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Development of 3D E-FIST as A Teaching Material for E-Learning on Temperature and Heat Materials

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Abstract

This study aims to describe the validity of E-FIST (Ebook Fisika STEM), namely the STEM physics ebook as e-learning teaching materials on temperature and heat material. The stages of development in this study were limited to the validity of the media, not up to practically and effectiveness trials in learning by students, this was due to the PSBB which was carried out in the prevention of the spread of Covid-19. The ebook was developed by integrating science, technology, engineering, and mathematics. This research was developed with the DDD-E model. The stages of the DDD-E model consist of the planning stage (decide), the design stage (design), the development stage (develop), and the assessment stage (evaluate). At the initial stage, namely planning, determining the learning objectives, material, knowledge analysis, and prerequisite skills was carried out so that a draft E-FIST was produced for further evaluation. The next stage is the development stage. After an assessment was carried out at the development stage, three expert lecturers were validated for E-FIST. The aspects that are validated are viewed from the aspects of learning, material, language, and media. The analytical method used is descriptive quantitative analysis. Based on the research results it can be concluded that E-FIST obtains a percentage of validity in terms of aspects of learning, material, language, media suitability with the principles of good learning media, media work processes, and media display respectively were categorized as very good, so that the E-FIST developed was declared very valid and suitable for use in learning. This research implies that it can provide further knowledge for educators regarding the use of ebook technology as the development of teaching materials. Also, further researchers, it can be carried out to test the effectiveness and practically to produce teaching materials that are suitable for use in supporting learning.

Keywords: E-FIST; Learning; STEM; Validity

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INTRODUCTION

Research on ebook development has been done a lot, but it is different from the development of E-FIST (Ebook Fisika STEM). As with previous research that named the development of his ebook, the author intends to introduce E-FIST which comes from an idea to make it easier to mention the ebook teaching materials that were developed (Kholiq, 2020). E-FIST is an acronym that comes from three words in

Indonesian, namely ebook, fisika, and STEM which are combined so that the ebook being developed is called E-FIST. E-FIST means an integrated STEM physics ebook. The developed E-FIST contains features by integrating the STEM (Science, Technology, Engineering, and Mathematics) approach to create active and cohesive learning because these four aspects are needed simultaneously in solving problems that occur in real life.

Books are a learning resource that plays an important role in supporting the learning process, including training students to be able to learn independently outside the teaching and learning process in class, as well as helping students to understand and master the material presented by educators (Rahmawati, 2015). With advances in technology. Nowadays books in digital form are known as ebooks. The ebook application can be downloaded for free and can be accessed anywhere and anytime and there are interesting features that make it easier for students to learn independently (Mentari, Sumpomo, & Ruyani, 2018). However, the facts that exist through previous research using a questionnaire to physics teachers explained that the current use of ebooks is still in PDF format in the form of text and images and does not integrate the integration of science, technology, engineering, and mathematics (Salamiyah, Zakiyatus, & Kholiq, 2020).

This research will develop an ebook in the form of a three-dimensional (3D) STEM physics ebook. The integration of science, technology, engineering, and mathematics in STEM learning is in line with the 2013 curriculum applied in Indonesia in supporting 21st-century skills including communication, collaboration, critical thinking, and creative skills (Cahyani, Mayasari, & Sasono, 2020).

Previous research that has been carried out in the development of ebooks was carried out with different objectives, including (1) developed an ebook on impulse and momentum integrated material for high-level thinking skills of students produced an ebook which suitable for use in learning (Ikhsan & Kholiq, 2019); (2) developed an ebook with a discussion model based an ebook that was suitable for use in learning (Indriani & Kholiq, 2019); (3) developed an ebook on global warming material produced an augmented reality-based ebook which is very suitable for use in learning to train students literacy skills (Kholiq, 2020); (4) developed an ebook on Ohm's Law material produced an ebook that is suitable for use in improving student's creative thinking skills (Salamiyah et al., 2020); (5) developed an ebook on dynamic fluid material containing scientific literacy produced an ebook that was suitable for use in learning (Khoiriah & Kholiq, 2020).

Based on this description, the development of the physics ebook that has been carried out previously has not integrated science, technology, engineering, and mathematics in learning (Agnezi, Khair, & Yolanda, 2019; Wijayanti, Fadiawati, & Tania, 2015). Therefore, a physics ebook will be developed which contains interesting and interactive features by integrating the integration of science, technology, engineering, and mathematics needed by students to support 21st-century skills.

One of the facilities and learning resources currently available that can support the use of ebooks is e-learning. E-learning can be done by utilizing technology, information, and communication (ICT) in delivering material, collecting assignments, and class discussions (Nurhayati, 2017). This is the course that can support the use of ebooks that utilize computer or laptop technology as a means of delivering material to students.

One of the materials in physics learning that can be applied in the ebook is temperature and heat material. This material is closely related to the application of the daily life of students (Lestari & Linuwih, 2012). It is hoped that the development of an ebook accompanied by moving animated images and videos can clarify the delivery of the material. The material that is emphasized is the concept of expansion in everyday life, the rate of heat transfer, Joule's experiment, and the Black's Law. The delivery of theory in the three-dimensional ebook with various interesting features that present audio-visual aspects such as video is expected to support learning to provide ease and interest in learning for students in remembering and studying the material presented.

The existence of policies related to the use of ICT for educators in the 2013 curriculum has provided opportunities for educators in developing teaching materials (Muzdalipah, Rustina, & Akbar, 2020). Teaching materials are needed to support the learning and literacy activities of students wherever they are. Several uses of teaching materials including clarifying the presentation of the material, overcoming the limitations of space and time, providing the same experience, stimulants and perceptions for every student (Kurniawati, 2015). According to Daryanto, & Dwicahyono (Setiawan & Basyari, 2017) the types of teaching materials include, (a) visual teaching materials (visual), (b) listening teaching materials (audio), (c) listening visual teaching materials (audiovisual), and (d) interactive multimedia teaching materials.

Ebooks include digital book technology teaching materials or electronic versions of books containing digital information in the form of text, images, audio, and video (Rules of Education and Culture Minister, 2016). The advantages of ebooks compared to printed designs are that they can be downloaded for free and then operated by students using a personal computer or laptop without being connected to the internet, ebooks can show real situations that are more convincing to students (Khoiriah & Kholiq, 2020). This allows students to access ebooks flexibly, regardless of place or limited learning time. The use of technology, information, and communication, for example, ebooks, is intended to increase the efficiency and effectiveness of learning (Alifya & Rahman, 2020).

Based on this description, the E-FIST 3D development was carried out as teaching material for e-learning on temperature and heat materials. This study aims to describe the validity of E-FIST to produce a viable and useful ebook in learning physics.

METHOD

This research is a type of development research using the DDD-E (Decide, Design, Develop, and Evaluate) model design. The stages of the DDD-E model according to Tegeh, Jampel, & Pudjawan (2014) consist of four stages, namely: (1) the planning stage (decide), (2) the design stage (design), (3) the development stage (develop), (4) the assessment stage (evaluate).

At the early stages (1) of E-FIST development, namely, the deciding stage, activities are carried out including the determination of learning objectives that will be achieved after setting goals for decision making related to the use of multimedia such as 3D page flip professional to support learning objectives. Then determine the prerequisite knowledge or skills needed by students in achieving learning goals use of a professional 3D page flip application.

At the second stage (2) of E-FIST development, namely the design stage, the researcher carried out several

activities including the preparation of the material content, designing the appearance of the ebook by selecting images, audio, videos, and animations that were following the learning objectives. Also, an overall content outline is made in the form of a cover page to the end of the ebook. In designing the appearance, the researchers pay attention to the appropriate colour font presentation so that later it can produce an attractive ebook appearance and following learning objectives.

In the third stage (3) of E-FIST development, namely the development stage, the researcher carried out activities including combining the results of the selection of all components of animation, images, graphics, audio, and videos. The use of animation and video can be innovated with existing animation or produce as needed. When the entire ebook content is ready, then validation is carried out on the ebook being developed.

In the last stage (4) of the E-FIST development, namely the evaluation stage, the researcher evaluates the development of the ebook as a whole so that it produces an ebook that is suitable for use. Evaluation in this research was carried out at every stage starting from the decide, design, and development stages. At the deciding stage, an assessment of the accuracy of the material and multimedia used is conducted. At the design stage, an assessment of the multimedia component and the overall outline of the ebook draft content is carried out. At the development stage, evaluate the multimedia elements that are combined. The evaluation results are in the form of an E-FIST validation assessment rubric by three expert lecturers who will later be used as a reference in improving the developed ebook. DDD-E research and development model is shown in Figure 1.

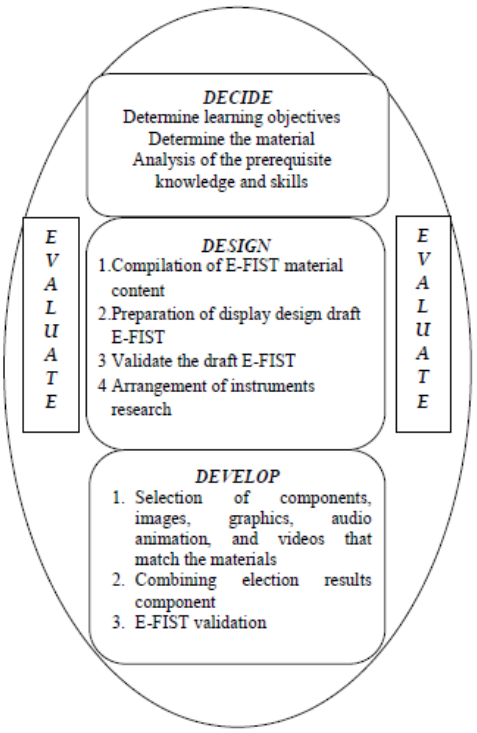

Figure 1 Stages of the DDD-E Development Model Research (Tegeh, Jampe, & Pudjawan, 2014)

The target of the resulting product is E-FIST teaching materials developed using the 3D Pageflip Professional application so that E-FIST products have a three-dimensional effect along with text, images, and learning videos that can be applied via computer, the program used is the 3D Pageflip Professional application which has a difference with other media, namely that it can be used to make PDF, Word, Powerpoint, and Excel files into flipbook form. This flipbook software is useful in creating an attractive magazine, catalogue, and ebook views in 3D by changing an exe file and then embedding it into an Html page, blog or web page (Rozy & Anggana, 2017). The development procedure performed in E-FIST development using the DDD-E model consists of four stages. The initial stage, namely the planning stage, determines the learning objectives, materials, knowledge analysis, and prerequisite

skills. Then the design stage was carried out so that a draft E-FIST was produced for further evaluation. The next stage is the development stage. After conducting an assessment at the development stage, an E-FIST product was produced for validation by two material expert lectures and one media expert lecturer. The aspects that are validated are viewed from the aspects of learning, theory, language, media suitability with good learning, work process, and media display.

The research instrument used was a validation assessment sheet based on the Likert scale score results in table 1. The percentage of each score indicates each criterion that can be used as a guide in analyzing the research results.

Table 1 Likert Scale Score

Percentage	Criteria
5	Very good
4	Good
3	Enough
2	Less
1	Very less

(Riduwan, 2015)

Based on the scores obtained, the validity percentage is added and calculated. Furthermore, the average value is then converted into a percentage using the formula:

$$P(\%) = \frac{the\ total\ score\ of\ the\ data\ collectors}{criteria\ score} \times 100\%$$

Information:

Criteria score = highest score x the number of aspects that were validated x number of respondents

(Riduwan, 2015)

Furthermore, the data from the questionnaire that has been processed are analyzed with the quantitative descriptive analysis techniques using the results of the Likert score interpretation in Table 2. Based on Table 2, it can be obtained the results of the feasibility of the ebook to be developed.

Table 2 Criteria for Validity Scores

Precentage	Information
0% - 20%	Very less
21% - 40%	Less
41% - 60%	Enough
61% - 80%	Good/Valid
81% - 100	Very Good/Very valid

(Riduwan, 2015)

The results of the feasibility test can be seen by assigning a value to the checklist sheet (√) in the column contained in the assessment sheet so that the interval for each aspect assessed can be found. The score ranges are as shown in table 2.

RESULT AND DISCUSSION

This research produces an E-FIST (Ebook Fisika STEM) product in the form of ebook teaching materials that can be used to support learning on temperature and heat materials. The results of the development of an interesting and interactive ebook will help students in understanding the concept of learning.

The cover page display design of the developed E-FIST can be shown in Figure 2. On the table of contents page, there is a subject matter that will be studied. The interesting thing about the table of contents is that the features are packaged in such a way that the table of contents icon can be clicked to go to the subject matter that the reader wants.

In Figure 3 it is shown that on each page there is a home icon button each page allowing readers to return to the table of contents page so that it can make it easier for students to open the page to be read. Besides, E-FIST also integrates literacy about science, technology, engineering, and mathematics to increase the literacy of students in understanding temperature and heat materials. The STEM (Science, Technology, Engineering, and Mathematics) display is packaged so attractively in Figure 3.

Figure 2 E-FIST Cover Page

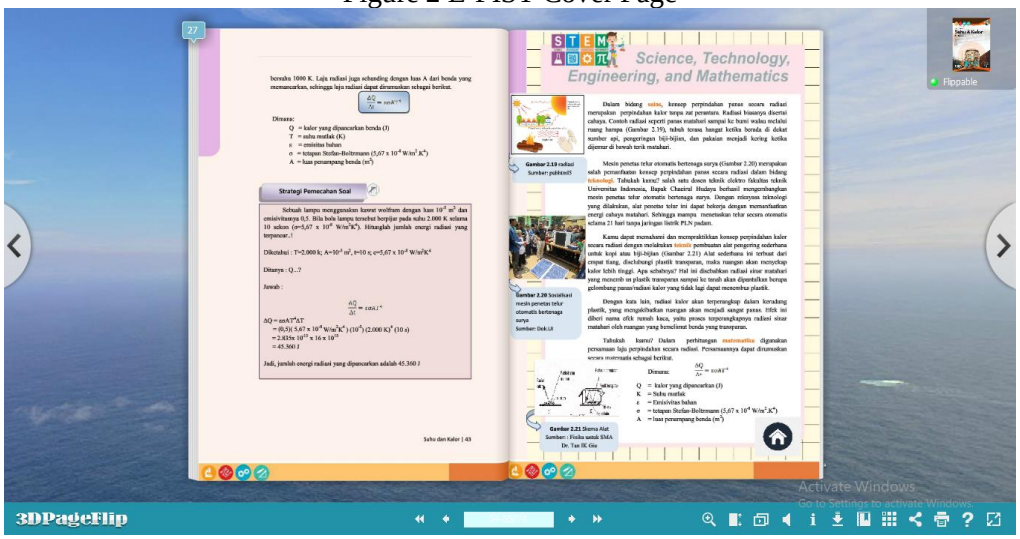

Figure 3 STEM Integrated Page

As stated in Permendikbud number 8 of 2016, the technical guidelines must contain the activities of students. Through these student activities, it is hoped that a learning process can be created that emphasizes the activeness of students physically and mentally, intellectually, and emotionally to obtain learning outcomes in the form of a combination of attitudes, knowledge, and skills (Rules of Education and Culture Minister, 2016). So that in this ebook there is also a practical animation that students can do to understand the concept of heat transfer shown in Figure 4. This animation can be executed by students by pressing the click button so that the concepts of heat transfer and temperature increase can be observed by students.

E-FIST uses a professional 3D page flip application in which can insert an animation that can be clicked to show a demonstration image. Educators can insert graphics and demonstrations of experiments that can be observed and carried out by students to build their knowledge in understanding the material presented.

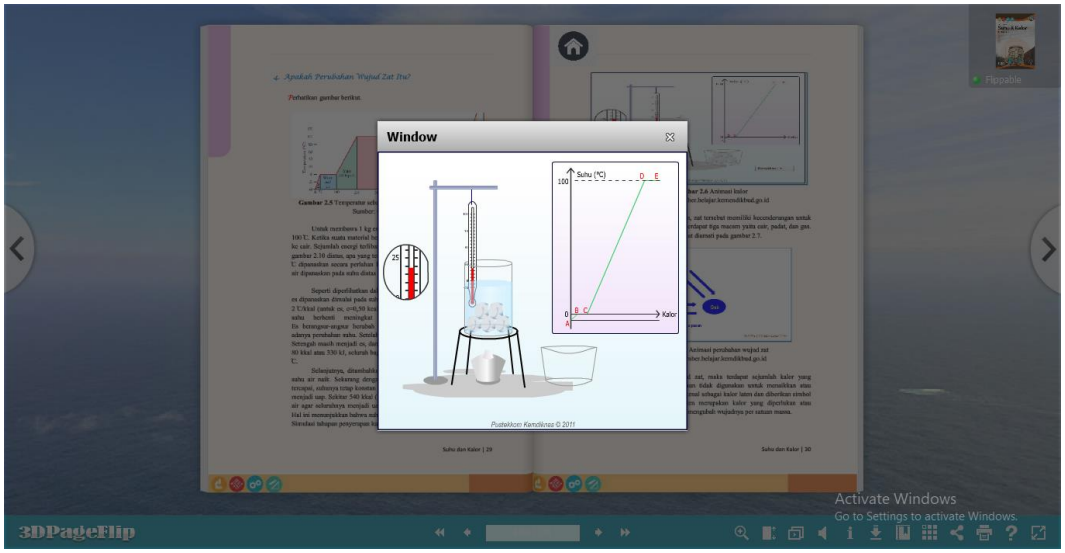

Figure 4 Heat Transfer Animation Page

Paul B. Diedrich (Sardiman, 2011) states that the activeness of students in learning, one of which aims to build student's knowledge. The activeness if students can be carried out with a variety of activities including viewing activities including reading, looking at demonstration images, experiments, and motor activities such as conducting experimental activities. The validity was carried out by three expert lecturers using a validation assessment sheet consisting of aspects of learning, material, media, language. The activity carried out before validation was to conduct a study and get some input in the form of an E-FIST design to make it more interesting and emphasize more on the STEM aspect. Animated images and videos are also added to make it more interesting. This is done so that students can be more motivated in learning physics, especially temperature and heat material.

At the time of the assessment by the validator, there were several suggestions and input. Some suggestions and input are used to improve the E-FIST that has been made to obtain an E-FIST that is valid and suitable for use in learning. The results of the validation by two material expert lecturers and one media expert lecturer. on each aspect are shown in Figure 5.

In the learning aspects, E-FIST obtained a validity percentage of 96% with the very good category. Learning aspects are reviewed based on the suitability of E-FIST with the 2013 curriculum learning criteria, scientific approach, and competencies to be achieved. E-FIST contains content in the form of a virtual laboratory and moving animation as a means used by students in conducting independent experiments. This was emphasized by relevant research that virtual laboratories can support practicum activities in laboratories that are interactive, dynamic, animative, and have a virtual environment so that students don't get bored and support learning activities (Jaya, 2012).

As previous research by Kusumawati, Wasis, Sanjaya, & Kholiq (2019), the use of ebooks that contain some interactive content can help and foster the attractiveness of students in learning. However, previous research has focused on improving scientific literacy skills on solar system material.

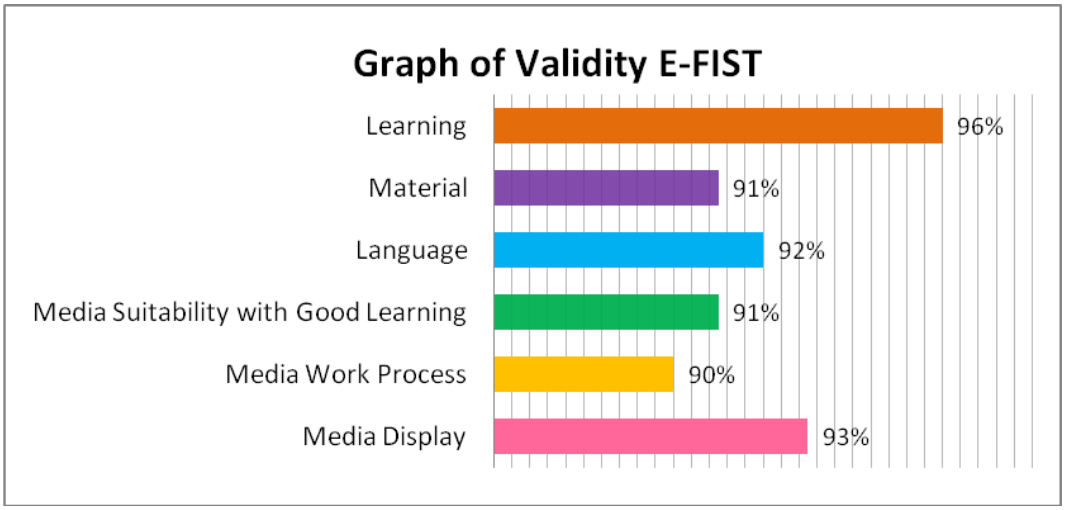

Figure 5 Graph of Validity E-FIST (Ebook Fisika STEM)

Besides, the E-FIST contains video content to further motivate students in learning. This is in line with previous research (Salamiyah et al., 2020). However, previous research was conducted to train creative thinking skills in solving daily problems.

In the material aspect, the percentage of E-FIST validity was 91% which was in the very good category. Some things that are reviewed from the material aspect are the formulation of the material in terms of importance, usefulness, ease of understanding the material, attractiveness. Also, it is seen from the suitability of the content of the material with learning indicators, the clutter and systematics of the material, the content, the use of concepts in everyday life, the suitability of the arrangement of letters, sentences, images, and equations used. In line with previous research (Almuharomah, Mayasari, & Kurniadi, 2019; Hartini, Mariani, Misbah, & F, 2019; Mahjatia, Susilowati, & Miriam, 2020; Septarini & Kholiq, 2021; Widayanti, Abdurrahman, & Suyatna, 2019), it can be said that the use of the material in ebooks influences in creating active, cohesive, and attractive learning for students in solving real problems through the STEM (Science, Technology, Engineering, and Mathematics) approach which includes aspects of science, technology, engineering, and mathematics due to ebook integrates these four aspects.

In the language aspect, E-FIST obtained a validity percentage of 92% in the very good category. Some things that are reviewed from the language aspect include the use of language following the rules of good language and the accuracy of sentence structures, the language use is effective and communicative, the consistency of the use of terms. As previous research (Kusumawati, Wasis, Sanjaya, & Kholiq, 2019), it can be said that the use of ebooks in learning has a high influence in changing the perspective of students in reading interactively, and making students comfortable because the ebook contains material with various features such as animation, audio, and video.

The validity of E-FIST in the aspect of suitability of media with learning obtained a validity percentage of 91% with a very good category. Assessment of the media aspect is viewed from several things including the suitability of the media with the principles of good learning media such as being easy to see, attractive, simple, beneficial to students, right on target, and coherently arranged. In line with previous research (Indriani & Kholiq, 2019) which obtained a very good category in the media aspect, but in

previous research is focused on practising critical thinking skills.

When viewed from the media work process, the validity percentage is 90% with the very good category. The assessment of the aspect of the media work process is viewed from several things including boot speed and page-turning, video playback, and is equipped with navigation buttons that make it easy to use E-FIST. This is in line with previous research (Ikhsan & Kholiq, 2019) that the development of ebooks obtained very good validity, but in previous studies, it was carried out to improve student's higher-order thinking skills.

Then in terms of the media display aspect, the validity percentage was 93% with the very good category. The assessment of the media display aspect is viewed from several things including harmonious layout font selection, background, colour, music, and information readability. After validation, there are several suggestions and input so that the instructions for using E-FIST are made as concise as possible so that they are easy to understand.

As previous research (M. Sari, 2018; Wardoyo, An'nur, & M Salam, 2017; Widodo, An'nur, & Mahardika, 2017), it can be said that the use of media display in ebooks affects stimulating the interest, feelings, and attention of students because it produces a good appearance in the presentation of text, images, and visually visible videos. More real and attractive to students because the ebook is displayed in three-dimensional form.

On the final page of E-FIST, there are ability test questions that can be used as training materials. The validity of the questions obtained a percentage of 96% in the material aspect, including the very good category. In the construction aspect, the ability to test questions obtained a validity of 86% including the very good category. Some of the things that are assessed include the material aspect, the suitability of the questions and indicators with the subject of temperature and heat, in terms of question sentence formulation, which demands decomposed answers, pictures, graphs are presented clearly and legibly. In terms of language, there is a communicative question formula, the use of question items according to the rules of Indonesian which is good and correct, and does not cause multiple interpretations. After an assessment of the validator, there are several suggestions and input, including questions made more communicative so that students can easily understand the meaning of the question submitted. Also, minor improvements to questions requiring description allow alternative answers.

The use of ebooks that are equipped with ability test questions can foster the potential for independence, reinforcing understanding, and knowledge of students (W. M. Sari, Riswanto, & Partono, 2019; Sulistyani, Jamzuri, & Rahardjo, 2013). As previous research (Khoiriah & Kholiq, 2020) which obtained a very good percentage of validity in the instrument validation of ability test questions, however, previous research was conducted to train scientific literacy skills in students.

The use of an ebook equipped with material that is integrated with STEM can improve understanding in learning because it can directly link the concept of learning with problems that occur in real life (Ristiani, Triwoelandari, & Yono, 2021). STEM can produce more meaningful learning and make students better able to solve real problems through systematic integration of knowledge, concepts, and skills (Dewati, Bhakti, & Astuti, 2019). So E-FIST which is integrated with STEM will be easier to assist teachers in increasing students' understanding of the material presented with more meaningful learning.

CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that E-FIST obtained a percentage of validity in terms of the aspects of language, material, media, learning, and evaluation questions including in a very good category so that the E-FIST developed is declared very valid and suitable for use in learning. This research implies that it can provide further knowledge for educators regarding the use of ebook technology as the development of teaching materials. Besides, for further researchers, it can be carried out to test the effectiveness and practically to produce teaching materials that are suitable for use in supporting learning.

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