5	5	14	4.67		
	Average	4.67	4.93	4.73	14.33	7.07	93%	

Student Respon

The students conducted trials of attractiveness in both small and large groups. We conducted the testing at SMAN 01 Bandar Lampung, SMA 02 Perintis Bandar Lampung, and SMAN 10 Bandar Lampung. Tables 6 and 7 present the data from the small group trials and field trials.

Table 6. Results of the Small Group Trials

No.	Aspect	Persentase (%)	Kriteria
1.	Aspect appearance/attractiveness	87%	Very Interesting
2.	Material aspects	89%	Very Interesting
3.	Language aspects	91%	Very Interesting
4.	Aspects of technical quality	92%	Very Interesting
	Average	90%	Very Interesting

Table 7. Results of the Field Trial

No.	Aspect	Persentase (%)	Kriteria
1.	Aspect Appearance/ Attractiveness	88%	Very Interesting
2.	Material Aspects	87%	Very Interesting
3.	Language aspects	86%	Very Interesting
4.	Aspects of technical quality	89%	Very Interesting
	Average	88%	Very Interesting

Validator E-LKPD

For electromagnetic material, E-LKPD uses the LOK-R model based on science literacy. Science literacy is used in various ways by students in one or more ways such as: (a) Knowledge of substantive science content and the ability to distinguish science from non-science; (b) Understanding science and its applications; (c) Knowledge of what is considered science; (d) Independence in learning science; (e) Ability to think scientifically; (f) Ability to use scientific knowledge in problem-solving; (g) Knowledge needed for intelligent participation in science-based social issues; (h) Understanding the nature of science, including its relationship with culture; (i) Appreciation and comfort with science, including its wonders and curiosities; (j) Knowledge of the risks and benefits of science; or (k) Ability to think critically about science and engage with scientific expertise. The LOK-R learning model activities focus on enhancing students collaboratively and cooperatively, which will help maximize students' cognitive development (Segara et al., 2022).

The E-LKPD features images, audio, animations, and videos to display content and learning activities more vividly, enhancing students' understanding of the presented material. Additionally, I want to simplify the use of E-LKPD and increase the number of innovations created with the hiyzine flip book. We can use this direct application from Canva, which takes the form of a flip book, to enhance the current E-LKPD development process by incorporating text, images, videos, animations, and audio (Choiru & Wisanti, 2023). E-LKPD is a learning medium designed to make electronic learning materials easier for students to understand. It can be used on mobile phones, computers, and so on (Shalahuddin & Hayuhantika, 2022).

The E-LKPD incorporates practical activities. The e-LKPD includes practical activities because their implementation in school learning is crucial. (Khoirun, 2023; Milatti & Fitrihidajati, 2024). By engaging in practical activities, students can discover their interests and actively participate in learning. In addition, practical activities are also beneficial for fostering a scientific attitude among students in physics learning. (Emda, 2017; Rachmat Rizaldi et al., 2023).

1. Media Validaton

You can access the e-LKPD media, which utilizes the LOK-R model to study electromagnetic material science, online at https://heyzine.com/flip-boo k/98958f5cdb.html .Various engaging learning content, such as instructional videos, interesting quizzes, exercises, practical activities, and problem-solving discussions, equip this e-LKPD. Notably, it includes material on physics, particularly electromagnetism.

Expert validation of the media revealed scores of 80% for media acquisition, 84% for cover design, 79% for content design, 82% for additional information, and 87% for ease of use. The average result for the six scores is 82%. Therefore, we declare the E-LKPD media's feasibility test, based on scientific literacy and the LOK-R model, very feasible.

2. Material Validation

The results for the content feasibility assessment show that the content feasibility scored 86%, the presentation feasibility scored 85%, the language feasibility scored 85%, and the assessment aspect scored 86%. The average score across the four aspects is 87%. Therefore, we deem the evaluation of the E-LKPD material based on science literacy using the LOK-R model as very feasible. Based on the percentage calculations (Putri et al., 2023), as well as the validity scale and intervals from (Adam Malik, 2018; Nugroho et al., 2017), the feasibility testing of the e-LKPD material using the LOK-R model based on science is declared very feasible.

Following the validation test of the media and materials, the e-LKPD undergoes a product trial to assess its attractiveness for physics learning. Educators and students of grade XII conduct this attractiveness test.

3. Educator Respon

Educators conduct the attractiveness test to assess three aspects: the difficulty in relation to the students' developmental level, communicativeness, and presentation techniques. The responses from educators at SMAN 1 Bandar Lampung indicate that difficulties with student development received a percentage score of 90%, communication received a percentage score of 90%, and presentation techniques received a percentage score of 87%. From the tableThe table and figures reveal an average of 89% for the three assessment aspects, placing them in the "very feasible" category. from educators at SMAS Peintis 2 Bandar Lampung show that difficulties with student development received a percentage score of 90%, communication received a percentage score of 90%, and presentation techniques received a percentage score of 93%. From the tableThe table and figures indicate that the three assessment aspects average 91%, placing them in the "very feasibThe diagram displays the average percentage score of 91% from both educator response tests from the three high schools, indicating a "very feasible" outcome. The responses from educators at SMAN 10 Bandar Lampung indicate that there are difficulties with student development, scoring a percentage of 92%, while the communicative aspect scored 80%, and the presentation technique also scored 93%. From the tableThe table and figures reveal that the three assessment aspects average 88%, placing them in the "very feasible" category. s also indicate that, in addition to deepening students' understanding, elements of attractiveness in media, such as additional videos, animations, and engaging images, help students obtain more detailed information (Santosa et al., 2019).

4. Student Respon

The attractiveness test of the e-LKPD for physics learning using the LOK-R model based on science literacy is the final test, conducted to assess four aspects: attractiveness, content, language, and technical quality. We conducted a small group trial with 30 students from class XII at SMAN 1 Bandar Lampung, SMA 2 Perintis Bandar Lampung, and SMAN 10 Bandar Lampung. We conducted the small group trial to ascertain the students' reactions to the developed product. Table 5 displays the assessment results of the small group presentation. Meanwhile, the large group trial (field trial) was conducted with 60 students in those three

schools. Both large group testing and small group testing follow the same procedure, which involves filling out a questionnaire.

A. Small Group Trial

There are five statements that make something attractive: how the science literacy-based e-LKPD on electromagnetic material looks, how interesting it is to learn with e-LKPD, how the colors in e-LKPD aren't all the same, how interesting it is to learn with science literacy-based LOK-R, and how there are examples of electromagnetism that can help with understanding. The results of the small group trial for the attractiveness aspect received a score of 87%, indicating that it is very attractive.

Under the material aspect, (Dewi & Lestari, 2020) present six statements: The presentation of material in science literacy-based e-LKPD is easy to understand and interesting to study further; learning using e-LKPD can provide engaging information (Sa'diyah, 2021). The presentaThe e-LKPD presents material in a way that encourages discussion and supports the mastery of physics lessons, particularly in the topic of electromagnetism. It also includes evaluation tests that assess the extent of understanding of the electromagnetism material, and its engaging motivation can foster a spirit of learning. material aspect scored 89%, indicating its high level of interest. The implementation of the LOK-R model in E-LKPD seeks to enhance students' conceptual comprehension by promoting critical and reflective thinking processes in scientific content, consistent with research indicating that science literacy-based education can improve students' proficiency in deep conceptual understanding (Sabila Fatkhi & Solihah, 2023)

There are five statements in the language aspect: the sentences are easy to understand, the language is simple, there are understandable symbols and signs, the sentences don't create double meanings, and the font size is appropriate and easy to read. The language aspect achieved a score of 91%, indicating its high appeal.

The implementation of E-LKPD utilising a science literacy approach, such as the LOK-R model, effectively enhances students' critical thinking abilities, particularly on complex subjects like electromagnetic waves, aligning with research that underscores the significance of innovation in educational design (Syahwati & Arif, 2022).

Three statements comprise the technical quality aspect: the e-LKPD's ease of use, its practicality, and its non-boring nature. The technical quality aspect achieved a score of 92%, indicating its high appeal. Thus, the results of the small group trial regarding the science-based e-LKPD on electromagnetism for 12th grade high school/Madrasah Aliyah physics learning are deemed very interesting.

B. Field Group Trial

Regarding the attractiveness aspect, four statements are made about the physical appearance of the science literacy-based e-LKPD on electromagnetic materials. According to the field trial results, the aspect of attractiveness received an 88% score, indicating it is very appealing. The content aspect also received a score of 88%, deemed very appealing. The language aspect scored 87%, classified as very appealing, and the technical quality aspect received a score of 89%, also considered very appealing.

The description above states that the E-LKPD for physics learning using the LOK-R model based on science literacy on electromagnetic material for 12th-grade high school/Madrasah Aliyah is proven to be very suitable in terms of media and content. The E-LKPD using the LOK-R model based on science literacy is also proven to be engaging because it has an attractive physical appearance, features a non-monotonous color combination (Astuti et al., 2021), includes evaluation questions, and provides examples that involve local culture, which can enhance understanding (Makhmudah et al., 2019). The implementation of the LOK-R model in E-LKPD seeks to enhance students' conceptual comprehension by promoting critical and reflective thinking in scientific content, consistent with research indicating that science literacy-oriented education can improve students' proficiency in deep conceptual

understanding (Novita Oktaviani & Ulinnuha Nur Faizah, 2024). Additionally, it provides opportunities for discussion, mastering lessons, and fostering interest and enthusiasm in learning. The language presented in this E-LKPD is simple, easy to understand, and flexible to use.

CONCLUSION

Based on the results and discussion, it can be concluded that the e-LKPD materials and media for physics learning using the LOK-R model based on science literacy are deemed very feasible and can be used. The appeal test was also conducted in this research and development also included the appeal test. The results show that the e-LKPD learning media developed was deemed very interesting by three educators in three schools, achieving a final percentage of 82%. Meanwhile, the e-LKPD's attractiveness test for physics learning was rated as very interesting by twelfth-grade students in three schools, with a final percentage of 89% for the small group trial and 88% for the large group trial or field trial, both falling into the very interesting category. This study on the development of e-LKPD is limited to the presentation of one material, so it is hoped that future research can expand to include the presentation of several more comprehensive materials. The main conclusions of the study may be presented in a short Conclusions section, which should stand alone. The conclusion section should lead the reader to important matter of the paper (answer of the objectives of the study). It also can be followed by suggestions or recommendations related to further research.

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