Volume 5 Number 2 (2023)
May-August 2023
Page: 1015-1035

E-ISSN: 2656-4491
P-ISSN: 2656-4548
DOI: 10.37680/scaffolding.v5i2.3151

SCAFFOLDING
Jurnal Pendidikan Islam dan Multikulturalisme

E-MODULE BASED ON AUGMENTED REALITY MEDIA ON MAGNETIC MATERIALS

Siti Khodijah Afsas
Universitas Negeri Semarang; Indonesia
Correspondence email; sitikhodijah06@students.unnes.ac.id

Submitted: 18/02/2023 Revised: 20/04/2023 Accepted:26/06/2023 Published:22/08/2023

Abstract

This study aims to develop e-modules based on Augmented Reality media and determine their effectiveness. The research method used is Research and Development (R&D) with the ADDIE development model (Analyze, Design, Develop, Implement, and Evaluate). Data collection techniques with documentation, interview, questionnaire, and test methods. The population for this study comprised students from SMPN 40 Semarang, totaling 62 students. The sample size consisted of 31 students. Using a random sampling technique. The data analysis technique used is the t-test to assess the effectiveness of the developed e-module. Data collection instruments through expert validation sheets and student readability test sheets. The validation results of material experts amounted to 93.70%, media experts amounted to 92.01% with very valid criteria, and supported by student readability tests of 83.76% with excellent criteria. The results of Augmented Reality-based E-module research have characteristics, namely digital form utilizing Augmented Reality applications, 3D image display is interactive and contains magnetic material sub-material magnetic material. The results of the effectiveness test with a pre-test completeness percentage of 64,5% and 90,3% proved that there was an increase so that Augmented Reality-based e-modules can be used as teaching materials in science learning on magnetic material sub materials.

Keywords Augmented Reality, E-module, Magnetism, SMPN 40 Semarang

INTRODUCTION

The development of education in Indonesia always goes along with the times that affect the environment, such as school children and educators. Indonesia is still using the 2013 curriculum to improve the Education Unit Level Curriculum (KTSP), where the curriculum must be sensitive to the development of knowledge, culture, technology, and art to develop students' curiosity and abilities. The 2013 curriculum has very good results in the application of learning considering the development of science and technology (IPTEK).

The development of science and technology facilitates the learning process, such as in science subjects. Learning activities can run effectively and efficiently if the learning process is supported by the presence of components (Rahayu & Sudarmin, 2015). The main components in the learning process are students, educators, learning media, lesson plans, and teaching materials (Sumatri, 2016). Components in the learning process are very influential in the education that takes place. One of the main components of learning is teaching materials or learning resources. Learning resources are one of the important components of improving the quality of learning (Samsinar, 2020). Teaching materials have the aim to facilitate students in achieving learning objectives. One type of teaching material that can be used is the learning module (Abdulrahaman et al., 2020a).

Learning modules are teaching materials that are arranged systematically and interestingly in order to increase literacy and motivation to learn students (Hutama, 2016). Learning modules contain materials, worksheets, evaluations, and learning activities so that learning modules can function as reference materials. The types of learning modules are divided into two, namely print modules and digital modules (E-Modules). E-module is a development of printed modules, designed and developed along with the times following the progress of science and technology. E-module is a teaching material media used by teachers in learning. E-modules in the form of electronic versions can be accessed through electronic devices such as mobile phones, laptops, computers, and tablets (Ningrum et al., 2022).

Based on interviews with Integrated Science learning outcomes, only 20% of students meet the KKM (Suhardiman et al., 2022). Students still do not understand the concept of Integrated Science, especially physics material about magnetism. Physics is an important science in life (Soraya, 2021). This is because in the learning process, educators do not utilize innovative learning models, learning media that are less than optimal, and learning resources are used little (Sudirama et al., 2021). One important component in the learning process is learning resources or teaching materials

that will be delivered by the teacher and will be reviewed again by students. The development of science and technology allows teaching materials or modules in the form of electronics, commonly called electronic modules (e-modules).

E-modules have advantages when developed, in which there are materials accompanied by interactive media such as images, animations, audio, or video that can be played repeatedly by students (Nisa et al., 2020). E-modules in which there are 2D images that can help students understand the material. Not all students can visualize 2D images into 3D image shadows because the shape of the image is abstract. Therefore, the required electronic teaching materials can visualize 3D images. The use of technology in learning plays an important role in solving problems (Abdulrahaman et al., 2020b).

One of the technologies used in developing applications based on learning media can be downloaded so that they can easily become learning resources for students. This is in line with the research of (Munandar & Ahmad, 2022), which developed an e-module based on the Nearpod application to increase student understanding. The development of technology-based learning media can be carried out through training on the creation of google sites as website-based learning media for teachers (Susanti et al., 2023). Technology-based learning media can be accessed by students anytime and anywhere so that learning is not limited because it cannot only be accessed at school. This is in line with (Sa'diah et al., 2022), where the development of technology-based teaching materials such as e-modules can be stored in the form of flipbooks and can be accessed through a website where links are shared with teachers. The display of interactive e-modules can help the learning process students to understand the material conveyed by the teacher, especially material that cannot be seen with the naked eye. This is in line with the research of (Saprudin et al., 2022) that the development of interactive e-modules can increase mastery of concepts, independent learning, and student learning outcomes (Linda et al., 2021).

Classes IX A and IX B at SMPN 40 Semarang are facing serious challenges in Science (IPA) learning, reflecting academic concerns. Findings from interviews revealed that only 20% of students have successfully met the Minimum Passing Criteria (KKM) in Integrated Science learning (Suhardiman et al., 2022). This issue is primarily manifested in the understanding of scientific concepts, particularly in physics material related to magnetism. Contributing factors include less innovative teaching approaches and suboptimal instructional media, which consequently impact students' comprehension of scientific concepts (Sudirama et al., 2021). The negative impact of these

challenges is highly significant. It not only undermines students' interest in cience learning but also potentially hampers their overall academic achievements. Consequently, this has prompted the researcher to address these concerns through the development of e-modules. This innovative approach captures attention due to its potential to enrich students' learning experiences through interactive and visual methods. E-modules allow the integration of theory and practice, thereby enhancing students' understanding and motivation (Nisa et al., 2020). With this foundation, the implementation of e-modules at SMPN 40 Semarang is supported by robust academic rationale, as it offers a solution to the current learning challenges.

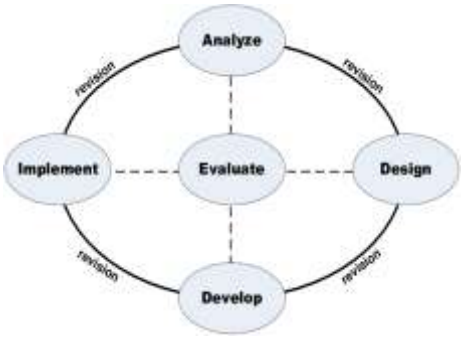
The ongoing development of learning modules at SMPN 40 Semarang needs further improvement. While the content is systematically organized, the lack of interactive and visual instructional media limits students' understanding of scientific concepts. Thus, a new approach that aligns with technological advancements and students' learning needs is required. E-modules emerge as an appealing solution by integrating technology into learning, making students' engagement more captivating and effective (Abdulrahaman et al., 2020b). By incorporating interactive elements like images, animations, audio, and video, e-modules assist students in better comprehending abstract concepts (Ningrum et al., 2022). Therefore, the introduction of e-modules at SMPN 40 Semarang promises diverse and profound learning experiences with the potential to enhance students' learning outcomes in Science subjects.

One of the interactive e-module displays can develop from 2D to 3D with the help of Augmented Reality applications. Augmented reality is one of the media that combines virtual media and real media (Harahap et al., 2020). The results of (Hurrahman et al., 2022) stated that Augmented Reality applications could be used easily, look attractive, help visualize material, and provide a sense of not boring to users. In addition, the results of research by Rahmawati et al. show that learning media based on Augmented Reality technology can increase spatial-visual intelligence, can increase student collaboration and engagement, can improve learning outcomes, and can motivate student learning (Muhammad et al., 2021). Based on the description above, this research innovates to develop an Augmented Reality-based e-module in which there is a menu to scan 2D images on the printed module so that 3D images appear in Augmented Reality applications. In addition, in the application, there are material contents and evaluations that can be used as teaching materials.

METHOD

Research and development methods with the ADDIE development model [Analyze, Design, Development, Implementation, Evaluate] (Herlambang et al., 2018). The stages of the ADDIE development model are as follows:

Figure 1. ADDIE Development Procedure



Source: https://www.researchgate.net/

The first stage is the analysis which aims to find out the needs needed by teachers in learning. The second stage is the design which aims to create Augmented Reality-based E-module products and compile expert validation sheets and student readability questionnaire sheets. The third stage, namely product development, aims to determine whether or not Augmented Reality-based E-Module products are applied in learning. After the product is declared valid by experts, the product is tested by a sample of students and given a readability questionnaire which aims to determine the readability of the developed E-Module. The fourth stage is product implementation which aims to determine the effectiveness of the product using the pre-test and post-test by students. The fifth stage is product evaluation which aims to evaluate every product preparation process starting from the first stage to the fifth stage. The final result at this stage is a product that will be applied to students.

The research location was conducted at SMPN 40 Semarang. The subjects of research and development consisted of expert validators and students. The population of this study comprised 62 students from classes IX A and IX B. The sampling technique employed was purposive sampling, where a sample of 31 students was selected from class IX B. This technique was chosen based on specific criteria that aligned with the research objectives, ensuring a representative and relevant sample for the study. Using a random sampling technique. The data collection method used at the analysis stage is the interview method. At the development stage is the questionnaire method by

expert validators and a sample of students, as well at the implementation stage is the test method using pre-test and post-test. The research instrument used consists of a validation questionnaire sheet for experts conducted before trials to students, product readability questionnaires by students after the product is declared valid, and a pre-test and post-test question sheet by students at the implementation stage to measure the effectiveness of the product being developed. The scoring technique uses the Likert Scale (1-4). The data analysis technique employed in this study is the t-test, which aims to assess the effectiveness of the developed e-module. This approach will provide a more appropriate and focused analysis, ensuring accurate insights into the impact of the e-module on the learning outcomes.

The formula for conducting a T-Test for Two Independent Samples is as follows:

$$t = \frac{\underline{x}\,1 - \underline{x}\,2}{\sqrt{\frac{s^2 1}{n1} + \frac{s^2 2}{n2}}}$$

Where:

- t = t-test statistic
- $\underline{x}$ 1= mean of sample 1
- $\underline{x}$ 2 = mean of sample 2
- s1 = standard deviation of sample 1
- s2= standard deviation of sample 2
- n1= number of observations in sample 1
- n2 = number of observations in sample 2

This test is used to determine if there is a statistically significant difference between the means of two independent groups. The calculated t-test statistic is then compared to a critical value from the t-distribution to assess whether the difference between the two means is significant or occurred by chance.

Data analysis to determine validity based on expert judgment and product legibility based on students' assessment before implementation by calculating the average score given by the validator and students using the following formula:

$$P = \frac{f}{N} \; x \; 100\%$$

Product readability criteria by learners can be considered in Table 1. Product readability criteria (Arikunto, 2021) are as follows.

Table 1. Product Readability Criteria

Percentage	Criterion
81.25% Score 100%<≤	Excellent
62.50% Score 81.24%<≤	Good
43.75% Score 62.49%<≤	Good enough
25.00% Score 42.4%<≤	Bad

Based on Table 1, the product can be declared good if the percentage obtained is > 62.50%. The validation assessment criteria can be considered in Table 2. The Validation Assessment Criteria (Arikunto, 2021) are as follows.

Table 2. Validation Assessment Criteria

Percentage	Criterion
81.85% Score 100%<≤	Highly Valid
62.50% Score 81.24%<≤	Valid
43.75% Score 62.49%<≤	Quite Valid
25.00% Score 42.4%<≤	Invalid

Based on Table 2. The product is declared valid if the percentage obtained is> 62.50%.

Analysis of the data used to measure the effectiveness of the product, at the data from the pre-test and post-test result, the formula is as follows

$$P = \frac{number\ of\ students\ who\ scored \geq 70}{total\ number\ of\ students} \; x \; 100$$

Where,

P = percentage of completeness (Arif et al., 2022).

Data

- Population: Students from SMPN 40 Semarang (62 students)
- Sample Size: 31 students
- Pre-test Completeness Percentage: 64.5%
- Post-test Completeness Percentage: 90.3%

- Expert Validation Results - Material Experts: 93.70%
- Expert Validation Results - Media Experts: 92.01%
- Student Readability Test Results: 83.76%

Primary Data Sources

- Documentation

Presumably collected through records of the research process, development stages, and outcomes.

- Expert Validation Sheets

Likely involved experts in material and media who reviewed and validated the developed e-module.

FINDINGS AND DISCUSSION

Findings

E-module preparation media-based *Augmented Reality* on the material magnetism through a number of stage method research and development carried out, among others, as follows:

1. Stage Analysis

   Stage analysis was done to get a description of conditions at school through analysis need learning. Based on the results, Observations made at SMP Negeri 40 Semarang show that the teaching materials used are Already fine but need done innovation. The teaching materials used by the teacher are relatively the same using book print or based technology such as e-modules. Where the appearance of teaching materials are used containing explanation material and evaluation causes participants to educate not enough to understand the submitted material. Master already does innovation by adding a picture as illustrations on teaching materials, but for material that is not can see in a manner visible to eyes and not can demonstrate or practiced in class, participant educate Still have difficulty understanding the material. Less effective teaching materials used by teachers to convey material can impact on lack of understanding of received material participants educate so, after analysis need related teaching materials found that the problem of understanding the material obtained by participants educate Still low. Analysis learning is done with observation in a manner direct eye teacher lessons at school-related activity learning, teaching materials used in learning, and understanding participant educate to submitted material moment learning going on.

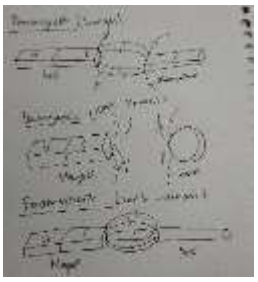
2. Design Stage

Stage design did for planning the developed product after analysis. The resulting product is in the form of e-modules based on augmented reality media. Cover design a number of planning e-module development, namely (1) selection competence basis, (2) determine achievement indicators competencies based on competencies basis, (3) drafting material, scanned 3D image barcodes, and the evaluation will be used based on indicator achievement competency, can be seen in the following figure 2 below.

Figure 2. Material Preparation, Image Scan Information, and Evaluation Preparation.

Further product design development (4) preparation of 2D images into 3D can be seen in the following figure 3 below.

Figure 3. Design 2D Images Into 3D



Further product design development (5) unify materials, pictures, and cameras for barcode scans, evaluation, and results evaluation of the e-module in the form application. In addition, researchers compile sheet validation expert, sheets questionnaire legibility participant students, and pre-test post-test questions. Appearance begins when you access the link seen in Figure 4 below.

Figure 4. Display Beginning from HP

Based on the appearance starting in Figure 4, E-module based *Augmented Reality* developed on the material the magnetism inside consists of one sub-material that is a magnetic material. Plus, it contains instruction use of e-modules, materials, 2D images, cameras to scan image barcodes into 3D, and equipped evaluation.

3. Stage Development

Stage development form activity validation or assessment product developed. Evaluation validation product based on expert judgment. There are three experts as the inner validator. In this assessment, there were science teachers at SMP Negeri 5 Kroya, SMP Negeri 1 Babakan, and Sultan Agung Islamic Middle School 3 Kalinyamatan. This E-module assessment includes evaluation from media experts and expert material so that the E-module is developed and can be valid for application in learning. Input is given can make reference for revised product. Revision of product done based on the suggestions given. The revision process is done over and over again so that we obtain valid products.

Other data used To ensure the utilization of this E-module is readability data Participants educate the eyes Integrated Science lesson on Magnetism Material class IXA SMP Negeri 40 Semarang as supporting data in determination validation product. At this development stage, students can download the e-module application developed via the following link https://drive.google.com/file/d/164KhNRNJZZDKumYrRoiihPEYeL3S7xTj/view?usp=drivesdk

The final result stage of development is A product to be implemented to measure the effectiveness product developed. Validation results expert material can see in Table 3 as follows.

Table 3. Percentage of Validation Results by Material Experts

No.	Aspect evaluation	Achievement (%)	Criteria
1.	Appropriateness content	91.67	Very valid
2.	language	95.00	Very valid
3.	Presentation	94.44	Very valid
	Average	**93.70**	**Very valid**

Based on results validation by experts, the material in Table 3 shows that E-module-based *Augmented Reality* belongs in the criterion is very valid and can utilize as science teaching materials on material magnetism with a percentage average of 93.70%. In addition, the developed E-module also carried out an evaluation based on aspect media assessment can see in Table 4 as follows.

Table 4. Percentage of Validation Results by Media Experts

No	Aspect evaluation	Achievement (%)	Criteria
1.	Presentation	95.83	Very valid
2.	Design	92.71	Very valid
3.	convenience use	87.50	Very valid
	Average	**92.01**	**Very valid**

Based on the results validation, media experts in Table 4 shows that E-module-based

Augmented Reality belongs in the criterion is very valid and can utilize as digital science teaching materials on material magnetism with an average percentage of 92.01%.

Assessment results validation products also pay attention to results evaluation legibility participant educate after using the E-module based on Augmented Reality. According to Arikunto (2021), If the results evaluate the legibility of participant educate Good, then the developed e-module is valid for utilization as teaching materials. The results of the assessment of the readability test participant educated about the product can see in Table 5 below.

No	Aspects assessed	Achievement (%)	Criteria
1.	module teaching materials AR-based looks new	84,48	Very good
2.	The form of writing on the e-module is easy AR-based read	86,29	Very good
3.	Size letters on the e-module AR base can be seen with clear	81.45	Very good
4.	Illustrations or pictures on the e-module visible AR based interesting	87,10	Very good
5.	Place the image on the e-module AR based already in accordance	82,26	Very good

6.	Language in the e-module is easy understood	AR based 82,26	Very good
7.	E-module AR based not boring	81.45	Very good
	Average	**83,76**	**Very good**

Based on Table 5, the results of the readability test products by participants educate showing that participant educate gave responses with very good criteria to the product with acquisition achievement of 83.76%.

4. Stage Implementation

At stage implementation, the product developed has already been declared valid and can implement to participant educate class IXA and IXB SMP Negeri 40 Semarang to measure the effectiveness of product use *pre-test post-test* through learning using e-modules that have been declared valid by experts and legible very good product based on questionnaire legibility participant educate.

Effectiveness results can be seen from the different results of the *pre-test* and *post-test* performed were performed for see the percentage of decision-learning outcomes before and after applying the product developed. Presentation results completeness participants educate after the pre-test of 64.5% and the percentage results completeness participant educate after the post-test of 90.3%.

5. Stage Evaluation

During the evaluation stage, the process serves to identify and rectify any imperfections and weaknesses in the product that arose during the developmental phases prior to its widespread implementation. The evaluation stage of this product's development encompasses analysis through to implementation. This comprehensive approach is essential to assess the product's feasibility, detect any shortcomings, and rectify errors that emerge throughout the development process.

In relation to the evaluation stage, it is imperative to incorporate the values obtained from both the pre-test and post-test results of all students. These values provide crucial insights into the product's impact on students' learning outcomes. This stage enables a thorough examination of the effectiveness and improvement achieved due to the product's implementation.

T-test was employed to determine whether there were statistically significant differences in the learning outcomes before and after the implementation of the e-module to assess the effectiveness of the developed e-module. This t-test would help determine which hypotheses were accepted and rejected based on the data provided.

Hypotheses

1. Null Hypothesis (H0)

There is no significant difference in learning outcomes before and after using the Augmented Reality-based e-module for the topic of magnetism.

2. Alternative Hypothesis (Ha)

There is a significant difference in learning outcomes before and after using the Augmented Reality-based e-module for the topic of magnetism.

Data Collection

The pre-test and post-test scores of students from classes IXA and IXB at SMP Negeri 40 Semarang were collected. The pre-test was administered before the implementation of the e-module, while the post-test was conducted after students had interacted with the e-module.

The collected pre-test and post-test scores were analyzed using a paired-sample t-test. The t-test would calculate the t-value, which would be used to determine whether the differences in the mean scores of the pre-test and post-test were statistically significant. If the t-value obtained was greater than the critical t-value (at a certain level of significance, such as 0.05), the null hypothesis would be rejected in favor of the alternative hypothesis.

Interpretation:

- If the null hypothesis (H0) is rejected, it would indicate that there is a significant difference in learning outcomes before and after using the e-module. This would suggest that the e-module has an impact on improving students' understanding of the magnetism topic.
- If the null hypothesis (H0) is not rejected, it would imply that there is no significant difference in learning outcomes, and the e-module may not have a significant effect on students' understanding.

The t-test results would provide valuable insights into the effectiveness of the developed e-module and whether it can be considered an effective tool for enhancing students' learning outcomes in the context of the magnetism topic.

Discussion

Compiled digital teaching materials as electronic teaching materials can be used in activity learning at school or outside school Because they are practical and usable open through *cellphones*. This developed electronic module only can be installed on *handphone/android* because in the manufacturing process product is already set only can install on Android with the format (.apk). Apart from that, *cell phones* / Android are more frequently used, so you can install the product via the link provided by the teacher with active internet conditions.

Validation results product based on aspect evaluation material can be outlined from the first aspect, that is aspect related eligibility with E-module suitability with material magnetic materials, KI, KD, indicator, and objectives learning obtained an average of 91.67%. Interview results participant educated obtained the suggestion that needs exists additional material. In tune with the study (Rosyidah et al., 2021), understanding the draft includes part important in learning. Aspect evaluation second that is the related language with suitability language used for development participant education obtained an average of 95.00%. Interview results with participant educate obtained information that there is a term yet is known However helped Because, in the product, there is the material that can be learned. Aspect evaluation third that is related to presentation with an interesting and accessible presentation of the e-module gives encouragement participants to educate visually obtained an average of 94.44%. Validation results aspect material the showing that draft presented material easily understood Because helped illustration 3d image. It is aligned with (Asih Banjarani et al., 2023) the use of AR can increase imagination participant education. In line with the results study (Ariama & Adrin Burhendi, 2022) that learning media AR based can increase enthusiasm for learning and the use of AR media in learning physics.

Validation results product based on aspect media assessment can be outlined from the first aspect, that is aspect related presentation with clarity instruction use of the E-module so that easy use obtained an average of 95.83%. This is corroborated by (Ramdani & Simamora, 2022) that the e-module need to be equipped with clear instruction usage. The second aspect related to designs with creativity e-module design so that interesting for learning obtained an average of 92.71%. The third aspect, convenience-related use with effectiveness use of e-modules, obtained an average of 87.50%. Based on the results interview with the participant, the educator got advice for giving guide access to stable products and networks. *Augmented Reality* can unite real objects with virtual technology supported (Christiano Mantaya Wenthe, 2021). Validation results media aspect can conclude that

technology can be utilized for developing learning media, learning resources, and teaching materials.

Readability test results can support developed digital teaching materials so that they can be valid for utilization as deep digital teaching materials in science learning. In the development process module, the effectiveness test is carried out at the stage of implementation through *pre-test* and *post-test* to know the difference in participant learning outcomes and educate before and after the application of the developed e-module in learning. Presentation results showed pre-test completeness before applied learning using the developed e-module by 64.5% and occurred enhancement percentage post-test completeness after applying the developed e-module by 90.3%. This goes hand in hand with the results of research by Mufida et al. (2022) that use modules proven effective for increasing participant learning outcomes educate.

E-module based *Augmented Reality* is equipped with 2D images, and the image scan menu features a 3D view. The developed e-module is equipped with instruction method use (Novayana et al., 2021). The developed E-module design has features it consists of feature material, image scan features, and features exercise questions. This is corroborated by Sabil *et al.* (2022) that component applications of *Augmented Reality*, namely markers, video cameras, views screens, and device soft. The image in the module print can be scanned using menu features contained in the E-module so that they become 3D images and can support understanding of participant education. View of the 3D image scan process as follows.

1. Setting up markers for scan 2D image becomes 3d image. Note Figure 5 as following

Figure 5. Ferromagnetic Marker

2. Open the AR camera features and click the start button for the scan marker. Look at Figure 6 as following

Figure 6. Marker Scan Results

One of the markers that can be scanned can observe in Figure 6, which aims To scan 2D images so that 3D objects already arranged Can detect and found visualized as in Figure 6. Not all 2D images can be scanned through AR applications because system applications in the manufacturing process, that is, compile 3D objects accordingly objective achievement participants learn, arrange customized 2D image markers with 3D objects, then 3D objects and markers together in the application so that only picture that has arranged as possible detected 3D visualization. Trial display by participants educate presented in Figure 7 as follows

Figure 7. 3D Image of an Attractive Magnet Interesting

Based on Figure 7, when two magnets are brought closer with polar differences will happen style pull interest between magnets. Pull force is interesting. It can be illustrated through scanned 2D images through one feature developed E-module application so that looks clearer. In addition, images that can be scanned adapt the number of images available on the module print so that No only can clarify the 3D image of pictures that don't list. E-module can use in a manner *offline* after downloading. In tune with Risdianto & Fathurrohman's (2021) application, *Augmented Reality* can become the solution to teaching materials in the area that do not have good enough signal.

Features in the E-module developed in it consists of instruction use, magnetic material sub material that can be studied by participant educate when at school or outside school, a menu

available for scanning 2D images contained in the module print so that can display 3d drawing for clarify illustration images, and an evaluation menu is available that aims know understanding participant educate. E-module based This *Augmented Reality* can help participant educate increase their Skills think about it and improve learning outcomes due to the sub-material method of making magnets can be seen as a clear illustration of magnet manufacture through the way a magnet rubs against a rod iron, inducing or bringing closer magnetic end with end stem iron, and winding wire on flowing iron DC current (electromagnetic) so can test try it direct moment learning If tools and materials allow. The following example of 3D images that can be practiced directly by students is seen in Figure 8 below.

Figure 8. How to Make Magnets with Rubbing On Iron

Based on Figure 8, the magnet is rubbed on the iron through a fixed direction, so at the end stem, the iron that is first rubbed by a magnet has the same pole with the magnetic poles it rubs. In addition, this e-module not only facilitates 3D materials and images only However can also be applied in activity practice. To know the method to magnetize or eliminate magnetism material, use the guidelines listed in the e-module material-based *Augmented Reality*. In tune with the study by Wamepa et al. (2022), the development of *Augmented Reality* as supporters practice Android-based can support practice in a manner *online* or *offline*.

Digital teaching materials or E-modules based on *Augmented* Reality have characteristics special distinction from e-module other. Characteristics of the E-module based *Augmented Reality*, the first is the digital form of teaching materials that utilize application *Augmented Reality*. Application of the design adapts the material to be used, especially in 2D images, to be developed become 3d images. Appearance 3D images do not solely appear when scanning 2D images from module print. However, designed Formerly from desired 3D images and then customized with the application.

The second characteristic, viz appearance, 3D images are interactive, so two communications occur actively. With the use of this developed e-module, participants will feel involved in a manner active good audio, visual and kinetic. Inner material This product is not only a limited description material course. However, be equipped with 2D drawings, features to scan images so appearance 3D images appear, and evaluation like question choice double for practice as far as knowledge participants educate. How *Augmented Reality* works is through the analysis object (2D image), then captured by the camera, then displays the virtual object in a real manner (Putra *et al.,* 2022). In the end, e-module activity-based *Augmented Reality* be equipped with feature form marks in a manner automatic after evaluation. The third characteristic is the developed e-module load material magnetism with sub-material magnetic material. The material presented, draft magnetic force, properties of magnetic material, way to make magnets, and how to remove magnets.

CONCLUSION

The developed digital teaching materials based on Augmented Reality offer a unique advantage in their ability to transform 2D images into interactive 3D images. Validation results from material experts yielded a score of 93.70%, while media experts assessed it as 92.01%, both achieving a "very valid" rating. Additionally, student readability tests garnered an impressive 83.76%, signifying high-quality usability. The Augmented Reality-based e-modules are characterized by their digital format, utilization of Augmented Reality applications, interactive 3D image display, and inclusion of magnetic material sub-topics. The effectiveness test demonstrated a notable improvement, with pre-test completeness at 64.5% and post-test at 90.3%, confirming its viability as a valuable teaching resource in science education.

In conclusion, the results highlight the efficacy of the developed Augmented Reality-based e-modules as a potent teaching aid. The data analysis, specifically the t-test, offers a comprehensive assessment of their effectiveness. The acceptance or rejection of hypotheses has provided a clear understanding of the impact of e-modules on students' learning outcomes. This robust evidence underscores the potential of Augmented Reality-enhanced digital teaching materials to significantly enhance science education, validating their role as a valuable addition to the pedagogical landscape.

REFERENCES

Abdulrahaman, M. D., Faruk, N., Oloyede, A. A., Surajudeen-Bakinde, N. T., Olawoyin, L. A., Mejabi, O. V, Imam-Fulani, Y. O., Fahm, A. O., & Azeez, A. L. (2020a). Multimedia tools in the teaching and learning processes: A systematic review. *Heliyon*, *6*(11), e05312.

Abdulrahaman, M. D., Faruk, N., Oloyede, A. A., Surajudeen-Bakinde, N. T., Olawoyin, L. A., Mejabi, O. V., Imam-Fulani, Y. O., Fahm, A. O., & Azeez, A. L. (2020b). Multimedia tools in the teaching and learning processes: A systematic review. In *Heliyon* (Vol. 6, Issue 11). Elsevier Ltd. https://doi.org/10.1016/j.heliyon.2020.e05312

Ariama, S., & Adrin Burhendi, F. C. (2022). Pengembangan Website Sebagai Media Pembelajaran Fisika Berbasis Augmented Reality Dengan Menggunakan Metode Marker Based Tracking Pada Materi Listrik Dinamis. *Jurnal Penelitian Pembelajaran Fisika*, *13*(2), 181–190. https://doi.org/10.26877/jp2f.v13i2.12132

Arikunto, S. (2021). *Dasar-dasar evaluasi pendidikan edisi 3*. Bumi Aksara.

Asih Banjarani, W., Ridwan, M., Lidah Wetan Kec Lakarsantri Kota Surabaya, J., & Timur, J. (2023). Pengaruh Media Augmented Reality Terhadap Motivasi Belajar Passing Sepak Bola. In *Jurnal Mahasiswa Pendidikan Olahraga* (Vol. 3, Issue 2).

Christiano Mantaya Wenthe, D. (2021). *Aplikasi Pengenalan Objek Untuk Anak Usia Dini Menggunakan Teknologi Augmented Reality*. https://www.researchgate.net/publication/352587890

Harahap, A., Sucipto, A., & Jupriyadi, J. (2020). Pemanfaatan Augmented Reality (Ar) Pada Media Pembelajaran Pengenalan Komponen Elektronika Berbasis Android. *Jurnal Ilmiah Infrastruktur Teknologi Informasi*, *1*(1), 20–25.

Herlambang, B. A., Dewanto, F. M., Harjanta, A. T., & Setyawati, V. A. V. (2018). Implementation of Profile Matching Methods In A Mobile Based Adolescent Nutritional Assessment Systems. *Jurnal Transformatika*, *16*(1), 1–13.

Hurrahman, M., Erlina, E., Melati, H. A., Enawaty, E., & Sartika, R. P. (2022). Pengembangan E-Modul Berbasis Multipel Representasi Dengan Bantuan Teknologi Augmented Reality untuk Pembelajaran Materi Bentuk Molekul. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *10*(1), 89–114.

Hutama, F. S. (2016). Pengembangan Bahan Ajar IPS Berbasis Nilai Budaya Using untuk Siswa Sekolah Dasar. *JPI (Jurnal Pendidikan Indonesia)*, *5*(2), 113–124.

Linda*, R., Zulfarina, Z., Mas'ud, M., & Putra, T. P. (2021). Peningkatan Kemandirian dan Hasil

Belajar Peserta Didik Melalui Implementasi E-Modul Interaktif IPA Terpadu Tipe Connected Pada Materi Energi SMP/MTs. *Jurnal Pendidikan Sains Indonesia*, *9*(2), 191–200. https://doi.org/10.24815/jpsi.v9i2.19012

Muhammad, K., Khan, N., Lee, M.-Y., Imran, A. S., & Sajjad, M. (2021). School of the future: A comprehensive study on the effectiveness of augmented reality as a tool for primary school children's education. *Applied Sciences*, *11*(11), 5277.

Munandar, T., & Ahmad, M. (2022). E-Modul Berbasis Nearpod pada Materi PPKn Kelas 2 Tema Hidup Rukun. *Jurnal Ilmiah Pendidikan Profesi Guru*, *5*(1), 11–20. https://doi.org/10.23887/jippg.v5i1.48503

Ningrum, D. S., Ratnaningsih, A., & Ngazizah, N. (2022). Pengembangan E-modul Berbasis Problem Solving dan Karakter Kelas V Peristiwa dalam Kehidupan di SD Negeri Kliwonan. *Journal on Teacher Education*, *4*(2), 265–280.

Nisa, H. A., Mujib, M., & Putra, R. W. Y. (2020). Efektivitas e-modul dengan flip PDF professional berbasis gamifikasi terhadap siswa SMP. *Jurnal Pendidikan Matematika Raflesia*, *5*(2), 13–25.

Rahayu, W. E., & Sudarmin, S. (2015). Pengembangan modul IPA terpadu berbasis etnosains tema energi dalam kehidupan untuk menanamkan jiwa konservasi siswa. *Unnes Science Education Journal*, *4*(2).

Ramdani, M. S., & Simamora, A. H. (2022). Meningkatkan Motivasi dan Hasil Belajar Mata Pelajaran Seni Budaya Melalui E-Modul. *Jurnal Edutech Undiksha*, *10*(1), 146–155. https://doi.org/10.23887/jeu.v10i1.44495

Rosyidah, U., Setyawati, A., & Qomariyah, S. (2021). Analisis Kemampuan Penalaran dan Kemampuan Pemahaman Konsep Matematis Mahasiswa Pendidikan Matematika Pada Mata Kuliah Aljabar Dasar. *SJME (Supremum Journal of Mathematics Education)*, *5*(1). https://doi.org/10.35706/sjme.v5i1.4488

Sa'diah, S., Ruhiat, Y., & Sholih, S. (2022). Pengembangan e-modul interaktif berbasis augmented reality untuk siswa sekolah dasar. *Vox edukasi: Jurnal Ilmiah Ilmu Pendidikan*, *13*(1), 21–29. https://doi.org/10.31932/ve.v13i1.1489

Samsinar, S. (2020). Urgensi learning resources (sumber belajar) dalam meningkatkan kualitas pembelajaran. *Didaktika: Jurnal Kependidikan*, *13*(2), 194–205.

Saprudin, S., Irfan Ahlak, Astuti Salim, Ade Hi Haerullah, Fatma Hamid, & Nurdin Abdul Rahman. (2022). Pengembangan e-Modul Interaktif Getaran dan Gelombang (eMIGG) untuk

Pembelajaran IPA di SMP. *Jurnal Pendidikan MIPA*, *12*(1), 97–106. https://doi.org/10.37630/jpm.v12i1.549

Soraya, A. (2021). Kelistrikmagnetan. *Journal Of Islamic Primary Education*, *1*(1), 49–59.

Sudirama, P. P., Japa, I. G. N., & Yasa, L. P. Y. (2021). Pembelajaran Discovery Learning Meningkatkan Hasil Belajar IPA Siswa Kelas IV Sekolah Dasar. *Journal for Lesson and Learning Studies*, *4*(2), 165–173.

Suhardiman, S., Cahyani, A., Kalsum, U., Ririn, R., Azizah, A. F. N., & Utami, B. D. (2022). Implementasi pendekatan pakematik untuk meningkatkan hasil belajar ipa terpadu pada peserta didik kelas ix. 5 di smp negeri 1 tarowang kab. Jeneponto pokok bahasan kemagnetan. *Al-khazini: jurnal pendidikan fisika*, *2*(1), 38–49.

Susanti, P., Jayadi, P., Hidayati, N. R., Riyanto, S., Bekti Kiswardianta, R., Informatika, T., Kimia, T., & Biologi, P. (n.d.). *Pelatihan pembuatan google sites sebagai media pembelajaran berbasis website bagi guru smk cendekia madiun*.