Journal of Education Technology
Volume 6, Number 4, 2022 pp. 711-721
P-ISSN: 2549-4856 E-ISSN : 2549-8290
Open Access: https://ejournal.undiksha.ac.id/index.php/JET

Physics E-Book based on STEM Integrated Modelling Instruction in Circular Motion

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ARTICLE INFO

Article history:
Received June 21, 2022
Revised June 24, 2022
Accepted September 12, 2022
Available online November 25, 2022

Kata Kunci:
E-Book, Modelling Instruction Terintegrasi STEM, Gerak Melingkar

Keywords:
E-Book, STEM-integrated Modeling Instruction, Circular Motion

DOI:
https://doi.org/10.23887/jet.v6i4.48680

ABSTRAK

Gerak melingkar memiliki banyak aplikasi dalam kehidupan sehari-hari. Namun, materi gerak melingkar termasuk salah satu konsep fisika yang abstrak. Penggunaan e-book sebagai media dalam pembelajaran fisika dapat membantu siswa memvisualisasikan konsep-konsep yang abstrak. Penelitian ini bertujuan untuk mengembangkan dan mengetahui kelayakan e-book fisika berbasis Modelling Instruction terintegrasi STEM pada materi gerak melingkar untuk siswa kelas X SMA. Penelitian ini merupakan penelitian dan pengembangan dengan model pengembangan 4D. E-book fisika dinilai menggunakan lembar validasi kelayakan untuk ahli materi dan ahli media. Validator produk ini terdiri dari dua dosen ahli, empat guru fisika, dan dua peer reviewer. Teknik pengumpulan data menggunakan teknik wawancara dan kuesioner. Instrument yang digunakan dalam mengumpulkan data yaitu angket. Teknik analisis data menggunakan analisis deskriptif. Hasil penelitian menunjukkan bahwa nilai rata-rata penilaian materi e-book yang dikembangkan ialah 3,92, termasuk dalam kategori sangat tinggi. Sedangkan, nilai rata-rata penilaian media e-book ialah 3,97, termasuk dalam kategori sangat tinggi. Hasil angket respon peserta didik termasuk kategori sangat tinggi dengan nilai rata-rata 3,69. Dengan demikian, e-book fisika berbasis Modelling Instruction terintegrasi STEM sangat layak digunakan sebagai media pembelajaran fisika secara mandiri pada materi gerak melingkar.

ABSTRACT

Circular motion has many applications in everyday life. However, the circular motion of matter is one of the abstract concepts of physics. The use of e-books as a medium for learning physics can help students visualize abstract concepts. This study aims to develop and determine the feasibility of a STEM-integrated Modeling Instruction-based physics e-book on circular motion material for class X high school students. This research is research and development with the 4D development model. Physics e-books are assessed using a feasibility validation sheet for material and media experts. The product validators consist of two expert lecturers, four physics teachers, and two peer reviewers. Data collection techniques using interview techniques and questionnaires. The instrument used in collecting data is a questionnaire. Data analysis technique using descriptive analysis. The results showed that the average score for the developed e-book material was 3.92, which was included in the very high category. Meanwhile, the average value of e-book media is 3.97, which is included in the very high category. The results of the student response questionnaire were included in the very high category with an average value of 3.69. Thus, the physics e-book based on STEM-integrated Modeling Instruction is very suitable to be used as a medium for learning physics independently on circular motion material.

1. INTRODUCTION

Circular motion is one of the topics in physics, especially in mechanics (Canlas, 2015; Ian Phil Canlas, 2016). The concept of circular motion has many applications in everyday life (Canlas, 2016; Serevina et al., 2018; Sunarti & Rusilowati, 2020). However, students still have difficulty understanding and mastering the concept of circular motion (Mutsvangwa, 2020; Zhou et al., 2011). It is because circular motion material includes abstract physics material (Zhou et al., 2011). Abstract physical phenomena require added media to explain the idea (Irwandani et al., 2017). This supplementary media applies as a tool to facilitate students in learning. Media helps students to understand abstract physics materials that are perceived hard (Diani et al., 2018; Nikmah & Ellianawati, 2019; Sari et al., 2017). Students gain direct experience and understanding of the teaching materials taught through learning media (Asrizal et al., 2020; Rahayuningsih, 2020; Wulandari et al., 2020). However, the results of interviews with physics teachers at SMAN 1 Aesesa stated that the delivery of circular motion material still uses the lecture method and PowerPoint media. It is evident by the statement in the teacher's interview "I sometimes use PPT, but because of my limitations in using technology, I often carry out direct learning, discussions, and

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occasionally practicum on basic materials such as measuring instruments." Explanation of the material refers to textbooks and student worksheets (LKPD). Teachers still use teaching materials and media conventional in delivering subject matter (Fahmi et al., 2021; Irwandani et al., 2017). Thus, interactive learning media is needed to explain the concept of circular motion.

The learning paradigm in the industrial revolution 4.0 is almost all controlled by the role of technology (Anggraeni et al., 2019; Haidir et al., 2021; Teo et al., 2021). The part of technology facilitates the world of education, especially teachers in delivering material to students. One of the technology-integrated learning media that can use by teachers is e-books. E-book users can include pictures, animations, and videos that support students' understanding of the lesson (Putri & Festiyed., 2019; Rahim et al., 2020). E-books can use by students as a source of independent learning at home. The use of e-books hopes will help students visualize the content of abstract subjects (Eladl & Musawi, 2020; Rahim et al., 2020). There have been many variations of physics e-books developed in physics learning activities, such as web-based and android-based e-books. The development of web-based static fluid and fluid dynamic e-books can improve students' physics problem-solving (Ramli et al., 2021).Web-based physics e-books can use as self-teaching for students. Better to web-based physics e-book expandable based on Android. E-book learning media creates an interactive and independent learning environment (Asrowi et al., 2019; Hediansah & Surjono, 2019; V. Wulandari et al., 2019). Students in classes using Android-based physics e-books have better achievements than students in classes using learning media commonly used in schools. However, there are still e-books in pdf form which only contain text and images that do not include video or sound. It causes students to be less interested in reading the material in the e-book.

The reality happening in implementations of physics learning is also not as expected. Based on interviews with physics teachers at SMAN 1 Aesesa, physics learning still uses textbooks once the teacher arranges print modules to convey the contents of physics material to students. The teacher has never developed learning media and only uses PowerPoint and google classroom in physics learning activities. It shows that learning physics is still not utilizing technology. Meanwhile, the acquisition of a needs questionnaire states that 98% of students already have an Android smartphone. Thus, have to evolve an interactive physics e-book that utilizes an android smartphone.

Learning will be directed and structured if the e-book developed refers to the appropriate learning method or model. The learning model that can use by the teacher is Modeling Instruction. Learning with Modeling Instruction teaches physics concepts by following the mindset of physical scientists (Hermawan et al., 2015; Wati & Widiansyah, 2020). Modeling Instruction uses models as a central aspect of learning through processes and attitudes based on phenomena in the real world (Purwaningsih et al., 2020; Rahman et al., 2013). Students work collaboratively in small groups to collect data and build conceptual models. In learning with Modeling Instruction, the teachers and traditional content are replaceable with modeling cycles. Modeling Instruction emphasizes student involvement in the scientific process (Hermawan et al., 2015; Jackson et al., 2005). Learning with Modeling Instruction is centered on students' ability to construct physics concepts and be able to solve problems with the ideas they already have. In Modeling Instruction, learning consists of two stages, namely the development stage and the implementation stage. Three activities involve students in the model development stage, namely pre-lab discussions, lab investigations, and post-lab discussions all the implementation stage includes worksheets, quizzes, lab work, and tests (Jackson et al., 2005; Wati & Widiansyah, 2020). Modeling Instruction does not explicitly link the knowledge learned with its application in real life (Purwaningsih et al., 2020). Therefore, multidisciplinary knowledge requiring in STEM (Breiner et al., 2012; Manosuttirit, 2019). STEM leverages the relationships between science, technology, engineering, and mathematics to reflect on how each discipline operates in a real-world context (Gardner, 2018; Guzey et al., 2016). STEM learning encourages students to practice learned they already have in solving real-world problems (Almuharomah et al., 2019; Bybee, 2010).

STEM learning that utilizes everyday problems will lead to more meaningful physics learning (Alatas & Yakin, 2021; Saputra et al., 2020). Learning with a STEM approach can make students have the ability to be critical, creative, collaborative, and communicative thinking (Pratiwi & Yulia, 2021; Rizaldi et al., 2020). The STEM approach supports Modeling Instruction in simulating experiments related to physics in everyday life. Application STEM integrated Modeling Instruction in physics learning helps students gain conceptual mastery and improve their critical thinking skills (Purwaningsih et al., 2020). Previous research has not explicitly used e-books that apply to learning using the STEM-integrated Modeling Instruction learning model. STEM-integrated Modeling Instruction newly applies to the concept of work and energy (Purwaningsih et al., 2020). Thus, a physics e-book based on STEM-integrated Modeling Instruction will evolve on circular motion material. This research varies from previous research. First, the teaching materials developed are in the form of physics e-books. The e-book display design uses Figma software, while the e-book extension in .apk format uses Flutter software. Physics e-books can use offline on android smartphones. Second, the physics learning material in the e-book includes circular motion material. The circular motion material presented in the e-book contains pictures, videos, formulas, quizzes, and questions that supply at every meeting. Third, the e-book evolved in line with the integrated STEM

Modeling Instruction syntax. Fourth, the composition of the physics e-book includes an introduction, instructions, student worksheet, material, evaluation, bibliography, glossary, and profile.

This study develops teaching materials, including an e-book based on STEM-integrated Modeling Instruction. Product development on circular motion material. This research aims to describe the validity and practicality of an e-book physics based on STEM integrated Modeling Instruction so that it can use in learning physics in the classroom. This interactive physics e-book that utilizes an android smartphone hopefully be an independent physics learning medium for students. So students can understand the concept of circular motion.

2. METHOD

This research includes development research with 4D models. The physics e-book evolves according to the 4D stages whereon Define, Design, Develop and Disseminate. The define stage is done with the preliminary study, student analysis, task analysis, concept analysis, and goal formulation. In the design stage, the initial design of the physics e-book manufactured the selection of learning device formats, the preparation of test instruments, and the first design. The development stage contains e-book development, product validation, and limited trials. The dissemination stage is enforceable later.

Data collection techniques use interview techniques and questionnaires. Interviews are enforceable to obtain information from the physics teacher. Meanwhile, the questionnaire used consisted of a student needs questionnaire, a product feasibility questionnaire, and a student response questionnaire. Product feasibility questionnaire rated by eight validators pervades two expert lecturers, four physics teachers, and two peer reviewers. The feasibility validation sheet for material experts contains learning, material, and language aspects. Currently, the feasibility validation sheet for media experts includes the audio-visual display and software engineering aspects. Each indicator has three criteria. If three criteria are met, then afford 4 points, if two criteria are met, then afford 3 points, if one criterion is met, then afford 2 points, and 1 point for indicators for which none of the criteria are met. Indicator of the product feasibility assessment prove in Table 1.

Table 1. Indicators of Product Feasibility Assessment

Product Eligibility based on	Aspect	Indicator
Material Expert	Learning	The suitability indicators with the KI, KD, and curriculum
		The suitability indicators with the material
		The suitability of learning objectives with indicators
		The suitability of the model and approach with the learning material emphasizes the ability to innovate
	Material	Clarity of material concepts and accuracy of material application in modeling instruction and STEM
		The breakdown of material explanation
		Interesting material in media and application to innovation capability
		The linkage of the material presented in the form of animation and narration with modeling instruction and STEM
		The suitability of writing the question formulation
		The suitability of the answer key to the question
	Language	Accuracy of language use
		The accuracy of the choice of sentences used (not multiple interpretations)
		The correct use of symbols and equations of physical units
Media Expert	Audio-visual display	Identity equipment
		Layout proportion suitability
		Color proportion match
		Background selection compatibility
		Letter selection compatibility
		Button display consistency
		Clarity of instructions for using media
	Software engineering	Ease of access
		Creativity and innovation
		Opportunities for media development in the development of science and technology

The level of reading and practicality of the physics e-book based on STEM integrated Modeling Instruction can be seen in the student response questionnaires. Students assess reading and understanding the physics e-book. Aspects in the student response questionnaire include aspects of appearance, aspects of material presentation, aspects of media operation, and aspects of benefits. Indicators of student response questionnaires exhibits in Table 2.

Table 2. Indicators of Student Response Questionnaire

Aspect	Indicator
Appearance	Text readable clearly
	The image presented is clear
	Image provide are interesting
	The animation provides clearly
	The animations provide interesting
	The video provides clearly
	The video provides interesting
Material Presentation	Learning materials provide clearly and easily understood
	Learning materials related to STEM integrated modeling instruction
	Examples and practice questions provided in the material
	Presentation of material encourages curiosity
	The language used is simple and easy to understand
Media Operation	Physics e-book accessible easily via Android
	Physics e-book operations easily
	Easy physics ebook installation process
	The button feature works fine
	All program menus work well
	All program buttons work fine
Benefits	Instructions for using the e-book are clear and easy to understand
	I find it easier to learn using this physics e-book
	I can understand the material easily using this physics e-book
	Physics e-books help me understand circular motion material
	Physics e-book helps me improve my learning independence
	Physics e-book helps me to innovate in solving physics problems in everyday life

The data analysis technique uses descriptive analysis. Validation and practicality of the data were calculated by means of the average score for each aspect assessed. The calculation results are fits to the eligibility criteria in Table 3.

Table 3. Physics E-Book Eligibility Validation Criteria

No	Score	Average	Category
1	$X \geq \bar{X} + 1{,}0SB_X$	X ≥ 3,00	Very High
2	$\bar{X} + 1{,}0SB_X > X \geq \bar{X}$	3,00 > X ≥ 2,50	High
3	$\bar{X} > X \geq \bar{X} - 1{,}0SB_X$	2,50 > X ≥ 2,00	Low
4	$X < \bar{X} - 1{,}0SB_X$	X < 2,00	Very Low

3. RESULT AND DISCUSSION

Result

First, define stage. At this stage, the needs of students and teachers in learning physics will be fit so that they can be adjustable to the product's evolve. Information from students and teachers will use the needs sheet, namely interviews for teachers and a needs questionnaire for students. The results obtained from this activity are to identify problems in learning physics so that the product developed can be a solution for students to overcome the issue in learning physics. Based on the results of the physics teacher interview stated that SMA Negeri 1 Aesesa has implemented the revised 2013 curriculum since the 2019/2020 school year. Learning physics still uses conventional methods where the teacher gives lectures, writes on the blackboard, and uses PowerPoint. Even if the 2013 curriculum, students are getting sued to be active, and the teacher only acts as a facilitator.

The teacher has never developed learning media before and only uses PowerPoint in physics learning activities. It makes students find it hard to understand physics material. In addition, students' difficulties result from many things, such as the many formulas that must be memorized and having trouble understanding the meaning of these questions. So that they cannot work and are confused about which equation to use in the problem, and the limited time of the lesson makes it difficult for students to understand the concept of physics. Students are used to memorizing equations rather than understanding the concepts taught.

The process of learning physics still does not use technology, even though the condition of the school environment is sufficient to integrate technology into learning. The results of the questionnaire on student needs stated that 95% students already had an android smartphone. Students can bring android to school when ordered by the teacher, and the school comes with wifi for students and teachers. The teacher will explain better using the learning media. Thus, it is necessary to develop an e-book based on an android smartphone so that students will get used to using a smartphone for learning.

A physics e-book based on STEM Integrated Modeling Instruction evolved to minimize some problems encountered in the initial analysis. The physics material studied includes facts, concepts, principles, and procedures on circular motion material. Meanwhile, the formulation of objectives that summed up as indicators of the achievement of competency students refers to KI and KD in circular motion material.

Second, design stage. Physics e-book based on STEM integrated Modeling Instruction was evolving at the design stage. The material developed in the physics e-book based on STEM integrated Modeling Instruction is circular motion material in KD 3.6 curriculum 2013 revision. Physics e-book based on STEM integrated Modeling Instruction designed in the form of an application on an Android smartphone. Before expanding the product, the researcher first prepares development guidelines, flowcharts, and storyboards. Some of the components in the STEM-integrated Modeling Instruction-based physics e-book are an introduction, instructions, worksheets, materials, evaluations, bibliography, glossary, and profiles, as shown in Table 4.

Table 4. Components in E-Book Physics

No	Section	Description
1	Introduction	a. KI and KD in the 2013 curriculum b. IPKD c. Learning objectives d. Concept maps e. Lesson Plans
2	Instructions	Instruction for using the physics e-book
3	LKPD	Student worksheets in each meeting include experimental analysis sheets
4	Materials	a. Circular motion b. Uniform circular motion c. Physical quantities in circular motion d. Circular motion changes uniformly e. The relationship of the wheels in a circular motion f. Project tasks
5	Evaluation	a. Problems example b. Exercises
6	Bibliography	References used in writing in the material section
7	Glossary	Collection of essential terms in physics e-book
8	Profiles	Developer profile information

Third, Develop stage. The results of the development stage are a physics e-book based on STEM-integrated Modeling Instruction and research instruments reviewed by material experts, media experts, practitioners, and peer reviewers. Development of physics e-book based on STEM-integrated Modeling Instruction uses Flutter and Figma software. Several components of the physics e-book based on STEM-integrated Modeling Instruction were developed, including the home page and the main page. The home page of the physics e-book consists of the title, developer, UNY logo, start button, identity, and a login button. The start button uses to enter the identity writing page before entering the main page. An exit button can use navigation according to smartphones. The home page view displayed in Figure 1.

The main page in this physics e-book includes an introduction, instructions, student worksheet, materials, evaluation, bibliography, glossary, and profile. First, the introductory menu consists of several menus, namely KI, KD, IPKD, learning objectives, concept maps, and lesson plans. In the lesson plan submenu, lesson plans provide at each meeting. The main page view gets displayed in Figure 2.

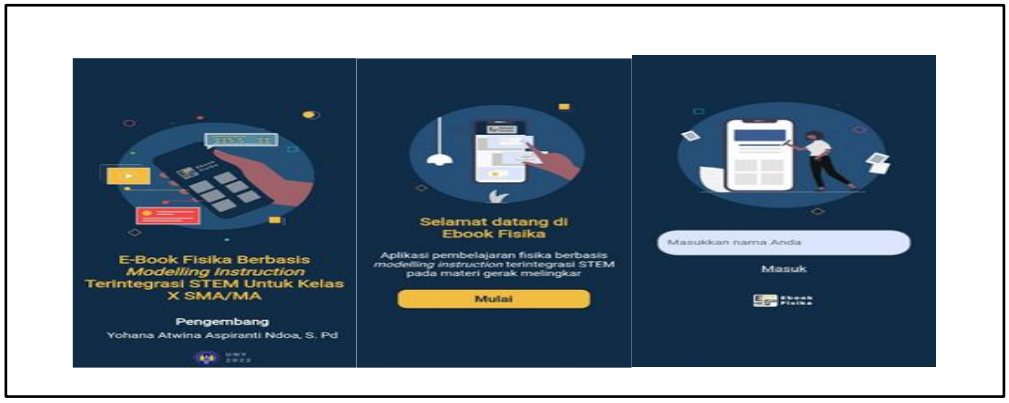

Figure 1. Home Page

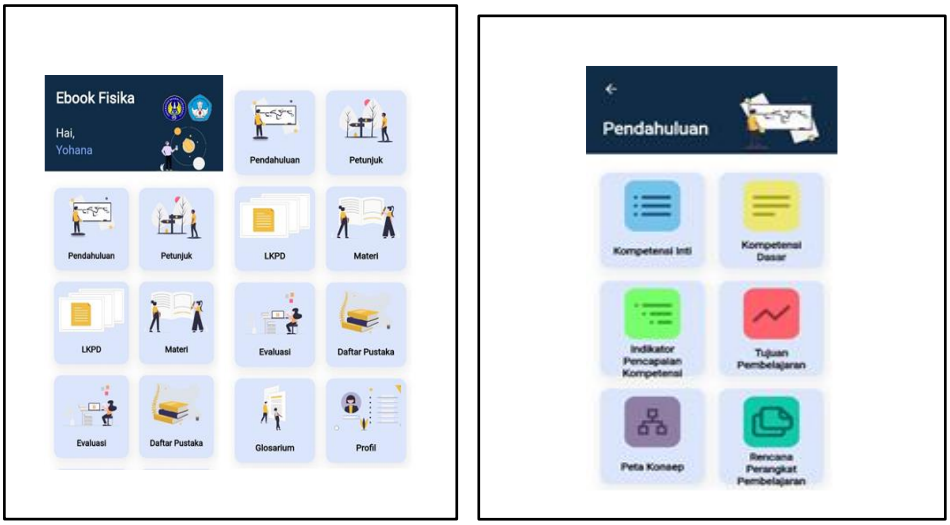

Figure 2. Main Page

Second, the instructions menu explained how to operate the physics e-book and the menus in the physics e-book. Third, the student worksheet menu presents worksheets used by students in learning physics. Student worksheet presented to students at each meeting, including an experimental analysis sheet. The components in the student worksheet consist of instructions for use, KD & IPKD, learning objectives, materials, tools and materials, work steps, and tables of experimental results. Fourth, the material menu presents material according to the stages of the STEM integrated Modeling Instruction learning model. The sub menu of the material section includes circular motion and uniform circular motion, physical quantities in a circular motion, uniform circular motion, and the relationship of the wheels in a circular motion. In the material section, there are project assignments that students will do in groups. Explanation of the material in the sub-material contains pictures, videos, and how to calculate them.

Fifth is the evaluation menu which consists of sample questions and practice questions. The sample questions consist of 15 description questions, while the practice questions consist of 15 multiple-choice questions. In practice questions, students must answer first before moving on to the next question. In the end, scores by the students appear after answering all the questions, including talking about the questions. Sixth, the bibliography menu presents a list of references used in writing the material section. Seventh, the glossary menu presents a collection of essential terms in physics e-books. Eighth, the profile menu contains developer profile information. The feasibility of the physics e-book product based on STEM integrated Modeling Instruction is viewed from the outcome of the validation of the material and media aspects. The assessment does by material experts, media experts, practitioners, and peer reviewers. The validation test does by two expert lecturers, four physics teachers, and two peer reviewers. Two experts lecturer are from the Department of Physics Education at Yogyakarta State University.

Materials feasibility assessment is assessed based on aspects of learning, material, and language. The learning aspect consists of four indicators, the material aspect consists of six indicators, and the language aspect

consists of three indicators. The results of the e-book assessment from the matter validation test appear in Table 5.

Table 5. Product Feasibility Results by Material Expert

No	Aspect	Score	Category
1	Learning	3.94	Very High
2	Material	3.98	Very High
3	Language	3.83	Very High
	Average	**3.92**	**Very High**

Based on Table 5, know that the average product feasibility of material validation is 3.92, included in the very high category. This physics e-book still needs to be fixed based on input and suggestions from assessors. A tip given by the assessor is to write undifferentiated scalar and vector quantities, writings units, and add diagrams from case examples and sentences that are still poorly understood. Then the product is revised according to input and suggestions, so it is suitable for use in physics learning. Media feasibility assessment includes aspects of audio-visual display and software engineering. The data from the analysis of the product feasibility assessment by media experts appear in Table 6.

Table 6. Product Eligibility Results by Media Expert

No	Aspect	Score	Category
1	Audio-visual display	3.98	Very High
2	Software engineering	3.96	Very High
	Average	**3.97**	**Very High**

Based on Table 6, the average product feasibility of media experts is 3.97, included in the very high category. Generally, the physics e-book that has been evolving is well and attractive. There were several revisions from the assessors on the media aspect, namely improving the proportion of the UNY logo, the text proportion in the RPP and LKPD, improvements to the menu of learning tools, and the back button on the lesson plan. Product revisions to improve the product so suitable for use in physics learning. Student response questionnaires were given to 32 students of class X SMA Negeri 1 Aesesa. Students fill out a response questionnaire after reading and understanding the physics e-book. Assessment by students with a range of 1-4. The results of the student response questionnaire appear in Table 7.

Table 7. Student Response Questionnaire Results

No	Aspect	Score	Category
1	Appearance	3.70	Very High
2	Material Presentation	3.73	Very High
3	Media Operation	3.75	Very High
4	Benefits	3.56	Very High
	Average	**3.69**	**Very High**

Based on Table 7, the average practicality of the product is 3.69, included in the very high category. Students can operate the physics e-book on their androids very well, and students easily understand the operation of the physics e-book. Don't happen any problems such as errors or jams when installing the physics e-book when it is opened or used. Several comments by students, the physics e-book is easy to understand and use as a physics learning media. Besides that, the physics e-book is well and attractive, the physics e-book helps students understand the material, and the physics e-book supports students in studying independently. Meanwhile, suggestions from students are to correct ambiguous sentences and some wrong words in the e-book. The results of the revised physics e-book based on student suggestions are used to improve the developed media. So, the physics e-book based on STEM integrated Modeling Instruction is feasible to use as a learning resource for the student in physics learning, specifically circular motion material. The dissemination of this product is providing applications to teachers and students of class X. It is one of the innovations in the field of physics that integrates technology and learning models of STEM integrated Modeling Instruction in the learning process.

Discussion

The physics e-book was developed according to the 4D development model through stages define, design, development, and dissemination. This stage is enforceable to obtain a physics e-book based on STEM-integrated

Modeling Instruction is feasible as physics teaching material. The development of physics e-book using flutter and figma software. Physics e-book developed an application with a .apk format, which can be installed and accessed offline on android smartphones. Physics e-books take advantage of Android to allow users to use the product inside and outside the classroom.

The physics e-book based on STEM integrated Modeling Instruction developed at circular motion material for class X high school students. The components of the physics e-book consist of the front page and the main page. The front page consists of a title, developer, UNY logo, start, identity, and login. This is by the previously developed e-book components, which consist of front pages and main pages (Arifah, 2017; Asrowi et al., 2019; Kusumayuni & Agung, 2021). The main page consists of an introduction, instructions, student worksheet, materials, evaluation, bibliography, glossary, and profile. The material description of circular motion is explained through text, images, and circular motion applications in everyday life that presenting in the form of video. Pengunaan gambar akan menarik perhatian siswa (Fahmi et al., 2021; Ningsih & Mahyuddin, 2021). Selain itu penggunaan video juga memudahkan siswa memahami materi (Satyawan, 2018; Sholikah et al., 2018; Widiyasanti & Ayriza, 2018).

Products developed are tested for feasibility and practicality before being implemented in the physics learning process. The product feasibility validation sheet is done by eight experts, including two expert lecturers, four physics teachers, and two peer reviewers. The results of the material expert's assessment on the learning aspect are 3.94, the material aspect is 3.98, and the language aspect is 3.83. All aspects of the material expert's judgment include in the very high category. So, the average assessment of physics e-books based on STEM-integrated Modeling Instruction based on results analysis of the expert is 3.92 of the three aspects of material assessment. This rating includes the very high category. While the results of the media expert's judgment of the audio-visual display aspect are 3.98, and the software engineering aspect is 3.96. All aspects of the media expert's assessment are in the very high category. So, the results analysis of the two aspects of media assessment obtained an average of 3.97. These gains belong to the very high categories. From the material aspects and media aspects, the physics e-book based on the android smartphone was suitable for use in physics learning and acceptable as one of the media to study physics independently (Bakri et al., 2021; Hediansah & Surjono, 2019; Kusumayuni & Agung, 2021).

The practicality of the physics e-book saw from the results of student response questionnaires distributed to 32 students of class X SMA Negeri 1 Aesesa. Assessment is done by filling out a questionnaire response by students. The results of the student response questionnaire on the Appearance aspect are 3.70, the Material Presentation aspect is 3.73, the Media Operation aspect is 3.75, and the Benefits aspect is 3.56. All aspects of the student response questionnaire include in the high category. That means the physics e-book is easy to understand and can be applied well to students. The physics e-book has developed an android .apk so students can use it anytime and anywhere. The results of this study agree with the research which stated that e-books are accessible anywhere and anytime. Students can download e-books and then access them offline on their android smartphones (Asrizal et al., 2020; Bakri et al., 2021; Suyatna et al., 2018).

In previous studies found that e-books have a positive impact on improving students' understanding (Komarudin et al., 2017; Kusumayuni & Agung, 2021; Tang, 2021). The results showed a significant difference with an alpha of 0.05 and an increase in the moderate category with an N-Gain of 0.32 at learning with STEM integrated Modeling Instruction (Purwaningsih et al., 2020). So, the STEM-integrated Modeling Instruction learning model is applicable in learning physics in schools. This study develops an e-book based on STEM integrated Modeling Instruction. The results of the feasibility assessment of the physics e-book show that the physics e-book is feasible to be used as a physics e-book teaching material in physics learning. This is because the physics e-book has met the eligibility criteria based on assessments by expert lecturers, physics teachers, peer reviewers, and practicality by students. These results are from the research which stated that a physics e-book based android is suitable for use in the learning process (Wardani & Mundilarto, 2021). Besides, an Android-based physics pocketbook is usable by students as an independent study material (Bakri et al., 2021; Bani & Masruddin, 2021).

A physics e-book based on STEM integrated Modeling Instruction contributes to the development of physics learning media. Physics e-books evolve through a collaboration between physics education and technology that hopefully increase student activities and supports physics learning activities at school. The improvement of physics e-books can support student learning activities, especially in circular motion material. This research only develops physics e-books on circular motion material, so hopefully, further researchers can evolve physics e-books based on STEM-integrated Modeling Instruction on other physics materials.

4. CONCLUSION

A physics e-book based on STEM-integrated Modeling Instruction has been developed to be used in the physics learning process. It was concluded that the development of this Physics e-book is valid and practical for

use in the classroom. However, the developed physics e-book contains only one material, namely circular motion material. It is hoped that the development of a physics e-book based on STEM Integrated Modeling Instruction will extend beyond more than just one material. So, this e-book can be implemented in classroom learning to learn more about the effectiveness and student response to the e-book. The results of this study are expected to help teachers design physics e-books and become the basis for further research for researchers.

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