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Development of Interactive Physics E-Module to Improve Critical Thinking Skills

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Abstract: This research is Research and Development (R&D). Development is carried out with reference to the ADDIE model. The ADDIE stages include the analyze, design, development, implementation, and evaluation stages. This development research aims to analyze the results of the developed interactive physics e-modules, analyze practitioners' assessment of interactive physics e-modules, analyze the use of interactive physics e-modules that have been developed in improving students' critical thinking skills. The instruments used in this study were interactive physics e-module validation sheets, practitioner assessment questionnaires (teachers/educators), and critical thinking skills test instruments. The e-module eligibility criteria are seen from the aspect of its validity. Criteria for the practicality of the physics e-module are seen from practitioners' assessment of the interactive e-module, and the criteria for the effectiveness of the interactive physics e-module are seen from the increase in the results of students' critical thinking skills after being given interactive physics e-modules. Based on the results of the analysis, it can be concluded that the interactive physics e-module which was developed based on expert judgment using the analysis of the Aiken V index is declared valid and suitable for use, then the interactive physics e-module in terms of practitioners' assessment is in the very good category, improving students' critical thinking skills after the application of the interactive physics e-module analyzed with an N-gain of 0.35 in the medium category, this means that there is an increase in students' critical thinking skills in physics.

Keywords: Critical thinking skills; Interactive e-module; Physics e-module

Introduction

The era of the industrial revolution 4.0 was marked by the emergence of new technologies such as information technology, communication networks, big data, artificial intelligence and virtualization. The emergence of digital technology and its increasingly rapid developments have an impact on all disciplines, the economy, and existing industries. The impact of the industrial revolution 4.0 is a big challenge for the world. One of the fundamental efforts that can be done is to focus on improving the quality of education. Education as a response to the industrial revolution 4.0 gave rise to the idea of education 4.0. The vision of education 4.0 is to motivate students to learn not only knowledge and skills, but to identify learning sources from these knowledge and skills (Retnaningsih, 2019). From this vision, it is clear that there are differences in ideas in learning.

This is in line with Aziz (2018) that stated the nine trends in education 4.0 can shift the main learning responsibilities from educators to students. Sajidin et al. (2018) explained that the paradigm shift from teacher as director to teacher as facilitator, guide, and consultant is natural, because learning resources and teaching materials do not only rely on one source but learning resources that are not limited by time or space become opportunities. For students to develop mindsets and skills appropriate to the 4.0 era. These skills are called 21st century skills. This emphasis is then explained in a 21st century learning framework that describes the skills, knowledge, and expertise that students must master to succeed in work and life. According to BSNP, the 21st century learning framework includes: critical

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thinking and problem solving skills, creative and innovation skills, communication and collaboration skills, information and communication technology literacy, and contextual learning skills.

Based on the above, teachers are required to be able to apply information and communication technology in an integrated, systematic, and effective manner according to situations and conditions, including being able to utilize technology as a source of learning and learning media, especially in learning physics. Physics is a science that discusses natural phenomena in everyday life and phenomena that occur in the universe. Based on this, learning physics has a higher level of abstraction based on the educational level of students. Difficulties in understanding physics lessons are generally caused by a lack of innovative teaching materials used by teachers in the learning process.

The availability of adequate teaching materials is very important for students in learning, teaching materials that are in accordance with the demands of the curriculum and the needs and characteristics of students will help build effective communication between teachers and students so that the learning process is more interactive. In addition, the availability of adequate teaching materials can support the independence of students in learning to develop 21st century character education.

One of the teaching materials that can be used independently and can be adapted to the characteristics of students is a module (Prasetya, 2012). Modules are also called independent learning resources because they are equipped with instructions for self-study. Learning physics using modules can assist teachers in delivering material in which students can study independently, develop thinking skills according to their individual abilities, reduce dependence on teachers, and make it easier to learn each competency so that students can achieve and complete their learning materials with modules and can control the ability and intensity of learning (Auliya et al., 2017).

Modules can be made more attractive and attractive to students by developing modules in electronic form or e-modules. E-modules are independent teaching materials that contain information in digital format, e-modules can make it easier for users. E-modules are the result of innovation from ICT-based modules and have advantages over printed modules, namely that they can make the learning process more interesting, more interactive, able to convey historical messages through pictures and videos, encourage student learning through interactive features, are able to develop auditory senses or students' hearing so that the material presented is easier to understand.

In the process of learning physics, in addition to teaching materials or learning resources, students also need thinking skills, especially critical thinking skills. Critical thinking skills are a systematic thinking process that allows students to formulate and evaluate their own beliefs and opinions (Johnson, 2007). Critical thinking skills include high-level skills such as analysis, synthesis, understanding and solving problems, inference, and evaluation. Implementation of indicators of critical thinking skills in learning physics requires mature readiness of the teacher. Improving students' critical thinking skills depends on how a teacher manages learning, the role of a teacher in the teaching and learning process of physics not only provides information to students but also must apply the principles the principles of science that are oriented to observation and experimentation, teachers must pay attention to the styles and ways of learning of students in learning. Each student has a different learning style so that the teacher must have the ability to vary learning according to the characteristics of students, so that students are not bored in learning and so that learning objectives are achieved.

Based on the problems obtained, a physics e-module was developed that can be used as teaching material to accompany printed books so that students are able to study independently. With the electronic physics module, students will easily access virtual laboratories, video and audio lessons provided so that students' theoretical and practicum understanding can be aligned and the ability to understand physics concepts. In order to be able to think critically, students must have an understanding of a good concept. A good understanding will greatly support students' critical thinking competence. The use of e-modules in learning can be a solution to monotonous teaching materials and a lack of practicum tools in schools. It is hoped that this development is one of the efforts to procure learning modules that are innovative and effective and meaningful for students.

One of the software used to produce electronic modules is flip pdf professional, this is because there are various features in it that make learning media attractive interactive so that learning is not monotonous, with a more attractive appearance with the addition of animation, images, video, audio-visual, navigation which makes it an interactive and interesting learning module with formats such as Exe, zip, Html, screen saver and others. The professional pdf flip application provides settings such as magazines, documents and so on (Kurnianto et al., 2022). Utilization of using professional flip pdf media is expected to explain abstract physics material that can be visualized using this media so that it makes it easier for students to receive knowledge effectively and efficiently which can be learned anytime and anywhere.

Interactive physics e-module with the help of the professional flip pdf application can present the contents of the material in a more complete and interactive

manner. The development of this interactive physics e-module presents slide shows with various interactive features that can develop students' kinesthetic abilities, for example, question and answer features, educational games, and others. In the interactive physics e-module, student exploration content can be inserted accompanied by student worksheets so that it can help students develop concepts, discussion content, simulations and experimental instructions, as well as animated videos. In addition, there are practice questions on each sub-material so that enable students to be able to learn independently. The learning process using interactive e-modules can train students to interpret problems, analyze problems, and provide conclusions about a problem given digitally. The user will experience an interaction controlling a command which then creates a two-way relationship with the module and acts actively, for example actively observing pictures, paying attention to writing that varies in color or moves, sounds, animations, even videos. Based on the explanation above, the researcher developed an interactive physics e-module to improve critical thinking skills. With the developed physics e-module, it is hoped that it will support learning activities for teachers and students.

Method

This type of research is development research. The development research in question is research conducted to produce an interactive physics e-module to improve students' critical thinking skills. This development research used the ADDIE Model developed by Brach (2009) covering the stages of Design Analysis, Develop, Implementation and Evaluation. Evaluation has an important role in the ADDIE model. Evaluation in the ADDIE instructional design is divided into two, namely formative evaluation, namely evaluation used to revise development before implementation and summative evaluation, namely evaluation used at the implementation stage. The results of the evaluation carried out at each stage can bring development to the next stage or continue to hold development at a stage until the revised results are approved. Therefore, the evaluation is intended to strengthen the objectives of product development, namely interactive physics e-modules. The activities carried out at each stage of the interactive physics e-module development can be explained as follows.

In the Analysis phase, the development of the Interactive physics e-module begins with analyzing the problems or school needs needed to improve physics learning. The concept at this stage is needs analysis to determine the right problems and solutions as well as determine student competencies which are the basis or reference in the development of Interactive physics e-modules. This preliminary research is expected to obtain aspects of needs analysis including: first, Gap analysis of the performance of the learning process which aims to produce a statement of objectives based on the performance of the physics learning process for class XI MIPA at public high school 15 Luwu. The analysis is carried out by measuring actual performance, confirming the desired performance, and identifying the causes of performance gaps in the physics learning process. Data analysis was obtained by observing and interviewing physics teachers regarding the characteristics of students, the involvement of students in the learning process, evaluating students' critical thinking skills, and learning that attracts students' learning interest in physics subjects, as well as internal and external obstacles in teaching physics; the second stage of setting instructional goals aims to respond to performance gaps that occur in learning physics. Instructional objectives describe the main tasks that students will get at the end of learning physics; the third analysis of students is used to identify students' critical thinking skills, intrinsic motivation and students' interest in learning physics, physics learning experiences, learning styles, and analysis of students' needs for physics materials; fourthly Identification of the required resources. At this stage, there are four identified resources, namely content resources, technological resources, instructional facilities, and human resources.

Evaluation of the analysis phase is carried out after the researcher has completed all parts of the analysis phase. At the evaluation stage, the researcher asked the physics teacher and supervisor to evaluate the feasibility of the analysis results to proceed to the design stage.

The design stage is the planning stage of the interactive physics e-module framework to be developed. At this stage, several preparations were made before developing interactive physics e-modules. The purpose of developing an interactive physics e-module is to close the performance gap in the physics learning process in class XI SMA Negeri 15 Luwu. The purpose of this development is to improve students' critical thinking skills. Activities at this stage include: Formatting and Drafting of Physics E-Modules; Preparation of KD Specifications and Learning Objectives; Media selection includes the stages of the process of collecting material, creating questions, and looking for examples of technology that apply material concepts to life. After the process of gathering material, then selecting the media to be presented in the e-module in the form of images, videos, animations, simulations of events that occur in everyday life related to the subject matter. This is intended so that students have an idea of the application or importance of this material to be studied; 4) the e-module design stage uses supporting applications such as Corel Draw X7, Microsoft Word

2019, and liveworksheet, storyline articulate 3, canvapro.

At the design stage, the development process is carried out after the supervisor and teacher agree on the design made to close the gaps in learning physics. After the evaluation is carried out, the results of the evaluation in the form of suggestions will be used as revision material before the development stage is carried out.

Development stage, this stage is the process of developing interactive e-modules using professional flip pdf software, which includes writing text, installing images, installing videos, links, animations, hyperlinks, and preparing and installing ready questions. The interactive physics e-module flowchart is as Figure 1.

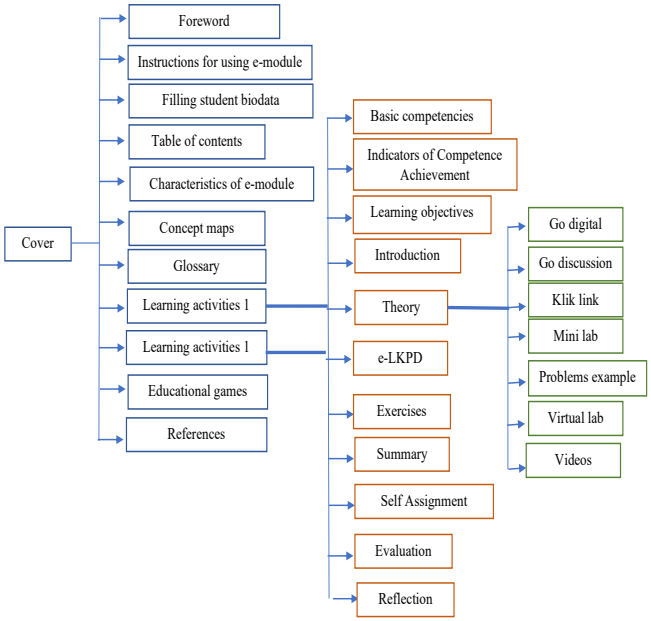

Figure 1. Interactive physics e-module flowchart

The formative evaluation aims to revise the interactive physics e-modules that have been developed prior to the implementation of the interactive physics e-modules. The first design or prototype I was validated by 3 experts to determine the level of validity of the e-module. Validity was carried out using Aiken V analysis or the results of expert assessment were used to measure the feasibility of the teaching materials, while corrections and suggestions from experts were used to revise the interactive physics e-module (prototype II). Interactive physics e-module. Which has been revised into the final product used in the implementation phase.

The Implementation phase consists of several parts, at this stage the interactive physics e-module that has been developed is tested on a number of respondents. Branch (2009) states that the implementation phase is carried out to prepare the learning environment and involve students in learning. At the implementation stage, learning with interactive physics e-modules shows conclusions from information by giving formative tests (evaluations) at the end of learning.

The trial design used was "Pre-test and Post-test Group". The test carried out before giving the treatment (O_1) is called the pre-test and the test after giving the treatment (O_2) is called the post-test. According to Sugiyono (2010) the trial design is described as follows.

$$O_1 \; X \; O_2$$

Figure 2. Research trial design

At this stage, the process of collecting data the researcher first distributes the pretest to students. This pretest serves to find out the initial knowledge of students, the test given is in the form of a critical thinking skills test. After that, the researcher carried out the learning process by applying an interactive physics e-module accompanied by a physics teacher using the discovery learning model. The discovery learning learning model used to implement interactive physics e-modules can help and facilitate students in obtaining information and make students more active in knowing the material being taught. After implementing the interactive physics e-module according to the trial design used, the researcher gave a post-test of critical thinking skills. The purpose of the test is to find out whether the physics e-module is able to improve students' critical thinking skills.

After the interactive physics e-module is implemented in physics learning, then the teacher will then provide an assessment of the interactive physics e-module that was developed based on the statements in the practitioner's assessment questionnaire sheet. The results of the assessment in the form of suggestions for the interactive physics e-module were used as the next revision of the interactive physics e-module, namely prototype III.

The results of the evaluation are then analyzed through data analysis to determine the success of the development of teaching materials. When the goal of e-module development is stated to be unable to improve students' critical thinking skills, the researcher will revise it at the analysis stage to find out the location of the problems in the development of interactive physics e-modules.

Result and Discussion

Interactive Physics E-Module Development Results

The interactive physics electronic module developed is packaged in a simple and easily accessible way for users, where interactive physics e-modules can be accessed via a link that can be opened on mobile phones as well as computers and laptops for teachers and students. Physics material developed with the help

of professional Pdf flip. At the beginning of the e-module there is a cover, instructions for use and there is a user page to fill in the identity before learning to use the interactive physics e-module that has been developed. This interactive physics e-module is divided into three parts, namely introduction, content and closing. The results of the development of interactive e-modules are as follows.

Introduction

Figure 3. Instructions for use

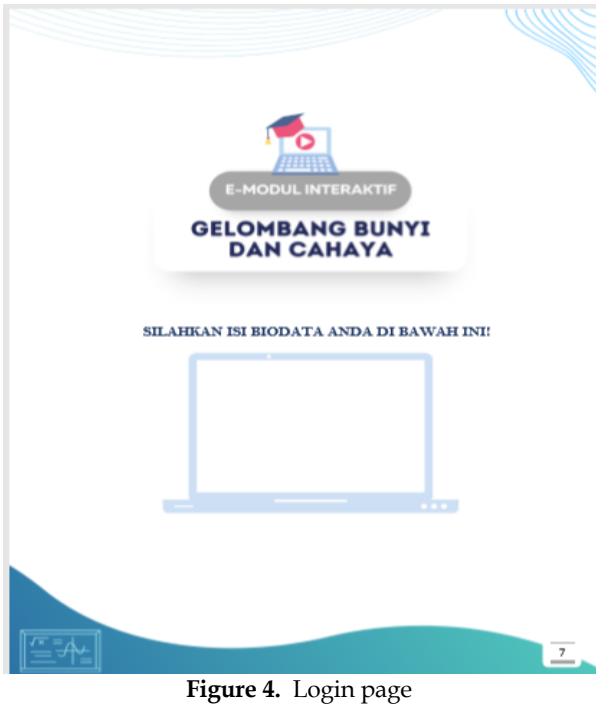

Figure 4. Login page

In the introduction there are characteristics of interactive e-modules (containing an explanation of the e-modules developed so that users can find out the parts and purposes of the e-modules); instructions for using interactive e-modules (containing tutorials or steps to access interactive e-modules that can be downloaded on the user manual page, by following the directions from the user manual, it will be easier for users to operate the e-modules); there is a page to fill in the student's identity; there is a brief description of the material in the form of a video which briefly explains the material to be discussed; there is a page that contains basic competencies and learning objectives to be achieved after the learning process uses interactive e-modules.

Discussion Forum

In the discussion forum section there are questions that will be discussed by students. Mandasari (2020) the role of discussion forums between teachers and students who discuss with each other can exchange information and share file links be it music, video images and others so that it is very supportive to improve communication and motivation. In this module there are several discussion room links that are adapted to the material, so that in one discussion room one can focus on one problem. If you want to answer discussion questions, click the submit button on the go discussion activity to connect to the discussion forum via WatsApp.

Figure 5. Display discussion forum

Learning Materials

In this section, material related to the concept of learning objectives is provided which is packaged into specific units to make it easier for students to study thoroughly. There can be text, audio, video and several links as additional learning resources for students. The use of interactive multimedia in the learning process helps students to better understand the material (Syawaludin et al., 2019). The final part of the learning material is provided by contacting the physics teacher if

students do not understand the material by pressing the message button contained in the e-module.

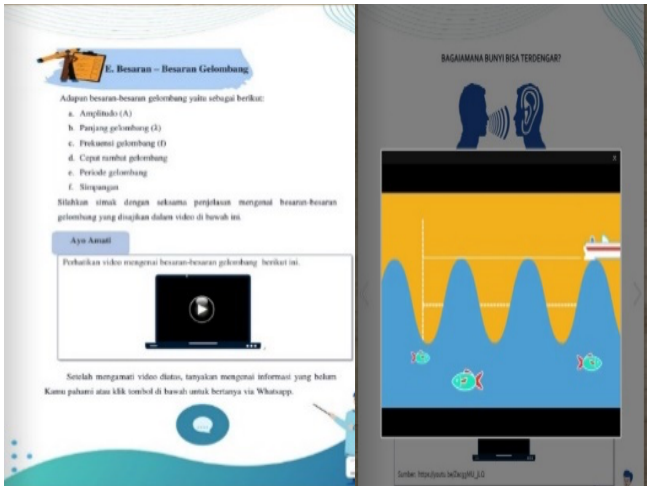

Figure 6. Display of learning materials

Virtual Laboratory

In the virtual laboratory section with the help of Phet Simulation students are able to carry out experiments without using equipment in the laboratory and students can conduct experiments anytime and anywhere, so that students can better understand the concept of waves. Fadieny & Fauzi (2021) stated that the use of experiment-based e-modules in learning is very beneficial for students. In this section there is also an LKPD which is a guide and worksheets that must be completed based on the practicum carried out. To do the practicum, click the start button and the practicum guide can be downloaded by clicking the download icon in the virtual lab.

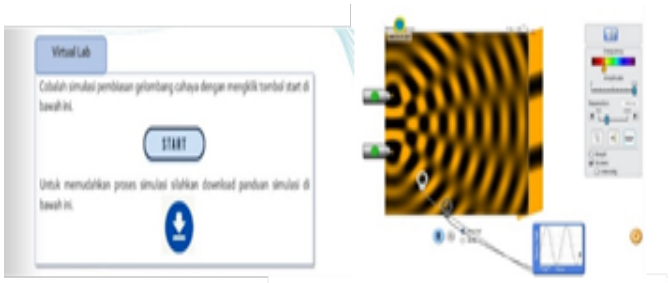

Figure 7. Virtual laboratory

Student Worksheet

Student worksheets contain student guides that are used to carry out activities and investigations that function to make students more independent in understanding the material to be achieved. Research by Rahayu et al. (2011) electronic worksheets can provide a good understanding of students more than that, students are not bored during the learning process because there are interesting features such as matchmaking activities, drop and drag, filling out descriptions. E-LKPD can be done directly in the module, after finishing working on it click the finish button then fill in the identity based on the command that appears then click send it will automatically be sent to the teacher's account.

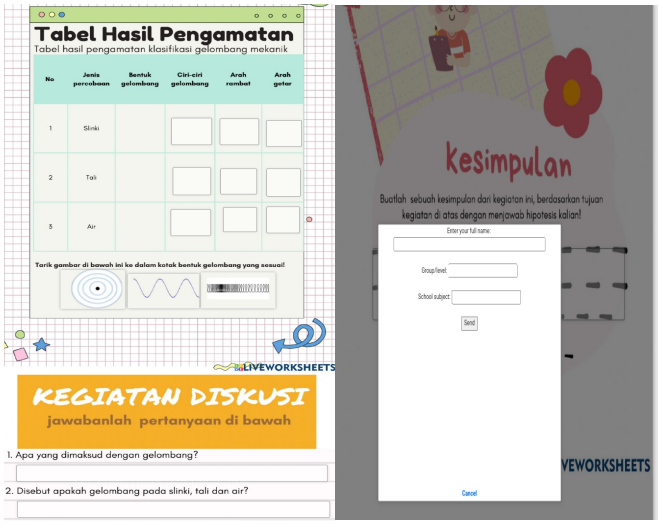

Figure 8. Display of E-LKPD

Exercises

Practice questions in this e-module to measure or test the extent to which students understand the material. Students interactively write answers on the page provided if the practice questions are in the form of essays and choose fixed answers if the exercise questions are in the form of multiple choices. The questions in the practice questions are presented according to indicators of critical thinking skills. Scores and evaluation results from practice questions accumulate automatically, so that students can immediately find out the results of their learning evaluation without having to wait for corrections from the teacher. To start working on the practice questions, click the button on the practice questions, then follow the instructions that are available and start working on the questions. After working on all the questions, the results will appear as well as menus for reviewing, repeating, discussing questions and submitting answers to the teacher.

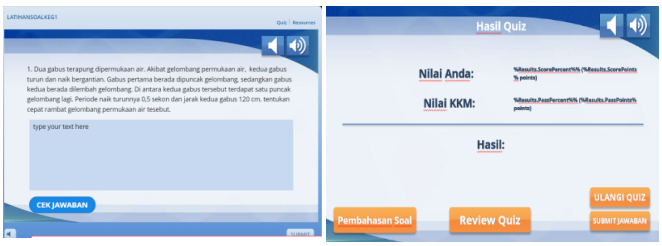

Figure 9. Display practice questions

Independent Assignment

Independent assignments are tasks given to students to measure and improve students' ability to

understand a material. To answer independent assignments, first download the questions, to make it easier for students to collect assignments, a link has been provided to collect assignments by pressing the message button on the independent assignment page.

Figure 10. Self-assignment display

The physics e-module is validated by the expert/expert with the aim of knowing the content validation of the product resulting from the development of the interactive physics e-module that has been made. The results of the content validity test were analyzed using the Aiken's V index. The results of the analysis of the coefficient content validity analysis of the expert agreement index for each component of content feasibility, presentation, language, graphics and software are tabulated in Table 1.

Table 1. Results of Expert Assessment of the Interactive Physics E-Module

Eligibility Aspect	Validation Index	Information
Contents	0.74	Valid
Presentation	0.76	Valid
Language	0.72	Valid
Graphics	0.78	Valid
Software	0.83	Valid

Table 1 shows that the validation results provided by the validator team have strong consistent responses. Thus, the interactive physics e-module that has been developed is declared to meet the eligibility criteria (valid) so that it can be used. Referring to the results of the discussion by following the suggestions and instructions from the validator in revising, researchers, so that this interactive physics e-module is valid and feasible for testing. Interactive physics e-modules that are declared valid mean that the e-module as a whole content or material and the components of the e-module are related consistently to one another.

Interactive physics e-modules that are declared valid mean that the interactive physics e-modules as a whole content or material and the components of the e-module are related consistently to one another. The component in question is the suitability of the content presented with the basic competencies and the applicable curriculum, linking the material to problems that are often encountered in everyday life, using language that is easy to understand. As stated by Rochmad (2012) that a development result (product) is said to be valid if the product is based on adequate theory and all components of learning products relate to each other consistently.

The developed e-learning module can be said to be good if the elements in the learning module have been fulfilled. E-module interactive physics flip pdf professional assistance that has been developed based on the results of validity analysis, the results show that the e-module is feasible or valid. The interactive physics module that has been developed contains relevant elements that can improve students' critical thinking skills. This validation is in line with research conducted by Sriwahyuni et al. (2019) who developed electronic teaching materials using professional pdf flips on material for optical instruments with the results of what validity was in the valid and appropriate category to use. The same thing was done by Ellisya et al. (2021) who developed e-modules with the help of professional flip pdfs on the basic subjects of electricity and electronics with the results of expert or expert assessments being in the valid or feasible category to use. Furthermore, Prime et al. (2016) stated that using e-modules can improve students' critical thinking skills and motivation in learning, so that the use of mobile-based learning modules is more effective than the use of printed books (Astalini et al., 2019). This study is in accordance with the results of the media expert validator and practitioner validator. This illustrates that the developed e-module is valid and can be used in the learning process.

Practitioner's Assessment Results of the Interactive Physics E-Module

Practitioners' assessment of the interactive physics e-module aims to determine the response of practitioners who are members of the Luwu Regency Physics Subject Teacher Consultation (MGMP) community to the interactive physics e-module that has been developed. The interactive physics e-module assessment includes aspects of content feasibility, presentation feasibility, language feasibility, graphics and software feasibility. The data from the analysis of the teacher's response assessment regarding the interactive physics e-module that has been developed can be seen in Table 2.

Table 2. Percentage of Practitioners' Assessment of the Interactive Physics E-Module

Aspect	Percentage (%)	Category
Content	83.1	Very good
Presentation	84.2	Very good
Language	82.5	Very good
Graphics	83.6	Very good
Software	86.7	Very good

Based on Table 2, all aspects of the interactive physics e-module assessment component assessed by practitioners obtain percentages above 80%. In general, the practitioner's score on the implementation of the interactive physics e-module is in the very good category. In line with research Putri et al. (2018), this research is in accordance with the results of practical validation which illustrates that the developed e-module can be used in the learning process. If the percentage of practitioners' ratings obtained is <80%, then the product is in the practical category. This means that the interactive physics e-module developed is easy to use in the learning process.

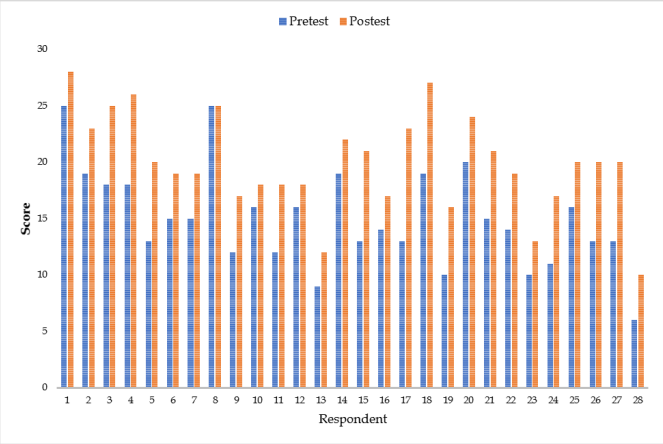

Figure 11. Pretest and posttest scores of students' critical thinking skills

In the interactive physics e-module developed, instructions for using each activity are presented to facilitate the teaching and learning process. In addition, several pictures are presented according to the material, videos, learning links, simulations/virtual labs related to material, e-LKPD, sample questions and practice questions and use language that is easy to understand so that it makes it easier for students to understand the material presented. In accordance with the opinion of Solihudin (2018) states that product practicality is when the product is easy to use. Practical is the level of use and implementation of the e-module by students and teachers, namely carrying out learning using the revised e-module based on the assessment of experts.

The results of students' critical thinking skills tests before and after using interactive physics e-modules, then N-Gain analysis is carried out to see whether there is an increase in students' critical thinking skills. The results of the analysis obtained an average N-Gain value of 0.35. This means that there is an increase in students' critical thinking skills in the medium category. Based on this, the interactive physics e-module with the help of professional flip pdf software that has been developed is effective in improving students' critical thinking skills.

Interactive e-modules have many roles as learning resources. Interactive e-modules are one of the independent teaching materials chosen because interactive e-modules can be used anytime and anywhere, are attractive, easily accessible and do not depend on other media so that they can support the learning process. In addition, the features contained in it are designed interactively so that they can support interaction and communication between teachers and students. This is in line with what was stated by Lee (2017) digital books not only contain text but also interactive media that can be accessed by readers that support the interaction of lecturers and students. In addition, the material presented relates to everyday life. Basic questions are presented in the form of discussions that invite students to think critically so that learning is more interactive, students are active in understanding the concepts given, so that students' learning motivation in learning can increase.

In interactive e-modules, material is presented in the form of text, images, animations and videos that are able to visualize material clearly, provided website links to several learning resources related to the material as additional references, and equipped with interactive quizzes and questions as well as evaluations at the end of learning activities who are able to hone abilities, especially critical thinking skills of students. This is in line with what was stated by Putri et al. (2022) that interactive features such as quizzes and practice questions make learning more effective and efficient. There is a virtual laboratory that makes it easier for students to understand the material being taught. In line with the results of Yuen (2006) virtual-based simulation is a learning need to encourage students to be more experienced and able to construct more solutive thinking. With this electronic module, the learning process should run more effectively and efficiently and support interaction between teachers and students so that students can understand the concept of the lesson and experience an increase in students' critical thinking skills.

As according to Suryadi stated that teaching materials can be said to be effective if students are active in the learning process and students' responses to the learning carried out (Djamas, 2015). Kartika (2001) also states that a learning process is said to be effective if 60% of the students can complete the minimum completeness criteria. In addition, in the Kamus Besar Bahasa Indonesia (2021), the word effective means effect, influence, consequence or can bring results. So effectiveness is activeness, usability, compatibility in an activity of a person carrying out a task with the intended target. The most important aspect of effectiveness is knowing the level or degree of product application (Rochmad, 2012). The effectiveness of learning e-modules can be measured by looking at the increase in students' critical thinking skills. In line with what was

stated by Suwatra et al. (2018) using interactive modules in learning can foster critical thinking skills.

Conclusion

Based on the results of the research and discussion, it can be concluded as follows: The results of the content validity coefficient test, the interactive physics e-module developed has met the valid category, Practitioners' assessment of the interactive physics e-module developed gave a positive response with a very good category, and increased skills Students' critical thinking after using interactive physics e-modules analyzed with N-gain is in the medium category, this means that the interactive physics e-modules developed have various benefits and are good enough to be used as learning media or learning resources in learning. especially in improving critical thinking skills.

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Author Contributions
Cynthia conceptualized the research idea, methodological design, data analysis, funding acquisition, investigative process, writing-original draft, software, visualization, management and coordination responsibility for the research activity planning and execution. Kaharuddin Arafah and Pariabti Palloan guided, wrote-reviewed and edited, supervised and validated the instruments used in the research.

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Conflicts of Interest
The author declares no conflict of interest. The data published in this article, both in data collection, analysis, data interpretation, in writing manuscripts or in the decision to publish research results, there is no conflict of interest with any party.

References

Astalini, Darmaji, Kurniawan, W., Anwar, K., & Kurniawan, D. A. (2019). Effectiveness of using e-module and e-assessment. *International Journal of Interactive Mobile Technologies*, *13*(9), 21–39. https://doi.org/10.3991/ijim.v13i09.11016

Auliya, M., & Kosim, K. (2017). Pengembangan Modul Fisika Materi Optik Dengan Pendekatan Saintifik Berbasis Fenomena Alam Untuk Meningkatkan Efektivitas Belajar Siswa SMA. *Jurnal Pijar Mipa*, *12*(2), 71–80. https://doi.org/10.29303/jpm.v12i2.344

Aziz, H. A. (2018). Education 4.0 made simple: ideas for teaching. *International Journal of Education and Literacy Studies*, *6*(3), 92. https://doi.org/10.7575/aiac.ijels.v.6n.3p.92

Branch, R. M. (2009). Instructional design: The ADDIE approach. In *Science and Education*. Springer Science & Business Media.

Djamas, D. (2015). *Perangkat Pembelajaran Statistik Pendidikan*. Program Pascasarjana Pendidikan Fisika.

Ellysia, A., & Irfan, D. (2021). Pengembangan e-Modul dengan Flip PDF Professional pada Mata Pelajaran Dasar Listrik dan Elektronika. *Jurnal Vote Teknika*, *9*(3), 92–96. https://doi.org/10.24036/voteteknika.v9i3.113525

Johnson, E. B. (2007). *Contextual Teaching and Learning - Center for Occupational Research and Development*. Mizan learning center. Retrieved from http://www.cord.org/contextual-teaching-and-learning/

Kartika, B. (2001). *Berbagi Strategi untuk Melibatkan Siswa Secara Aktif dalam Proses Pembelajaran Fisika di SMU, Efektivitas dan Sikap Merdeka pada Strategi tersebut*. USD: Widya Dharma.

Kurnianto, D., Sudiansyan, Heriyanto, Yani T., A., & T., H. (2022). Development of Mathematics E-Modules Through the Professional Flip PDF Application Assisted React Strategy to Improve Problem Solving Ability of Vocational Middle School Students Concentration of Accounting Expertise. *International Journal of Science and Society*, *4*(3), 499–512. https://doi.org/10.54783/ijsoc.v4i3.544

Lee, S. H. (2017). A Study on the Design of Book Design through Digital Edit Design Grid Study - Focused on the Case of Digital Electronic Textbook Based on Pad -. *Journal of the Korean Society Design Culture*, *23*(3), 581–590. https://doi.org/10.18208/ksdc.2017.23.3.581

Mandasari, R. D. (2020). Forum Diskusi Online Pada SMART Learning System. *INSANTEK-Jurnal Inovasi Dan Sains Teknik*, *1*(1), 40–46. Retrieved from https://ejournal.bsi.ac.id/ejurnal/index.php/insantek/article/view/8914

Prasetya, T. I. (2012). Meningkatkan Keterampilan Menyusun Instrumen Hasil Belajar Berbasis Modul Interaktif Bagi Guru-Guru Ipa Smp N Kota Magelang. *Journal of Educational Research and Evaluation*, *1*(2), 106–112. Retrieved from http://journal.unnes.ac.id/sju/index.php/jere

Putri, D. D., & Wijayati, P. H. (2022). Digitizing Lehrwerkanalyse Materials with the Flip PDF

Professional Application. *Randwick International of Education and Linguistics Science Journal*, *3*(3), 504–513. https://doi.org/10.47175/rielsj.v3i3.538

Putri, E. H., Sumarmin, R., & Advinda, L. (2018). Development Module Biology Learning Completely by Conceptual Map for Student Grade XI of Senior High School. *International Journal of Progressive Sciences and Technologies*, *6*(2), 340–346. Retrieved from https://rb.gy/81nkn

Retnaningsih, D. (2019). Tantangan dan Strategi Guru di Era Revolusi Industri 4.0 dalam Meningkatkan Kualitas Pendidikan. *Prosiding Seminar Nasional: Kebijakan Dan Pengembangan Pendidikan Di Era Revolusi Industri 4.0.*, *September*, 23–30. Retrieved from https://jurnal.ustjogja.ac.id/index.php/snpep2019/article/view/5624

Rochmad, R. (2012). Desain Model Pengembangan Perangkat Pembelajaran Matematika. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *3*(1), 59–72. https://doi.org/10.15294/kreano.v3i1.2613

Sajidan, Baedhowi, Triyanto, Totalia, S. A., & Masykuri, M. (2018). Peningkatan Proses Pembelajaran dan Penilaian Pembelajaran Abad 21 dalam Meningkatkan Kualitas Pembelajaran SMK. In *Direktorat Pembinaan Sekolah Menengah Kejuruan Direktorat Jenderal Pendidikan Dasar dan Menengah Kementerian Pendidikan dan Kebudayaan*. Retrieved from http://repositori.kemdikbud.go.id/id/eprint/10842

Solihudin, T. J. H. (2018). Pengembangan E-Modul Berbasis Web untuk Meningkatkan Pencapaian Kompetensi Pengetahuan Fisika pada Materi Listrik Statis dan Dinamis SMA. *Jurnal Wanaha Pendidikan Fisika*, *3*(2), 51–61. https://doi.org/10.17509/wapfi.v3i2.13731

Sriwahyuni, I., Risdianto, E., & Johan, H. (2019). Pengembangan Bahan Ajar Elektronik Menggunakan Flip Pdf Professional pada Materi Alat-Alat Optik Di SMA. *Jurnal Kumparan Fisika*, *2*(3), 145–152. https://doi.org/10.33369/jkf.2.3.145-152

Suwatra, W., Suyatna, A., & Rosidin, U. (2018). Development of Interactive E-Module for Global Warming to Grow of Critical Thinking Skills. *International Journal of Advanced Engineering, Management and Science*, *4*(7), 543–549. https://doi.org/10.22161/ijaems.4.7.7

Syawaludin, A., Gunarhadi, & Rintayati, P. (2019). Development of augmented reality-based interactive multimedia to improve critical thinking skills in science learning. *International Journal of Instruction*, *12*(4), 331–344. https://doi.org/10.29333/iji.2019.12421a

Yuen, A. H. K. (2006). Learning to program through interactive simulation. *Educational Media International*, *43*(3), 251–268. https://doi.org/10.1080/09523980600641452