PILLAR OF PHYSICS EDUCATION
Vol. 16 (4), 2023, page.339-347
ISSN (Print) : 2337-9618
ISSN (Online) : 2684-8880

DEVELOPMENT OF LEARNING MEDIA USING SCRATCH ON ELECTRICAL MEASURING INSTRUMENT MATERIAL TO IMPROVE STUDENT LEARNING OUTCOMES

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ABSTRACT

Physics learning media is very important to be used in learning to attract students' interest in teaching and learning activities. These learning media can be created using the help of 3D application Scratch. One of the materials that can be made using Scratch media is a voltmeter electric measuring instrument. Abstract physics material can be explained using the help of Scratch-assisted learning media. Therefore, a 3D application-assisted physics learning media was created on the topic of voltmeter electric measuring instruments to improve student learning outcomes. The purpose of this research is to develop Scratch-based physics learning media on the subject of voltmeter electric measuring instruments. In addition, this study also aims to determine the feasibility of Scratch-based physics learning media on the subject of voltmeter electric measuring instruments that have been made. The research was conducted with a 4D development model with stages in the form of define, planning stage, development stage, and dissemination stage. The analysis was performed using the SBi method by converting ordinal data to intervals using MSi analysis. The results showed that the learning media created was in the feasible category. Thus, learning media can be used in learning.

Keywords :*Electrical Measuring Instruments, Physics, Learning Media, Scratch, Voltmeter.*

I. INTRODUCTION

One branch of natural science that is close to our daily lives is physics. Physics is a branch of science where its application requires analytical power [1]. Physics has a crucial function in the development of science and technology [2]. However, there are still many students who obtain unsatisfactory physics scores [3]. This can be because physical matter is very difficult to understand.

Physical material is difficult to understand because it is abstract. Research [4, 5, 6, 7] revealed that students also disliked physics lessons. This is reinforced by research [8] which shows that physics subjects are considered difficult, disliked, and considered to have no benefit for conducting future studies. This can happen because the physics learning process that is carried out today is still stuck in a monotonous routine. The routine is created from the teacher who only provides formulas, sample questions, and exercises, so that students will quickly feel bored [9]. Therefore, it is necessary to create physics learning that is more fun and does not make students bored quickly.

Some learning media that have been created in physics subjects include using flipbooks. Some of them are about research conducted by Rahmawati, Wahyuni, and Yushardi [10] regarding the development of flipbook learning media. The development of flipbook learning media has several shortcomings. The disadvantage of flipbook learning media is that the learning media can only be used individually on each student's [11]. Therefore, it is necessary to create other alternatives in the use of technology in learning media to make it easier for students to understand physics material.

These problems can be overcome with the existence of suitable learning media and can provide understanding and overview of the physics material to be taught. Learning media is a tool used to explain concepts, demonstrate facts, and explain certain principles or procedures to make them appear more concrete [12]. The right learning media will support the teaching and learning process [13]. Learning media can help clarify students' understanding in understanding a material taught by the teacher.

Learning media can be created by utilizing digital technology. Digital technology can make learning more effective and efficient and cause its own attraction [14]. With the existence of digital learning media, it will increase students' interest in learning physics material.

One of the uses of technology can be made using the Scratch application. Scratch is a basic programming application used to create animations. The app was designed by the Kindergarden Lifelong Learning Group at MIT. Scratch can make abstract learning materials more interactive and fun [15]. With the menu inside the Scratch application, we can use to learn programming [16]. Scratch can be used to create instructional learning media. Suitable instructional learning media can stimulate student interest in learning [17]. Scratch-based learning media will attract students in teaching and learning activities.

Scratch media can be applied to power tool materials, for example on voltmeter materials. This is because the voltmeter material is still abstract and difficult to explain without the help of learning media. Scratch learning media will help clarify the material taught by the teacher. In addition, the media will attract students' interest in learning.

This research aims to develop Scratch-based physics learning media on the subject of voltmeter electric measuring instruments. In addition, this study also aims to determine the feasibility of Scratch-based physics learning media on the subject of voltmeter electric measuring instruments that have been made.

II. METHOD

The method used in this research is development research with a 4-D model from Thiagarajan [18]. The development of learning media consists of the defining stage (define), planning stage (design), development stage (develop), and dissemination stage (disseminate). The four stages of research are listed in the picture below.

Figure 1. Thiagarajan 4-D Development Model Modification

The first stage of this research begins with the defining stage. At this stage, an overview of the learning media to be applied will be compiled. This stage will also define, elaborate, and search for material in more depth. The results of this stage will then be compiled as material in making designs.

The second stage is carried out by designing Scratch-based learning media. At this stage, a learning media design will be created using the help of the Canva application. Then the resulting design will be applied and created in the Scratch application.

The third stage is carried out by developing learning media consisting of feasibility tests by several prospective physics teacher students. The feasibility of Scratch-based learning media is assessed by students in the field of Physics Education. The feasibility test of the application design has the following instrument grid.

Table 1. Learning Media Feasibility Test Instrument Grid

Number	Aspects	Question
1	Display	Completeness of identity
2		Suitability of layout proportions
3		Compatibility of color proportions
4		Suitability of background selection
5		Suitability of font selection
6		Button display consistency
7	Access	Accessibility
8		Creativity and innovation
9		Media development opportunities for the development of science and technology
10		Compatibility with physics concepts
11	Language	Language structure in easy to understand
12		Effective and unambiguous sentences
13		Language used communicatively

14	Spelling used according to EYD
15	The terms used have corresponding meanings

Data in this study were collected by questionnaire distribution method. The purpose of using questionnaires is to assess the learning media developed. Questionnaires are used to assess the appearance, access, and language of the learning media developed.

The questionnaire will then be analyzed and processed, so that conclusions can be drawn whether or not the learning media used is feasible. Questionnaire questionnaires are distributed using Likert scale. Likert scale is a psychometric scale using a combination of question items, so that it can form a value or score that is able to present an individual [19]. After obtaining the research data, the data was analyzed using SBi (Ideal Standard Deviation) analysis. Scores and assessment criteria based on due diligence according to Widoyoko [20] are determined in the following table.

Table 2. Score Level and Assessment Criteria

Number	Achievement	Criteria
1	$x > \overline{x}_t + 1{,}8$ SBi	Very Feasible
2	$\overline{x}_t + 0{,}6$ SBi $< x \leq \overline{x}_t + 1{,}8$ SBi	Feasible
3	$\overline{x}_t - 0{,}6$ SBi $< x \leq \overline{x}_t + 0{,}6$ SBi	Quite Feasible
4	$\overline{x}_t - 1{,}8$ SBi $< x \leq \overline{x}_t - 0{,}6$ SBi	Less Suitable
5	$x \leq \overline{x}_t - 1{,}8$ SBi	Very Unsuitable

The average score of the components can be calculated using the following formula:

$$\overline{x} = \frac{\sum x}{n} \tag{1}$$

Then the score can be converted in the following way.

Calculates the ideal average,

$$\overline{x}_t = \frac{1}{2}(\text{Ideal maximum score + ideal minimum score}) \tag{2}$$

With an ideal maximum score,

$$\text{Ideal maximum score} = \sum \text{item criteria} \times \text{maximum score} \tag{3}$$

Ideal minimum score,

$$\text{Ideal minimum score} = \sum \text{item criteria} \times \text{lowest score} \tag{4}$$

Determine the ideal standard deviation (SBi),

$$SBi = \frac{1}{6}(\text{Ideal maximum score} - \text{ ideal minimum score}) \tag{5}$$

Then the assessment result criteria can be determined based on table 2.

The fourth stage is disseminated. This stage is carried out by spreading the Scratch learning media that has been created. The goal is to increase the range of use of Scratch learning media with the subject of voltmeter measuring instruments and so that they can be used by the wider community. Dissemination will be carried out by uploading reports and results of Scratch media feasibility research into journals.

III. RESULTS AND DISCUSSION

The first stage is the defining stage. At this stage, identification of problems faced by students is carried out and formulation of solutions to existing problems is carried out. These problems include the absence of massive learning media on the material of voltmeter electric measuring instruments. To overcome the problems that arise, a solution is given in the form of developing Scratch-based learning media on the subject of voltmeter electric measuring instruments. After that, a specification of the purpose of making learning media is carried out. The goal is to develop Scratch as a learning medium on the subject of voltmeter electric measuring instruments and to find out the feasibility of learning media that have been made.

The design stage is carried out by making Scratch-based learning media designs. The features developed in this design are in the form of an initial display, home menu, materials, practice questions, and experiments. The results and designs that have been created using Scratch are shown in the following image.

Figure 2. Initial View of Learning Media

The design of the voltmeter electric measuring media has several features and buttons such as information buttons, music buttons, next buttons, back buttons, home buttons, finish buttons, and several other buttons. The button is located in several parts of the learning media. Some button placements as shown on the following home display.

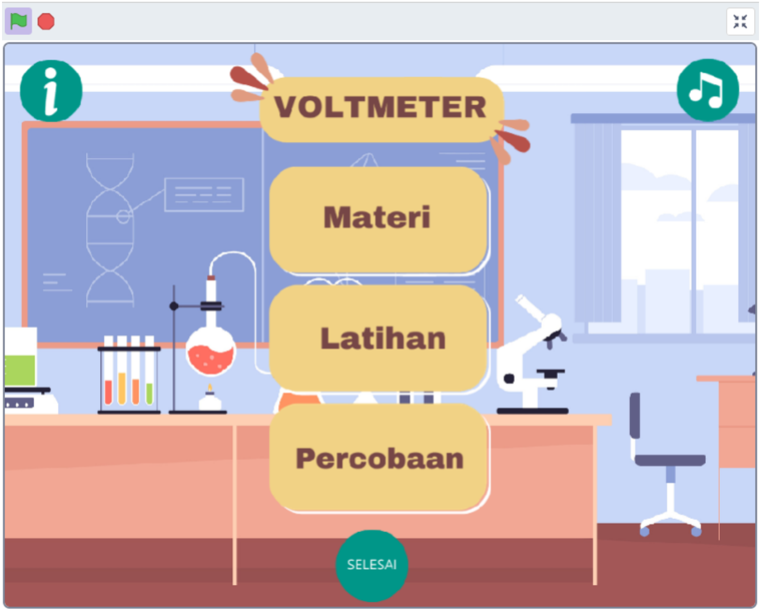

Figure 3. Learning Media Home Display

The material on the learning media of voltmeter electric measuring instruments is divided into nine sub-materials. In the material explained about the understanding of the voltmeter, the function of the voltmeter, the type of voltmeter, the working principle of the voltmeter, how to use the voltmeter, important formulas about the voltmeter, the resistance of the voltmeter, errors in using the voltmeter, and examples of problems related to the voltmeter. The sub-material explains in detail and in detail about the subject matter according to the topic of discussion. In the sub-material, images are also given to help users understand the material more clearly. The sub material section will be shown in the following image.

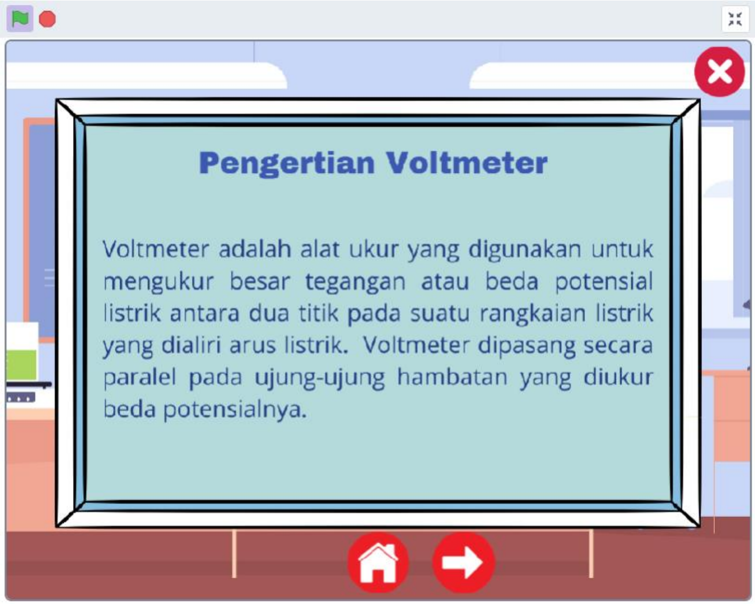

Figure 4. Material on Learning Media

In the practice section, the questions will help users to measure their level of understanding of the material of the voltmeter electric measuring instrument. In this section, there is an information board on how to do practice questions. In the practice question section, five practice questions will be presented consisting of five answer choices. Users can choose one of the answers that they feel is correct. After answering, they will get a response whether the answer they chose is wrong or correct. After the response comes out, the page will change to the next question and the score will increase if the answer clicked and selected is correct. However, if the answer choice clicked is not correct, then the score will be fixed. After all the questions are answered, the page will automatically change to the discussion of the questions. The goal is for users to understand and know why their answers are wrong. The practice questions are displayed as shown below.

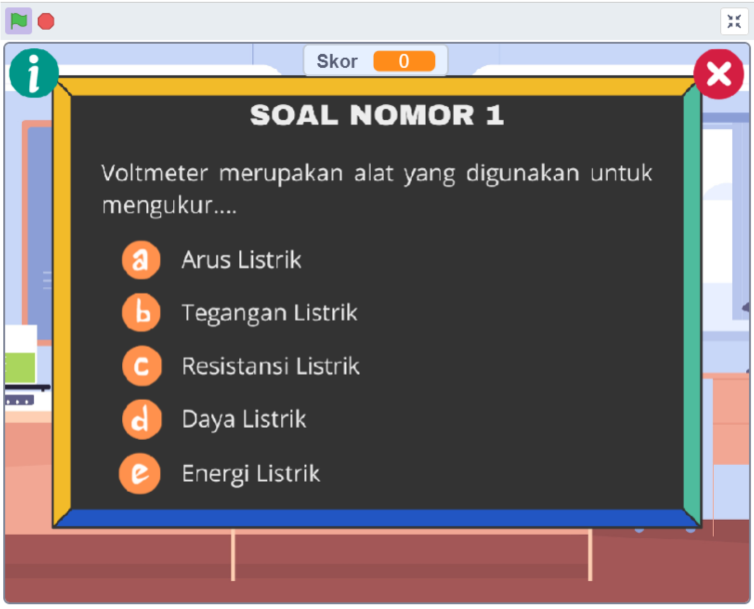

Figure 5. Practice Questions on Learning Media

In the experiment section, an experiment will be displayed on a voltmeter electric measuring instrument. In this section, users can press the information button to find out more details about the procedures for conducting voltmeter electric measuring instrument experiments. This section also provides a conversion formula regarding the measurement results that will be obtained later. In the experiment, two voltmeter measuring limits were given, namely 3 volts and 9 volts. Users can select one of the measuring limits by pressing the red button provided. This measurement is also given a measurement scale limit of 180 where users can freely change and change the measuring scale to be measured. When the measuring scale points to a number, the pointing needle will move according to the selected scale magnitude. At that time, the measured voltage value will come out when the user presses the red button on the maximum scale. The voltmeter experiment looks like in the following picture.

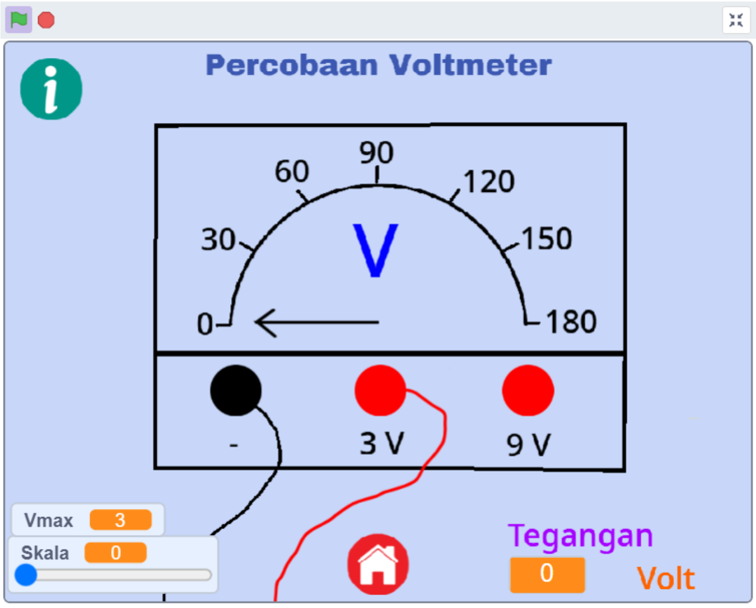

Figure 6. Experiments on Learning Media

After the design activities then proceed with the feasibility test of the learning media that has been made. The feasibility test assesses aspects of display, access, and language. Display feasibility consists of assessing the completeness of identity, suitability of layout proportions, suitability of color proportions, suitability of background selection, suitability of font selection, and suitability of button display. Feasibility of access consists of assessing ease of access, creativity and innovation, opportunities for media development for the development of science and technology, and conformity with physics concepts. Language feasibility consists of assessing language structure, effective and not ambiguous sentences, the language used is communicative, the spelling used is in accordance with the EYD, and the terms used have appropriate meanings. The assessment was conducted by three physics education students as candidates for a physics teacher. The assessment is carried out using a Likert scale with values of one to four. This assessment aims to find out the qualifications of the learning media Scratch has made. The results of the due diligence will then be analyzed with SBi (ideal standard standard) and will be matched with the following scores and eligibility criteria.

Table 3. Score Level and Eligibility Criteria

Number	Achievement	Criteria
1	$x > 36$	Very Feasible
2	$27 < x \leq 36$	Feasible
3	$18 < x \leq 27$	Quite Feasible
4	$9 < x \leq 18$	Less Suitable
5	$x \leq 9$	Very Unsuitable

The feasibility results of learning media can be interpreted according to the number of achievements obtained. If the learning media has a score of more than 36, it is declared very feasible to use. If the score obtained is between 27 to 36, then the learning media can be said to be suitable for use. If the score obtained is between 18 to 27, then the learning media can be said to be quite feasible to use. If the score obtained is between 9 to 18, then the learning media can be said to be less suitable for use. If the learning media has a score of less than 9, it is declared very unfit for use.

The following is a recapitulation of the feasibility test of the appearance, access, and language of the learning media that has been created. The results of the feasibility test of Scratch learning media on the topic of voltmeter electric measuring instruments after analysis using the MSI method are presented in the following diagram.

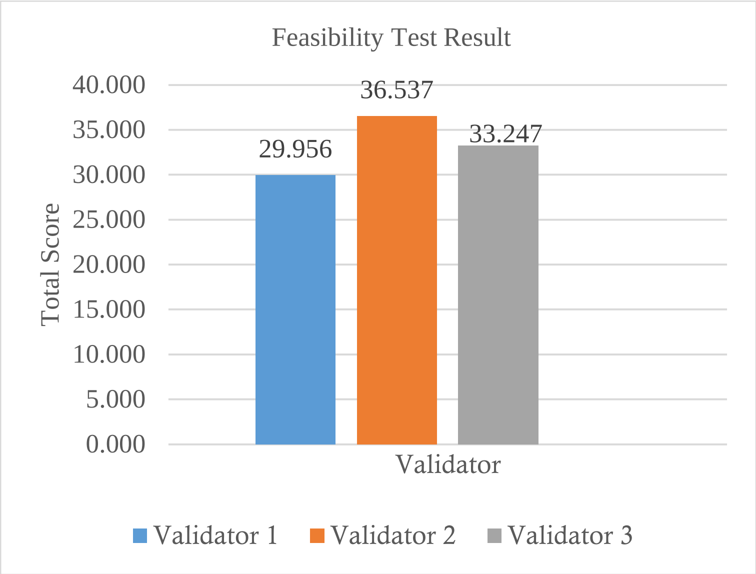

Figure 7. Learning Media Feasibility Test Results

Based on figure 7, it can be seen that the results of validator 1 due diligence get a score of 29,956 which, when matched in table 3, gets feasible criteria. This means that according to validator 1, the learning media that has been created is suitable for use and dissemination for learning. Validator 2 gives a feasibility score of 35,537 which means that the learning media is very feasible to be used and disseminated for learning purposes. Validator 3 gave a feasibility score of 33,247 which means that the learning media is suitable for use and distribution for learning purposes. With this feasibility test score, if averaged, a score of 33,247 will be obtained which means that learning media about voltmeter electric measuring instruments are suitable for use and distribution for learning.

The learning media has not reached a very feasible stage because there are still some parts that need to be revised again. There are several suggestions from experts for improving the learning media. Among these suggestions is the use of a more varied back sound on each slide by paying attention to the volume so that it is not too loud or slow. In addition, validators also provide suggestions to reduce subchapters in the material and replace the voice of the conversation with your own. With these suggestions, it is necessary to refine the learning media that has been made so that it can be used more optimally and function better.

The development of this learning media is in line with research conducted by Intana, Hardyanto, and Akhlis [15] regarding the development of Scratch-assisted physics learning media. This learning media has advantages compared to previous research where the learning media of this voltmeter electric measuring instrument combines material, exercises, and experiments, so that users can better understand the material by directly conducting experiments and answering practice questions to test their understanding. The features presented in the learning media are also complete and can add interest to learning voltmeter material. The learning media developed also has an attractive design and pleasing to the eye. With the addition of a back sound that is pleasant to hear, it can increase student enjoyment when using these learning media.

The development of Scratch-assisted learning media on voltmeter electric measuring instrument material has the opportunity to improve student learning outcomes. Indicators of improving student learning outcomes can be seen from the cognitive, affective, and psychomotor domains [21]. In the cognitive realm, students can obtain academic knowledge through material in learning media. In addition, students can also do practice questions in learning media to improve their learning outcomes. Through the delivery of information in learning media, students can improve their cognitive aspects. In the affective realm, students can increase self-confidence and also responsibility to learn the material in the learning media. Students will also be trained to be honest and never give up when doing practice questions in learning media. With that ability, students can improve their affective aspects. In addition, students can also improve psychomotor aspects through experimental features listed on learning media. Students can improve their ability to use experimental media voltmeter measuring instruments and are also able to analyze the right measurement results. With these learning media, students can improve their learning outcomes through the use of Scratch media.

The development of Scratch-based learning media requires support from all parties. There needs to be active participation and support from all elements of society in supporting the use and dissemination of learning media. Thus, the deployment process will be easier and the media can be used on a wide scale.

IV. CONCLUSION

Based on the research that has been done, it can be concluded that Scratch-based learning media can be done, applied, and developed on the subject of voltmeter electric measuring instruments. The results of the feasibility test conducted showed an average score of 33,247 which means that the learning media has a decent category. The learning media developed also needs to be improved again to make it better, so that it is expected to be used for the wider community.

ACKNOWLEDGMENT

The author's gratitude is conveyed to the Faculty of Mathematics and Natural Sciences, Yogyakarta State University who has provided support to the author and all parties involved and assisted the author in completing this research.

REFERENCES

[1] E. B. Harefa, “Efektivitas pembelajaran daring mata kuliah fisika di perguruan tinggi,” *EDUCATIVO: JURNAL PENDIDIKAN,* vol. 1, no. 1, pp. 75-83, 2022.

[2] E. M. Ramadani dan Nana, “Penerapan problem based learning berbantuan virtual lab phet pada pembelajaran fisika guna meningkatkan pemahaman konsep siswa SMA: literature review,” *Jurnal Pendidikan Fisika Tadulako Online (JPFT),* vol. 8, no. 1, pp. 87-92, 2020.

[3] A. Ramadhanti, Kholilah, R. Fitriani, E. F. S. Rini dan M. R. Pratiwi, “Hubungan motivasi terhadap hasil belajar fisika kelas X MIPA di SMAN 1 Kota Jambi,” *Journal Evaluation in Education (JEE),* vol. 3, no. 2, pp. 60-65, 2022.

[4] Mastuti, Nurlina, & Mutmainna, “Identifikasi kesulitan belajar peserta didik dalam pembelajaran fisika secara daring pada masa pandemi Covid-19,” *Jurnal Fisika dan Pembelajarannya (PHYDAGOGIC),* vol. 5, no. 1, pp. 32-40, 2022.

[5] Parlika, R., ‘Azizah, L., Nugroho, A. C., Prabawani, D. A., & Handono, S. F., “Game learning fisika "Asah Otak" berbasis android dengan APP inventor 2,” *E-jurnal: Spirit Pro Patria,* vol. *5, no.* 1, pp. 1-10, 2022.

[6] Mastuti, Nurlina, & Mutmainna, “Identifikasi kesulitan belajar peserta didik dalam pembelajaran fisika secara daring pada masa pandemi Covid-19,” *Jurnal Fisika dan Pembelajarannya (PHYDAGOGIC),* vol. *5, no. 1*, pp. 32-40, 2022.

[7] Parlika, R., ‘Azizah, L., Nugroho, A. C., Prabawani, D. A., & Handono, S. F. (2019). Game learning fisika "Asah Otak" berbasis android dengan APP inventor 2. *E-jurnal: Spirit Pro Patria*, *5*(1), 1-10.

[8] F. S. Hia dan S. A. Sulandari, “Persepsi siswa SMA se Kabupaten Nias Barat terhadap fisika,” dalam *Prosiding Pertemuan Ilmiah XXX HFI Jateng & DIY*, Salatiga, 2016.

[9] L. P. Arfiansyah, I. Akhlis dan Susilo, “Pengembangan media pembelajaran berbasis scratch pada pokok bahasan alat optik,” *Unnes Physics Education Journal,* vol. 8, no. 1, pp. 66-74, 2019.

[10] D. Rahmawati, S. Wahyuni dan Yushardi, “Pengembangan media pembelajaran flipbook pada materi gerak benda di SMP,” *Jurnal Pembelajaran Fisika,* vol. 6, no. 4, pp. 326-332, 2017.

[11] E. Prisila, N. Riska dan A. Kandriasari, “Pengembangan media pembelajaran flipbook digital panduan praktikum sequence of service pada mata kuliah tata hidang,” *Risenologi,* vol. 6, no. 2, pp. 9-16, 2021.

[12] F. Firmadani, “Media pembelajaran berbasis teknologi sebagai inovasi pembelajaran era revolusi industri 4.0,” dalam *Prosiding Konferensi Pendidikan Nasional “Strategi dan Implementasi Pendidikan Karakter pada Era Revolusi Industri 4.0”*, 2020.

[13] H. Suhardi dan T. J. Hartanto, “Penerapan model pembelajaran langsung dengan bantuan media simulasi PHET pada mata pelajaran IPA materi listrik dinamis,” *Bahana Pendidikan: Jurnal Pendidikan Sains,* vol. 1, no. 2, pp. 39-45, 2019.

[14] E. Z. Wityastuti, S. Masrofah, T. A. F. Haqqi dan U. H. Salsabila, “Implementasi penggunaan media pembelajaran digital di masa pandemi COVID-19,” *Jurnal Penelitian Inovatif (JUPIN),* vol. 2, no. 1, pp. 39-46, 2022.

[15] N. M. Intana, W. Hardyanto dan I. Akhlis, “Pengembangan multimedia pembelajaran fisika berbasis scratch pada pokok bahasan Hukum Oersted,” *Unnes Physics Education Journa,* vol. 7, no. 2, pp. 1-8, 2018.

[16] W. Hardyanto, S. Wahyuni, I. Akhlis dan S. Sugiyanto, "Scratch sebagai solusi simulasi praktikum digital di masa pandemi," *Journal of Community Empowerment,* vol. 2, no. 1, pp. 07-11, 2022.

[17] B. Hardiansyah, A. P. Armin dan A. A. Rahmadi, "Implementasi aplikasi game menggunakan Scratch dalam meningkatkan hasil belajar dan motivasi belajar siswa," *J-Abdi: Jurnal Pengabdian Kepada Masyarakat,* vol. 3, no. 4, pp. 707-716, 2023.

[18] Thiagarajan, S., & dkk., "*Intructional development for training teachers of exceptional children: A sourcebook,"* Minnesota: Central for Innovation on Teaching the Handicaped, 1974.

[19] R. A. Setyawan dan W. F. Atapukan, "Pengukuran usability website e-commerce sambal nyoss menggunakan metode skala likert," *COMPILER*, vol. 7, no. 1, pp. 54-61, 2018.

[20] Widoyoko, E. P., " *Evaluasi program pembelajaran,"* Yogyakarta: Pustaka Pelajar, 2017.

[21] H. Fauhah, "Analisis model pembelajaran make A match terhadap hasil belajar siswa," *Jurnal Pendidikan Administrasi Perkantoran,* vol. 9, no. 2, pp. 321-334, 2021.