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Practicality of Physics E-books Based on Problem-Based Learning Oriented to Higher Order Thinking Skills for Students

Silvia Agustin*[1], Pakhrur Razi[2]

[1] Masters Study Program of Physics Education, Universitas Negeri Padang, West Sumatera, Indonesia.
[2] Department of Physics, Universitas Negeri Padang, West Sumatera, Indonesia.

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Correspondence
Email : 16.silvia.16@gmail.com
Phone :

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ABSTRACT

Human resources with high-level thinking abilities, such as critical thinking, creativity, communication, teamwork, independence, cross-cultural understanding, and ICT literacy, are needed for 21st-century growth. However, cultivating high-order thinking skills is still not optimal and does not meet the needs of the 21st century. In fact, learning in schools has not met expectations, as reflected in TIMSS and PISA. The result of this research is the development of a physics e-book based on problem-based learning oriented towards higher-order thinking skills for high school class X. This research aims to measure the practicality of the e-book. The method used in R&D uses the Plomp model. The results of practicality are seen based on the responses from physics teachers and students. The practicality instrument uses five criteria consisting of several indicators. The practicality of e-books based on teacher responses shows an average of 92% with a very high category. The practicality of e-books based on student responses shows an average of 81% with a very high category. The research results show that the developed e-book is practical and can be used during the physics learning process.

INTRODUCTION

The development of science and technology occurred very quickly in the era of the Industrial Revolution 4.0. This situation requires people to have complex thinking skills and communication skills. Four critical 21st-century skills include learning and innovation, life and career skills, information literacy, media and technology, and literacy skills (Sulaiman & Ismail, 2020; Widana, 2017). The sophistication of information technology makes it easy for people to access various information anywhere and anytime. Communication between people can be simple, convenient, anywhere, anytime. The 21st-century learning paradigm emphasizes the diversity of students' abilities. Students must be able to apply critical and creative thinking, connect science with the real world, apply technology and knowledge, collaborate, and communicate effectively (Asrizal et al., 2020).

In the 21st century, science and technology are developing without limits. The 21st-century learning paradigm is characterized by learning in accessible spaces, independently,

collaborating, using digital teaching materials, and using information technology and electronic communication media (Erdisna et al., 2020; Widana, 2017). With the advancement of the 21st century, which uses ICT technology in all industries, including education, there is a very high opportunity to adopt learning through mobile devices (Razi & Amali, 2014). The 21st-century learning paradigm has emphasized the various abilities of students. They must be able to apply critical and creative thinking, connect science with the real world, apply technology and information, work together, and communicate effectively (Asrizal et al., 2020). The 21st-century education field demands changes in teaching materials, learning media, facilities, and learning models provided to students to face the 21st century (Mardhiyah et al., 2021). The 21st-century learning model usually uses technology and is developed interactively (Sofiana et al., 2014). Learning in schools should be integrated with technology as a learning tool to develop 21st-century skills.

However, in reality, learning at school has not met expectations. This is reflected in the Trends in International Mathematics and Science Study (TIMSS) results, which measures students' critical thinking. Indonesia ranks 50th out of 53 countries in physics (Provasnik et al., 2016). Indonesian students' learning outcomes are also reported in PISA (Program for International Student Assessment) as reported by the OECD (Organization for Economic Cooperation and Development). The low quality of education is reflected in several indicators, including academic quality through the PISA program (Razi, 2013). The PISA rating from this research is lower than the 2015 PISA results. Indonesia is the sixth weakest (74th) out of 79 PISA participating countries. Indonesia ranks 7th or 73rd in math skills, and Indonesia ranks 9th or 71st in Science skills (OECD, 2019). This problem can be seen from the low critical thinking skills and scientific literacy of students in Indonesia in dealing with 21st-century skills.

The government's efforts in Indonesian education are reflected in improving the education curriculum. The curriculum is student-centered and requires problem-solving, critical thinking, collaboration, and creativity skills. However, it has not been able to create the expected learning in practice. One way to do this is by changing learning facilities, such as those that usually use printed materials, into digital teaching materials. The current situation aligns with the demands of skills and learning paradigms with technology in the 21st century. Teachers and students must know the sophistication of technology, information, and communication (Amin, 2016; Syamsuar & Reflianto, 2018).

Various efforts that the government and educators have made to meet the demands of the 21st century are still not in line with expectations. Based on field conditions from the observations made in three schools in Padang. Observations were carried out by interviewing Physics teachers. Based on the physics teacher interview using a teacher interview sheet. The interview results show that students' HOTS abilities are still very low, and only a few students in the class have HOTS abilities. The textbooks used in schools are still dominated by textbooks published by publishers (printed teaching materials). Teaching materials used in schools are not yet interactive. There is no interaction between students and the teaching materials, so they are less attractive to students. Other teaching materials used are videos from YouTube materials from the internet. Students often use WhatsApp Groups, Google Forms, etc., as learning media. Because the learning process is carried out online, learning models cannot be used correctly during the learning process, so teaching materials are needed that can help the online learning process.

Efforts to improve learning outcomes by the 21st-century paradigm need to be made by developing teaching materials in the form of electronic books (e-books) based on the Higher Order Thinking Skills (HOTS) oriented Problem-Based Learning (PBL) learning model. E-books display information containing text, images, audio, and video (Novalia et al., 2020). The e-book features being developed will be more varied, presenting more

dynamic content to make it more interactive. The benefits of using e-books include having interactive content, affordable prices, easy to store, and easy to carry. Due to the development of the internet network, e-books can be easily opened anywhere and anytime. Currently, many physics e-books have been developed. The development of e-books mainly focuses on presentation, such as affordable prices, easy storage, and ease of carrying. The e-book features being developed will be more varied by presenting more dynamic content to make it more interactive. The benefits of using e-books include having interactive content, affordable prices, easy to store, and easy to carry. Due to the development of the internet network, e-books can be easily opened anywhere and anytime. Currently, many physics e-books have been developed. The development of e-books mainly focuses on appearance, such as affordable prices, easy storage, and ease of carrying (Ummah et al., 2019). E-books have a coherent presentation format, good language, high scientific level, and extensive discussion. Digital books or e-books are books in electronic format that can be run on a PC/laptop computer or other electronic devices (Pradani & Aziza, 2019). The advantages of e-books include easy browsing and reading, savings on paper materials, and can be combined with interactive media such as animations, videos, and images. Hopefully, this e-book can trigger students' interest, motivation, and critical thinking in the learning process.

The PBL learning model aims to provide real problems to students' study groups, find relevant information, collect information, process data, and solve problems to train students with the 21st-century paradigm (Malmia et al., 2019). The PBL model trains higher-order thinking skills, helps students process existing information, and gathers their knowledge about the social world and its surroundings (Yustina et al., 2022). PBL is a learner-centered learning model with learning methods that encourage students to solve real problem cases in investigations (Fidan & Tuncel, 2019). HOTS learning trains students to transfer one concept to another, process and apply information, connect information, solve complex problems, and analyze critically (Supeno et al., 2019). HOTS is a complex process of describing material, drawing conclusions, building representations, analyzing, and building relationships involving the most basic mental activities (Resnick, 1987). HOTS is a high-level thinking process strategy that encourages students to seek and explore information independently, look for underlying structures, relationships, and facts, and use them appropriately to solve problems (Tiur et al., 2019). Based on the demands and problems in the field, the solution offered to meet the 21st-century demands is to develop a Physics e-book based on a problem-based learning model oriented towards higher-order thinking skills for SMA/MA Class X. This research aims to see the practicality of the product being developed so that it can use during the learning process.

METHODS

The type of research used in this research is research and development (R&D). The development model used is the development model from Plomp. The Plomp model consists of three stages, namely: (1) Preliminary Research (preliminary analysis stage), (2) Prototyping Phase (design stage), and (3) Assessment Phase (evaluation stage) (Plomp & Nieveen, 2013). A needs analysis and literature study were carried out in the Preliminary Research stage. The Prototyping Phase is where the product is developed (developed), evaluated, and revised repeatedly. Some formative evaluations include self-evaluation, expert review, one-to-one evaluation, small group evaluation, and field tests. Self-evaluation is a stage where researchers evaluate and revise the Physics e-book products that have been designed themselves. The evaluation results are called prototype I. Expert review is the evaluation stage by experts. Validation is an activity to measure the suitability of the e-book that has been developed. The results of the expert evaluation are called prototype II.

One-on-one evaluation is by testing products in the form of valid e-books with students. Three students were involved. The three students each represent a level of ability in high, medium, and low-ability classes. The results of the evaluation are called prototype III. Small group evaluation is tested on small groups of students with different abilities. The way to select small groups is by grouping students and selecting nine based on ability. The nine students included three people, each with high, medium, and low abilities. The results of the evaluation are called prototype IV. The field test stage is the stage described in the current research.

This research contains the results of one-on-one evaluations, small group evaluations, and field tests to see the practicality of the product being developed. The practicality instrument uses a practicality questionnaire consisting of questionnaire responses from teachers and students. The response questionnaire aims to obtain teacher and student responses to the Physics e-book being developed. Practical instruments include e-book content, e-book display and media, convenience in e-books, application of PBL learning models, and higher-order thinking skills (HOTS). The practicality questionnaire instrument used is a practicality sheet validated first. The test subjects for this research were students at Adabiah 2 Padang High School, totaling 42 students and two teachers. Practicality analysis was obtained from practicality instruments using response questionnaires from teachers and students. The practicality analysis using a Likert scale. Practicality analysis can be obtained by dividing the score obtained by the maximum score and multiplying by one hundred percent. In addition, the practicality value category ranges from 0 to 20 in the very low category, 21 to 40 in the low category, 41 to 60 in the moderately high category, 61 to 80 in the high category, 81 to 100 in the very high category (Riduwan, 2015).

RESULTS AND DISCUSSION

Results

One-on-One Evaluation Results

The one-to-one evaluation involved three students with high, medium, and low abilities. Retrieval of data by using questionnaires on the practicality of student responses. The small group practicality instrument consists of five components, namely, e-book content (SO1), e-book appearance and media (SO2), ease of e-books (SO3), application of the PBL learning model (SO4), and HOTS (SO5). This questionnaire includes several indicators. The results of the practicality of the e-book based on student responses can be seen in Figure 1.

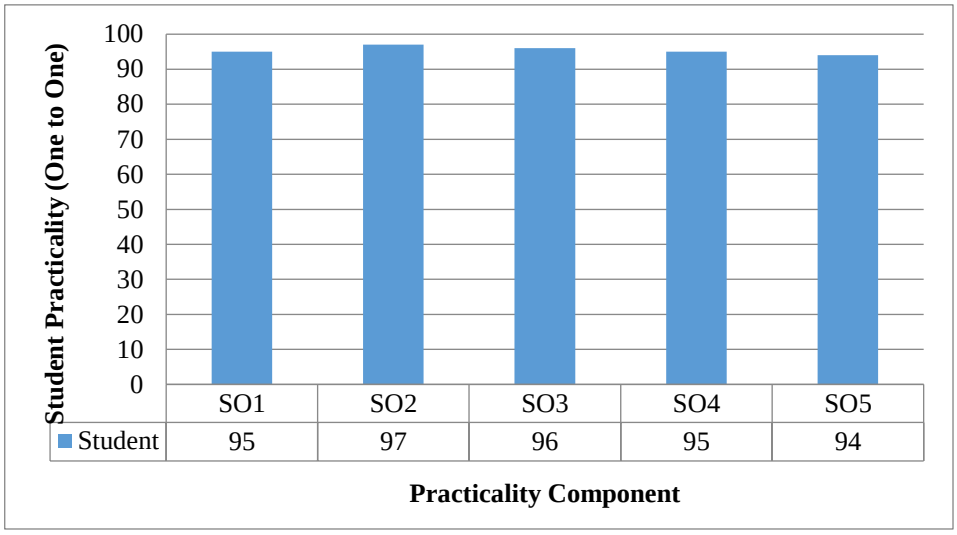

Figure 1. The practicality of E-books in One-on-one Evaluation

Figure 1 shows that the practicality value based on student responses in the one-on-one evaluation is in the very high category. E-book content indicator (SO1) with an average value of 95%. E-book display and media indicators (SO2) with an average value of 97%. The ease of e-book indicator (SO3) has an average value of 96%. Indicator for implementing the PBL learning model (SO4) with an average value of 95%. HOTS indicator (SO5) with an average value of 94%. The highest value is in the attractive appearance and media of the e-book when used by students. The lowest value was found in the HOTS indicator, and this is because students have not been trained to use HOTS teaching materials that students have just used. The average practicality score of students in the one-on-one evaluation was 95%, which is in the very high category.

Small Group Evaluation Results

Small group evaluations involved nine students with high, medium, and low abilities. Retrieval of data by using questionnaires on the practicality of student responses. The small group practicality instrument consists of five components, namely, e-book content (SG1), e-book appearance and media (SG2), ease of e-books (SG3), application of the PBL learning model (SG4), and HOTS (SG5). This questionnaire includes several indicators. The results of the practicality of the e-book based on student responses to small group evaluations can be seen in Figure 2.

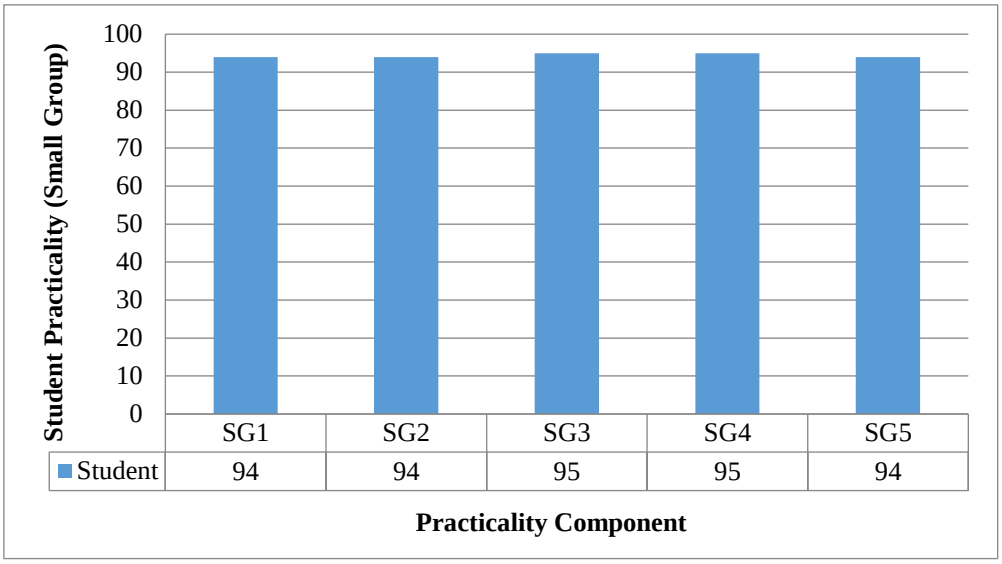

Figure 2. Practicality of E-books in Small Group Evaluation

Figure 2 shows the practicality value is based on student responses in small group evaluations with very high categories. E-book content indicator (SG1) with an average value of 94%. E-book display and media indicators (SG2) with an average value of 94%. E-book convenience indicator (SG3) with an average value of 95%. Indicator for implementing the PBL learning model (SG4) with an average value of 95%. HOTS indicator (SG5) with an average value of 94%. The highest score is in the indicator of ease of e-books and application of the PBL learning model. This shows that the e-book is easy to use during the learning process with the PBL model, which helps students to understand learning physics and solve problems. The average practical value of students in the small group evaluation was 94%, which is in the very high category.

Field Test Results

The field test was conducted on class X, which contained 30 students and two Adabiah 2 Padang High School physics teachers. Learning using e-books was carried out in four meetings. Data were collected using a questionnaire sheet on the practicality of teacher and student responses. First, a teacher response questionnaire was used to determine teachers' responses to using physics e-books. The teacher practicality instrument consists of five components, namely, the content of the e-book (G1), the appearance and media of the e-book (G2), the convenience of the e-book (G3), the application of the PBL learning model (G4), and HOTS (G5). This questionnaire includes several indicators. The results of the practicality of e-books based on teacher responses can be seen in Figure 3.

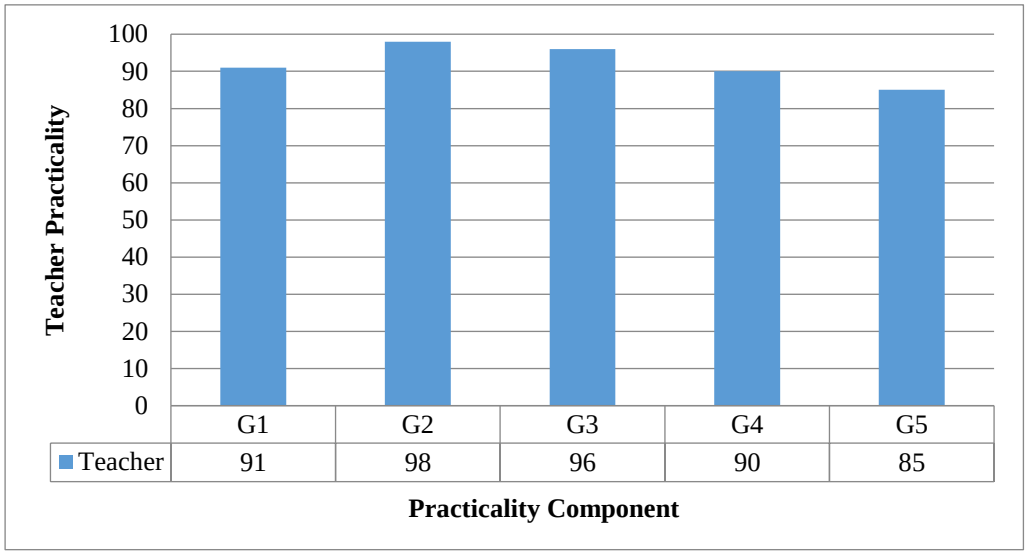

Figure 3. Practicality of E-books in Field Tests Based on Teacher Responses

Figure 3 shows that the practicality value based on teacher responses is very high. The G2 indicator has the highest percentage value of 98%. This is because the appearance and media of the e-book are attractive. The e-book is prepared with effective, easy-to-understand sentences, clear audio, and display. The indicator with the lowest percentage is 85%. This is because there needs to be improvements to HOTS-oriented e-books in order to develop students' HOTS abilities further. Students need stimulus to develop their creative/inventive abilities, think critically, be creative, and solve problems. The average value of practicality obtained was 92% in the very high category. Second, a student response questionnaire was used to determine the level of practicality of the e-book. The practicality instrument for students consists of five components, namely, e-book content (S1), e-book appearance and media (S2), ease of e-books (S3), application of the PBL learning model (S4), and HOTS (S5). Each student is given a questionnaire consisting of several indicators. The results of the practicality of e-books based on student responses are seen in Figure 4.

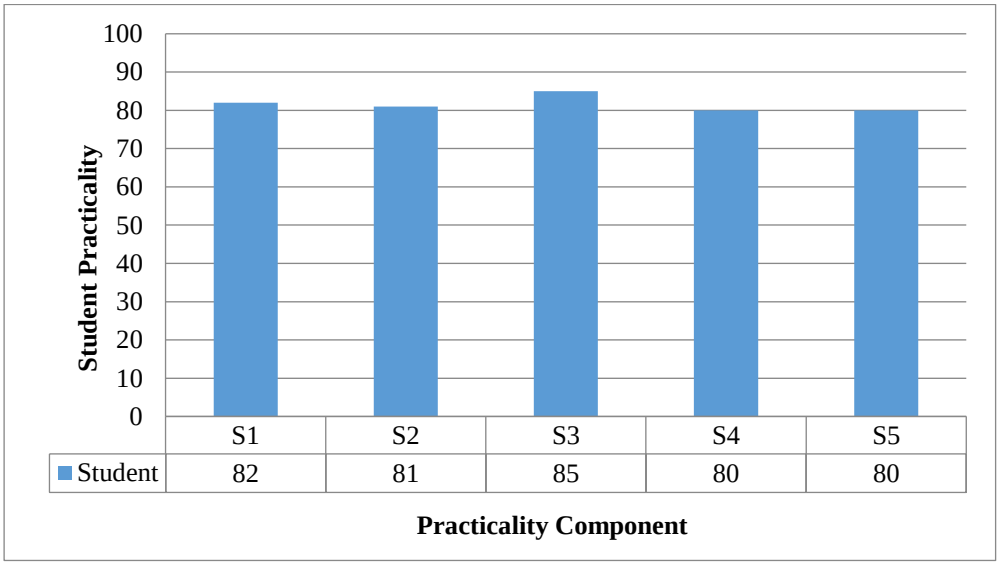

Figure 4. Practicality of E-books in Field Tests Based on Student Responses

Figure 4 shows that the results of practicality based on student responses are in the very high category. The S3 indicator has the highest percentage value of 85%. This is due to the ease of e-books that can be used. Students can access e-books using smartphones. E-books can be used for independent learning, and the examples and illustrations in e-books are present in everyday life, making it easier for students to learn. Furthermore, students can study independently. The indicator with the lowest percentage is 80%. This low percentage is because they are not used to HOTS-oriented PBL-based e-books. The compiled e-book also needs better improvement in stimulating students in the PBL learning model and HOTS orientation. The application of PBL begins with orienting students to problems, organizing students for learning, investing independently and in groups, developing and presenting results, and analyzing and evaluating the problem-solving process. The HOTS orientation needs to be developed on students' critical thinking skills, which can be stimulated with examples and questions. The average value of the practicality of the students obtained was 81% in the very high category.

Discussion

The practicality of the field test involves teachers and students of class X SMA Adabiah 2 Padang. The practical results obtained for teachers and students are very high. The results of the practicality of the Physics e-book that has been developed as a whole are in the very high category. A practicality test needs to be carried out as a reference for how easy it is to use e-books. Electronic books are packaged as attractively as possible so they are not boring when used in learning. It is hoped to increase students' interest in learning (Setiyoaji dkk., 2020). Practicality is based on teacher responses, which consist of five indicators, including e-book content, e-book appearance and media, ease of e-books, application of the problem-based learning model, and higher-order thinking skills. The practicality indicator in the e-book's contents has an average value of 91% in the very high category. The practicality indicator on display and e-book media averages 98% in the very high category. The practicality indicator for convenience in e-books has an average value of 96% in the very high category. The practicality indicator in applying the problem-based learning model has an average value of 90% with a very high category. The practicality indicator for higher-order thinking skills has an average value of 85%, with a very high category.

Practicality is based on student responses, which consist of five indicators, including e-book content, e-book appearance and media, ease of e-books, application of the problem-based learning model, and higher-order thinking skills. The practicality indicator for e-book content has an average value of 82% in the very high category. Practicality indicators in the appearance and media of e-books have an average value of 81% in the very high category. The practicality indicator for convenience in e-books has an average value of 85% in the very high category. The practicality indicator in applying the problem-based learning model has an average value of 80% in the very high category. The practicality indicator for higher-order thinking skills averages 80% in the high category. Both teacher and student practicality results show a very high category.

The practicality of teaching materials makes learning easier for teachers and students, creating a meaningful, interesting, and enjoyable learning atmosphere (Alfitriani & Hutabri, 2017). Bahan ajar dibuat dan dikembangkan seinteraktif mungkin sehingga proses belajar tidak satu arah lagi (Razi & Amali, 2014). Multimedia will be more interesting for students if it is interactive and will be better if it is arranged according to the syntax of the learning

model (Ilahi dkk., 2021). The product in the form of an e-book is easy for students to open anywhere, anytime. The material presented in the e-book is easy to understand, so it can speed up students' understanding and improve student learning outcomes (Elvisa & Hamdi, 2021). Based on the practical results, it can be concluded that problem-based learning-based physics e-books oriented to higher-order thinking skills are already practical and can be used in the learning process.

CONCLUSION

Based on the research conducted, it was concluded that the problem-based learning physics e-book oriented to higher-order thinking skills for class X SMA has practical criteria. Practicality is seen from the results of teacher and student assessments after using e-books during the learning process. Teacher practicality results obtained on average were 92% in the very high category. The students' practicality results were average at 81% in the very high category. The e-book developed is practical and can be used during the learning process.

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