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Augmented Reality Media Design for Electro-Pneumatic Practical Learning for Vocational High School Students (VHS)

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ABSTRAK

Banyak siswa yang belum terampil dan mampu dalam praktik bidang keahlian elektro-pneumatik. Tujuan penelitian ini adalah merancang media augmented reality pada mata pelajaran elektro-pneumatik. Penelitian ini menggunakan metode penelitian pengembangan, dengan mengadopsi model ADDIE dengan 5 tahapan. Media yang dihasilkan dalam penelitian ini akan dianalisis kepraktisannya. Sampel dalam dalam penelitian ini adalah 16 siswa kelas X. Instrument yang digunakan untuk ahli menggunakan kuisioner dengan 4 option. Instrument yang diberikan kepada siswa untuk mengetahui kepraktisan berupa kuisioner dengan 2 pilihan iya dan tidak. Teknik pengumpulan data menggunakan dokumentasi, wawancara, kuesioner dan literature review. Analisis data menggunakan teknik analisis data deskriptif kuantitatif. Hasil penelitian yaitu penilaian ahli desain instruksional dari dua ahli memperoleh skor 4.43. penilaian dari dua ahli materi memperolah skor 4.5, dan penilaian dari dua ahli media memperolah skor 4.22. Disimpulkan bahwa media augmented reality yang dirancang untuk mata pelajaran elektro-pneumatik layak untuk diimplementasikan. Hasil kuisioner yang diisi oleh siswa mendapat skor di atas 80. Dari hasil uji kepraktisan maka dapat disimpulkan media augmented reality ini cukup praktis. Implikasi dari penerapan media augmented reality dalam pembelajaran praktik elektro-pneumatik di Sekolah akan dapat meningkatkan keterampilan praktik siswa.

ABSTRACT

Many students still need to be skilled and able to practice electro-pneumatic expertise. This research aims to design augmented reality media for electro-pneumatic subjects. This study uses the development research method by adopting the ADDIE model with 5 stages. The media produced in this study will be analyzed for its practicality. The sample in this study was 16 students of class X. The instrument used for experts was using a questionnaire with 4 options. The instrument given to students to find out practicality is in the form of a questionnaire with 2 yes and no options. Data collection techniques using documentation, interviews, questionnaires, and literature review. Data analysis used quantitative descriptive data analysis techniques. The study's results, namely the assessment of instructional design experts from two experts, obtained a score of 4.43. the assessment of two material experts obtained a score of 4.5, and the assessment of two media experts obtained a score of 4.22. It was concluded that augmented reality media designed for electro-pneumatic subjects is feasible. The results of the questionnaire filled out by students scored above 80. From the results of the practicality test, it can be concluded that augmented reality media is quite practical. The implications of applying augmented reality media in practical electro-pneumatic learning in schools will be able to improve students' practical skills.

1. INTRODUCTION

The rapid development of technology has an impact on the increasingly sophisticated world of education making it easier for students to obtain information and learning materials. Digitalization of society, changes in educational structures, and rapidly increasing resources have accelerated an open learning environment (Danniels et al., 2020; Goldin & Katz, 2019; Tiwery et al., 2021). This is very helpful in the field of Education, especially in practical learning activities (Machaba & Bedada, 2022; Padmo et al., 2020; Pereira & Nganga, 2020). Learning can be done wherever and whenever according to the wishes of students and not fixated on the classroom and time, thus giving students the freedom to study well without any pressure and coercion from the school.

Practical learning in vocational high schools is very important to improve students' skills and abilities in terms of their interests and talents as well as in facing job competition in the real world (Rahim et al., 2020; Edy

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Supriyadi et al., 2019; Zurqoni et al., 2018). However, based on preliminary studies, there are still many VHS students who do not have the competence to accordance with the demands of the curriculum (Nurlaela et al., 2019; Sudana et al., 2019). During practical learning, the teacher always refers to the worksheet that has been prepared. The job sheet is the media used by the teacher as an electro-pneumatic module. The use of non-varied and monotonous media causes students to experience difficulties in understanding (Ahmadi et al., 2017; Cahyani et al., 2021; Ningtiyas et al., 2019). In addition to this, the very short time allocation of 2 hours a week is a problem when it comes to electro-pneumatic practice activities. 2 hours is considered very lacking in electro-pneumatic practical learning activities, so students find it difficult to concentrate on realizing how airflow works in electro-pneumatics.

Based on the existing problems, it is necessary to design augmented reality media to make it easier for students to practice assembling electro-pneumatic circuits. Supposedly, a teacher must be able to facilitate students in learning to make it easier to understand the material to be delivered, either by using methods or approaches in the learning process (Arman et al., 2020; Edi Supriyadi & Wijayati, 2020; Tri Astuti et al., 2019). The use of varied media will attract and motivate students in practicum activities (Chasanah et al., 2019; Mauliana et al., 2022; Nuswowati et al., 2020). The existence of augmented reality media is designed to save costs and time in practice (Lai et al., 2019; Liono et al., 2021). It is because the tools used in practical activities require expensive costs and take a long time to be used interchangeably between one student and another. Ideally one tool for one student, but the limited tools that exist in these conditions cannot be carried out in practicum activities (Garzón & Acevedo, 2019; Hadi et al., 2022). The practicum learning process using tools tends to make a lot of mistakes in assembling electro-pneumatic circuits and is not optimal in the time used. The nature of the use of learning media to facilitate learning in practical activities can be designed in a learning model with the help of a virtual laboratory. Virtual Laboratories are widely used in higher engineering education due to the COVID-19 pandemic, and they have taken on even greater relevance (Dwiningsih et al., 2018; Yusuf & Widyaningsih, 2020). The use virtual laboratories in higher education are widely used to meet the need not only for learning but is used in applying engineering concepts which are part of the pedagogical process (Garcia-Moran et al., 2021).

Since the early 2000s, many strategies and approaches have been applied in providing web, hands-on access to remote facilities. The approach taken aims to facilitate traditional learning, such as demonstrating analytic concepts, exposing students to various potential issues and problems, and comparing theory and real-world results (Heradio et al., 2016; Potkonjak et al., 2016). The use of engineering concepts by students is also experienced by students as an alternative design decision in real-time and increases the specific perception of interior design (Chang et., al, 2020). The concept of engineering on augmented reality media can be used in practical activities to save time and minimize errors in assembling electro-pneumatic circuits in this paper. Virtual Reality technology has evolved drastically over the years by reducing form factors while increasing features and power. The popularity of technology in gaming platforms is well-established today, but it is also gaining interest in education, training, and healthcare (Soliman et al., 2021). Virtual Reality is a computer-simulated environment that allows users to interact with and change their perceptions as a result of a mixture of sensory information sent to the human brain (Bhaskara et al., 2017; di Lanzo et al., 2020; Stojšić et al., 2016). Virtual Reality technology is now easier for us to find and reach on mobile devices (smartphones) which allows users to have a lower Virtual Reality experience due to lower processing power, at a much lower cost (Papanastasiou et al., 2019; Radianti et al., 2020).

The augmented reality design referred to here is a design that is designed taking into account the ease of use for the practice (Mustaqim, 2017; Tekedere & Göker, 2016). The convenience obtained with the media as an introductory message from the teacher to students is expected to achieve the maximum learning objectives. The use of virtual reality as a teaching and learning tool adjunct to traditional engineering education methods presents positive results and beneficial effects for cognitive, skills-based, and affective learning outcomes (Criollo-C et al., 2021; di Lanzo et al., 2020; Hincapie et al., 2021). The application of augmented reality for the implementation of educational projects will be expected to increase students' interest in new materials in the formation of Education in real-time artificial virtual environments with three-dimensional information with which people can interact naturally (Hendriyani et al., 2019; Hlod & Doroshenko, 2021). When students enter a virtual environment, they can have an immersive experience and feel that is truly real. Through various sensing devices, people can examine or manipulate objects in virtual environments, and manipulate and communicate with the environment in real-time as in the real world (Diao & Shih, 2019; Geng & Wu, 2021). The definition of augmented reality is a concept that has developed since the early 1900s and is defined as the superimposition of virtual elements in a real environment (Criollo-C et al., 2021). The existing system in augmented reality media places other meaningful 3D virtual elements in the real world so that users can interact with them (Y.-S. Chang et al., 2020; Guest et al., 2018). When augmented reality media is used, one will never lose touch with the real world and, at the same time, one can interact with all the overlapping virtual information (Andujar et al., 2011).

The design of augmented reality media in the practical activities of this electro-pneumatic subject is for vocational high school students in the electronics engineering department. In augmented reality media designed for practical electro-pneumatic learning activities with 8 circuit designs, an explanation is given on how to assemble a pneumatic circuit to minimize errors error. With the hope that students can easily learn anywhere and anytime and can save time and money so that practical learning can run well and is conducive. Previous research findings state that students have a positive view of the use of AR. Other research findings also state that ar media can improve the quality of students' knowledge (Cai et al., 2020; Juan Garzón et al., 2019). Other findings also state that the application of augmented reality technology is suitable for training in certain fields in the era of technological development (Iatsyshyn et al., 2020; Lavrentieva et al., 2020). AR media has been thoroughly proven to form future teacher readiness to improve higher pedagogical abilities (Palamar et al., 2021; Papanastasiou et al., 2019). But there has never been a design of augmented reality media aimed at practical learning in assembling electro-pneumatic circuits. The novelty in this research lies in designing a series of 8 electro-pneumatic circuits visualized on augmented reality media. Augmented reality is designed in such a way as to engineer electro-pneumatic concepts into real works that students can access anytime and anywhere to make it easier for students to improve their pneumatic stringing skills. This research aims to design augmented reality media for electro-pneumatic subjects.

2. METHOD

The type of research used is a type of quantitative descriptive research. This quantitative descriptive research is to obtain independent variable values, either one variable or more by not comparing or connecting one variable with other variables (Sugiyono, 2008). In research will be analyzed the practicality of augmented reality media in a quantitative descriptive manner. The research method used in this study uses development research. The development model used in this study adapts the ADDIE development model pioneered by Robert M Branch (Branch, 2009), which includes five stages, namely the Analysis, Design, Development, Implementation, and Implementation stages. Evaluation (Evaluation). Respondents in this study were 16 students. To obtain data on the value of the practicality test, it was carried out with class X students at Vocational High School 5, Bekasi City, using a questionnaire.

Data collection techniques used in this study include interviews and documentation to find out the current situation and what it should be, questionnaires and literature review. Questionnaires were used to determine the feasibility of augmented reality media from experts, while for the practicality of augmented reality media, questionnaires were filled in by students. The instruments used for expert assessment, one-to-one tests, small groups, and practical tests all use questionnaires. The data obtained were analyzed by descriptive quantitative. The instructional design instrument grid consists of 7 statement items that are used to assess the feasibility of augmented reality media by general learning objectives and specific learning objectives. Points of instructional design expert statements showed in Table 1. The material instrument grid consists of 13 assessment indicators which are carried out to see whether the augmented reality media design is by the material being studied by students. Material assessment indicators designed to use augmented reality media in electro-pneumatic practical learning showed in Table 2.

Table 1. Instructional Design Expert Instrument Grid

No	Dimension	4	3	2	1
1	Conformity of the general purpose formulation	4	3	2	1
2	Conformity of the formulation of special objectives	4	3	2	1
3	Relevance of specific goals to general goals	4	3	2	1
4	The sequence of presentation of practical material	4	3	2	1
5	Relevance of Learning Strategies with General Objectives	4	3	2	1
6	Relevance of Learning Content with General Objectives	4	3	2	1
7	Jobsheet quality	4	3	2	1

(Dick, W., Carey, L., & Carey, 2015; Suparman & Sallama, 2014).

Table 2. Material Expert Instrument Grid

No	Dimensions/Indicators	4	3	2	1
1	Suitability Formulation of general learning objectives	4	3	2	1
2	Suitability Formulation of specific learning objectives	4	3	2	1
3	Appropriateness of electro-pneumatic practical learning materials with instructional objectives	4	3	2	1

No	Dimensions/Indicators	4	3	2	1
4	Completeness of the scope of material to achieve learning objectives	4	3	2	1
5	The truth of the concept of electro-pneumatic practical learning materials	4	3	2	1
6	The novelty of electro-pneumatic practical learning materials	4	3	2	1
7	The messages conveyed include component images, electro-pneumatic circuits, ways of working, and narratives in AR that are by the learning objectives	4	3	2	1
8	Drawings and electro-pneumatic practical circuits are self-explanatory and easy to recognize	4	3	2	1
9	Electro-pneumatic components and electro-pneumatic circuit drawings are by the electro-pneumatic concept	4	3	2	1
10	The accuracy of delivering electro-pneumatic material in AR media	4	3	2	1
11	The sequence of delivery of AR electro-pneumatic media material is appropriate	4	3	2	1
12	Presentation of AR media-based electro-pneumatic learning material makes it easier for students to recognize components and understand how circuits work	4	3	2	1
13	Delivery of electro-pneumatic learning material through AR media makes it easier for students to repeat material to understand how work works	4	3	2	1

(Dick, W., Carey, L., & Carey, 2015; Smaldino et al., 2012; Suparman & Sallama, 2014).

The media instrument grid consists of 8 assessment indicators that are used to consider the suitability of augmented reality media with material and ease of use when learning. Indicators of expert assessment of augmented reality media in Table 3. The practicality test instrument grid consists of 27 assessment indicators that are used to determine the practicality of the designed electro-pneumatic augmented reality media. The instrument grid in Table 4.

Table 3. Media Expert Instrument Grid

No	Dimensi	4	3	2	1
1	Augmented Reality learning media design	4	3	2	1
2	The image quality of Augmented Reality learning media	4	3	2	1
3	Augmented Reality media sound quality	4	3	2	1
4	Augmented Reality media video quality	4	3	2	1
5	Compatibility of color composition on Augmented Reality media	4	3	2	1
6	The quality of the fonts contained in Augmented Reality media	4	3	2	1
7	Ease of use of Augmented Reality media	4	3	2	1
8	Feasibility of Augmented Reality media	4	3	2	1

(Dick, W., Carey, L., & Carey, 2015; Smaldino et al., 2012)

Table 4. Augmented Reality Media Practicality Test Instrument Grid

No	Dimension
1	The images contained in Augmented Reality media are by pneumatic learning materials
2	This Pneumatic Augmented Reality Media makes me interested and motivated to explore pneumatic material
3	The letters contained in the Augmented Reality media are quite clear
4	The size of the letters contained in this Augmented Reality media is appropriate
5	The image size in the pneumatic installation circuit on Augmented Reality media is appropriate
6	The sound contained in Augmented Reality media is clear and audible
7	The pneumatic circuit contained in this Augmented Reality media is quite good
8	The layout and settings on the cellphone screen displayed in this pneumatic Augmented Reality media are good
9	Visual images in Augmented Reality media are of good quality
10	The material contained in Augmented Reality media is easy to learn
11	The pneumatic material presented in this Augmented Reality media is simple
12	The order of this pneumatic material is by the syllabus
13	The pneumatic material contained in Augmented Reality media is by the learning objectives
14	Pneumatic material presented through Augmented Reality media is easy to understand
15	The pneumatic material contained in Augmented Reality media is useful for mastering concepts and adding insight
16	An example of an illustration of Pneumatic material contained in Augmented Reality media according to the topic of discussion

No	Dimension
17	The delivery of pneumatic material learning objectives in augmented reality media is quite clear
18	The pneumatic materials in augmented reality have been sorted from easy to difficult
19	The pneumatic material presented in augmented reality is ordered from simple to complex
20	The material presented in augmented reality media is in various forms of knowledge (principles, procedural, facts, metacognitive)
21	Pneumatic material in augmented reality media is presented coherently
22	Pneumatic material in augmented reality media is easy to understand
23	Examples of pneumatic material in augmented reality media are relevant to the concept of material and learning objectives
24	The language heard in Augmented Reality media is standard Indonesian
25	Conformity of voice intonation with pronunciation contained in Augmented Reality media
26	The accuracy of the use of upper and lower case letters contained in Augmented reality media
27	Messages and information contained in Augmented Reality media are easy to understand

(Basuki Wibawa, Mahdiyah, 2014; Mentes & Turan, 2012)

The stages of developing augmented reality media are designed using the ADDIE development model with 5 stages. The first stage is to analyze the needs of the Vocational High School (VHS) in Bekasi City. In addition to analyzing the needs in the field, an analysis of the learning system that has been carried out so far has also been carried out. At this design stage, augmented reality media is designed based on an analysis of the syllabus, annual program, semester program, and lesson plan. Augmented reality media is designed according to the characteristics of class X students. The design of electro-pneumatic augmented reality media includes a series of animations, a voice that explains how to work according to the series of drawings, picture descriptions, and instructions for using AR. The step in this development is developing augmented reality media with 8 job sheets and an explanation is given on each job sheet to make it easier for students to assemble pneumatic circuits. For the feasibility of augmented reality media, validation is carried out on media experts, and material experts, using instructional design. After being validated by experts and getting revisions. Augmented reality media is revised according to the advice of experts. After the augmented reality media was revised and declared fit for use in research, field trials were carried out to find out the practicality of augmented reality media in class X students of VHS 5 Bekasi City. Evaluation is carried out to see whether augmented reality media is effective to be applied to real classes. The data analysis technique used is descriptive qualitative and quantitative analysis.

3. RESULT AND DISCUSSION

Result

First, analysis results. The results of the needs analysis obtained in a preliminary study conducted at Vocational High School 5 in Bekasi City, in practicum learning of electro-pneumatic subjects, there was still a lack of media used by teachers. the media used is still a job sheet as an electro-pneumatic module. With these findings, media needed that can be used in practical electro-pneumatic learning activities to make it easier for students to understand and assemble electro-pneumatic circuits. The results of the augmented media design are in the form of material that will be demonstrated 8 times with the following material: 1) The circuit that will explain the single-acting cylinder control valve using a 3/2 push button valve; 2) circuit design for knowing control work and double acting cylinder using 3/2 and 5/2 push button valve; 3) double acting cylinder control circuit design using 2 3/2 push button valves; 4) double acting cylinder control circuit design using 3/2 button valve and 3/2 roller valve; 5) design of the double acting cylinder control circuit using 3/2 push button valves and 2 3/2 roller valves; 6) double acting cylinder control circuit design using 3/2 manual valve, 5/2 push button valve, equipped with or valve, and valve and flow control; 7) design of a double acting cylinder control circuit electrically using 2 push buttons and a 5/2 solenoid valve; 8) double acting cylinder control circuit design electrically using 2 timers, a detten switch, and a 5/2 way double solenoid valve. Results are the main part of scientific articles, containing: final results without data analysis process, and hypothesis testing results. Results can be presented with tables or graphs, to clarify the results verbally. Discussion is the most important part of the entire content of scientific articles. The objectives of the discussion are: to answer research problems, interpret findings, integrate findings from research into existing sets of knowledge, and compose new theories or modify existing theories. The circuit design for the augmented reality media prototype consists of 8 circuit designs, showed in Figure 1 and Figure 2.

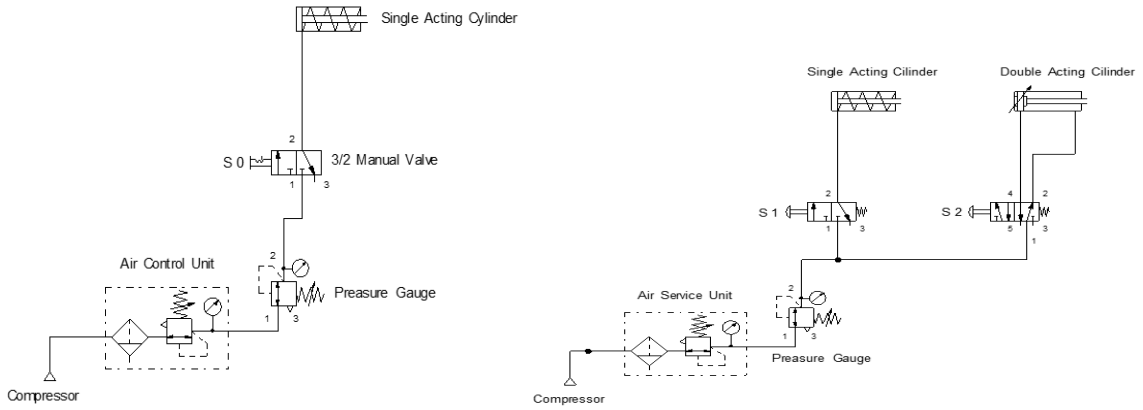

Figure 1. (a) Design of a Single-Acting Cylinder Control Valve Circuit Using a 3/2 Push Button Valve, (b) Single and Double-Acting Cylinder Control Circuit Design Using 3/2 and 5/2 Push Button Valve

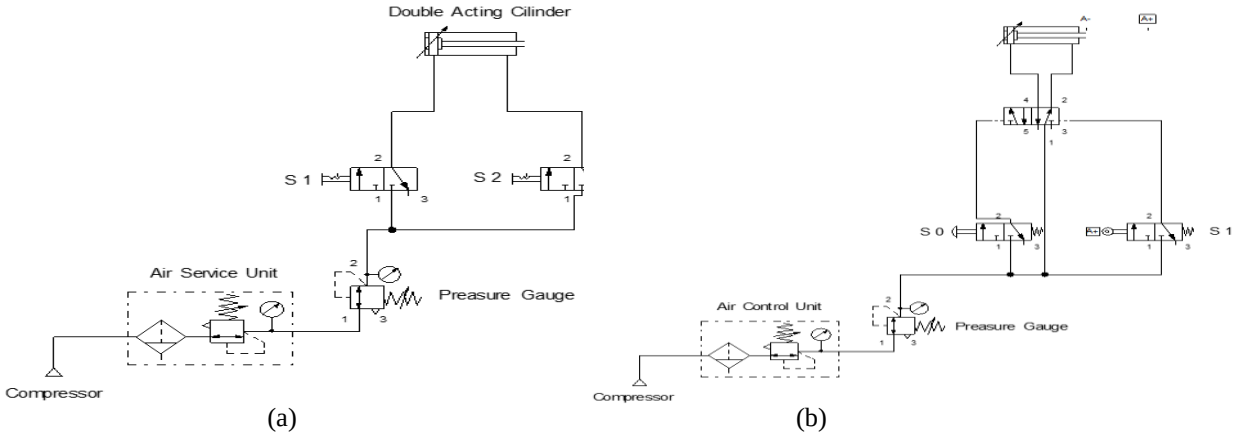

Figure 2. (a) Design of a Double-Acting Cylinder Control Circuit Using 2 3/2 Button Valves, (b) Double-Acting Cylinder Control Circuit Design Using 3/2 Button Valve and 3/2 Roller Valve

After completing the media development, a feasibility assessment is carried out by instructional design experts, material experts, and media experts. Assessment for instructional design was carried out by 2 experts. The results of the assessment of the 2 experts showed in Figure 3.

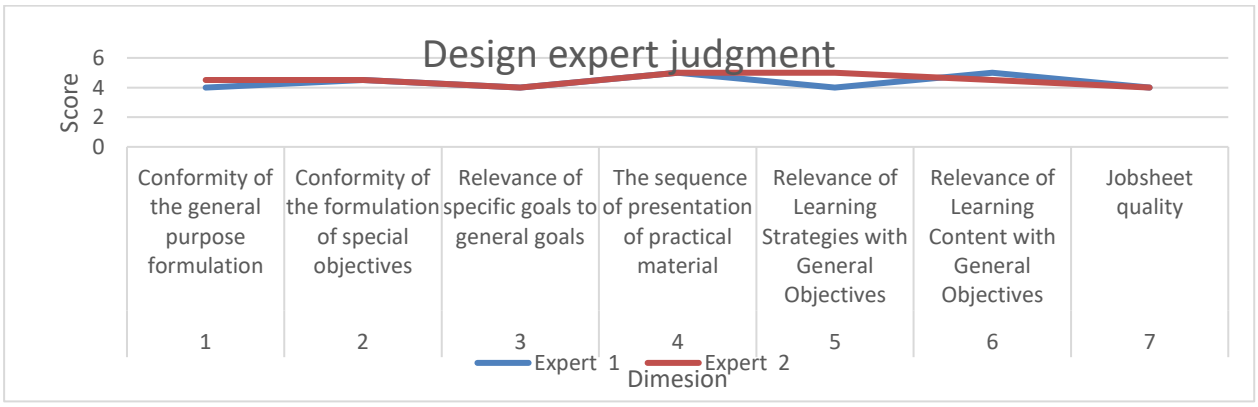

Figure 3. The Results of the Instructional Design Expert's Assessment

Based on Figure 3, an average score of 4.42 is obtained, this indicates that the design of augmented reality media design is feasible to implement. The material expert assessment was carried out by 2 experts to find

out that the material presented in the electro-pneumatic augmented reality media design was by the concept. The results of the assessment showed in Figure 4.

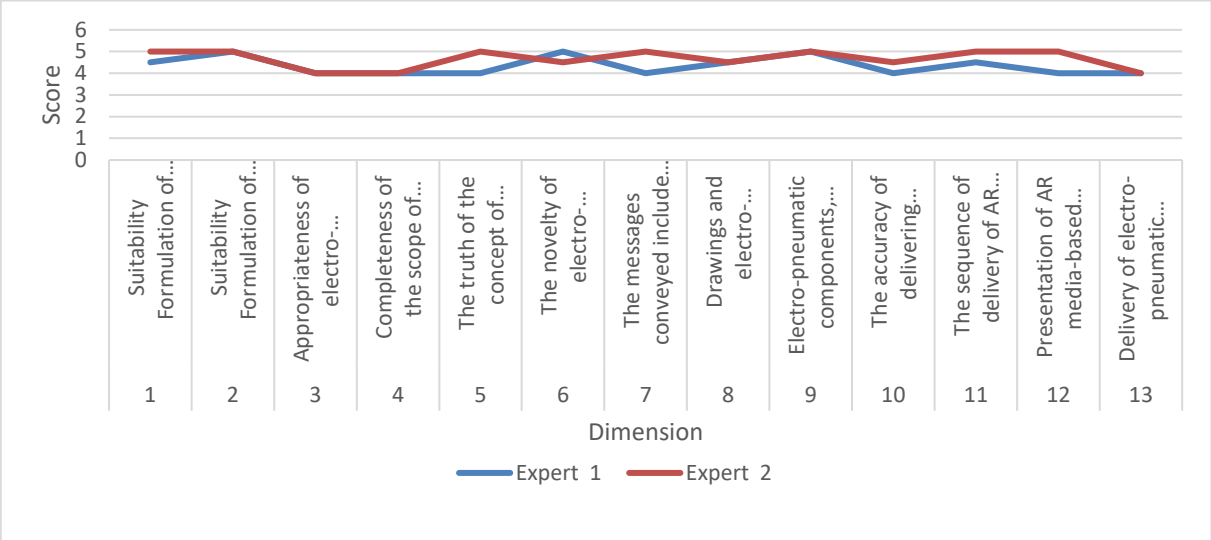

Figure 4. The Results of the Material Expert's Assessment

Based on Figure 4, obtaining an average score of 4.5, categorized very well. This shows that augmented reality media is by the concept of practical electro-pneumatic learning. Assessment of the feasibility of electro-pneumatic augmented reality media was carried out with 2 experts with an average score of 4.22, which is categorized as very good. The media is declared feasible and can be implemented. Electro-pneumatic augmented reality media was also carried out in practical tests on class X students of VHS Bekasi City. The results of the practicality test in Figure 5. All respondents scored above 80, with details of 3 respondents obtaining a score of 87.5, 6 respondents obtaining a score of 93.75, and 7 respondents with a score of 100. Thus it is said that augmented reality media for electro-pneumatic practice is very practical.

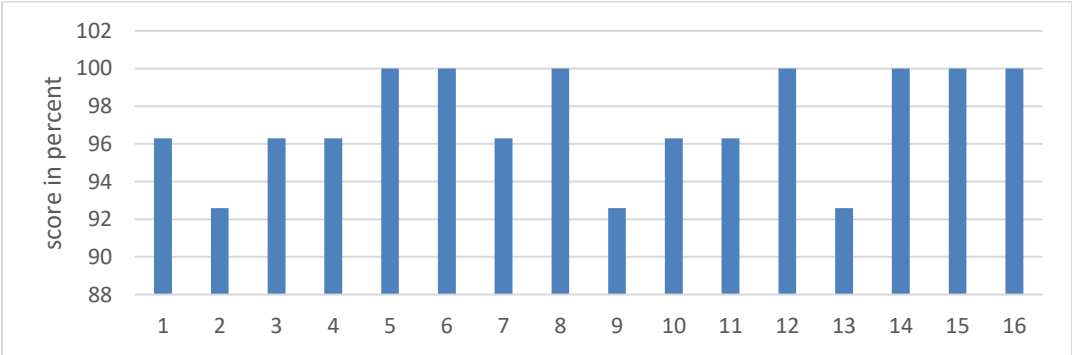

Figure 5. Practical Test Results of Electro-Pneumatic Augmented Reality Media

Discussion

The augmented reality media in the practical activities of electro-pneumatic subject for vocational high school students in class X is designed to make it easier for students to carry out electro-pneumatic stringing practice activities. The advantage of this augmented reality design is that there are 8 job sheets for electro-pneumatic practical activities. 8 job sheets were developed, including first, job sheet 1 control single-acting cylinder. Second, job sheet 2 control and double-acting cylinder using 3/2 and 5/2 push button valves. Third, job sheet 3 control double-acting cylinder using 2 pieces 3/2 push button valve. Fourth, job sheet 4 control double acting cylinder using 3/2 button valve and 3/2 roller valve. Fifth, job sheet 5 control double acting cylinder using 3/2 push button valve and 2 pieces 3 /2 roller valve. Sixth, job sheet 6 double acting cylinder control using 3/2 manual valve, 5/2 push button valve, equipped with or valve, and valve and flow control. Seventh, job sheet 7 electrically controlling double acting cylinder using 2 push buttons and a 5/2 solenoid valve. Eighth, job sheet 8 double acting cylinder control electrically using 2 timers, a detten switch, and 5/2 way double solenoid valve. 8

worksheets that have been designed provide an overview of assembling electro-pneumatic circuits and their functions.

By using the practical electro-pneumatic learning model for vocational high school (VHS), it is easier for students to follow the learning steps presented in the form of augmented reality. Practical troubleshooting activities can be carried out by using a simulation application which is a solution for virtual learning (Cahyanto & Munadi, 2021; di Lanzo et al., 2020; Zhou et al., 2011). Besides being designed with pictures and explanations, it is also equipped with audio and music explanations which can increase student motivation and interest in learning practical activities. The development of cellular augmented reality-based modules was also developed in a pneumatic system to improve practical skills and theoretical knowledge for vocational school students. Other findings also state that augmented reality can help students learn (Jamhari et al., 2018; Rasalingam et al., 2014; Weng et al., 2019).

The use of mobile devices in education provides a new educational paradigm, called M-Learning, which offers many opportunities for students to develop their creativity, as well as being an element of motivation and collaboration (Arulanand et al., 2020; Astutia et al., 2017; J.-H. Chang et al., 2019; Mutambara & Bayaga, 2021). In Engineering Education, learning by doing is essential to supplement theoretical concepts with technical introductions to maximize learning outcomes. The use of Augmented Reality in Engineering Education as an interactive learning tool in various fields of engineering education, and its contribution to student motivation in classroom scenarios (Kaur et al., 2020). Visualization in science and engineering education uses augmented reality in the context of biology education based on constructivist and constructionist concepts (R. W. Chen & Chan, 2019; Herbert et al., 2021; Yavuz et al., 2021). Students' understanding is deeper, their motivation is greater, and, last but not least, their creativity is greatly supported. The students are motivated by the new method, they work very well together and the learning is constructive (Fuchsova & Korenova, 2019; Khan et al., 2019).

The appropriate type of AR system should be selected based on the training content, before system design and development. The system can also be accompanied by functions, such as instant online assessment, synchronized assessment, and exchange skills to help learn what has been taught and develop critical thinking skills (Diao & Shih, 2019; Hlod & Doroshenko, 2021). The application of augmented reality (AR) in education provides important benefits, such as increased engagement and interactivity, and can help minimize the negative effects of disruptive face-to-face education (Khan et al., 2019; Yavuz et al., 2021). Therefore, this paper focuses on describing the effects of augmented reality mobile applications (NetAR) developed for engineering students as a complement to traditional education (Criollo-C et al., 2021). From the several studies above, the use of focused augmented reality media tends to increase cognitive abilities, while in this study the design of augmented reality media is focused on providing an understanding of practical skills in electro-pneumatic subjects.

This augmented reality media provides a new experience for students to interact with the virtual world using real-like 3D media displays (C. H. Chen et al., 2016; Elsayed & Al-Najrani, 2021). Augmented reality media in practical activities can improve skills and minimize mistakes in carrying out real practice in the laboratory. The implications of this research can be widely used in vocational high schools and those who have an interest in the field of electro-pneumatics. The limitations of this study are that this series is still a very basic/simple circuit, and this Augmented Reality media cannot be accessed on Apple devices. This research is still at the practical level, therefore it needs to be disseminated in several vocational high schools both in villages and in cities throughout Indonesia. It is necessary to study students' interest and motivation in using augmented reality media. More complex and complicated circuits can also be designed for further research. For future research, social field research can be developed using augmented reality media.

4. CONCLUSION

The results of this augmented reality media design are very feasible and can be implemented in electro-pneumatic subjects for class X VHS students. In addition, after testing the augmented reality media design on students, it is concluded that this augmented reality media is very practical in improving practical skills. student electro-pneumatic. Based on the findings of this study, it shows that there is a connection between augmented reality media designed by using AR application and electro-pneumatic practicum activities. The augmented reality media design can improve students' skills and abilities in electro-pneumatic practice. However, augmented reality media designed can be used in electro-pneumatic practical activities only and it cannot be used in other subjects. Thus, the augmented reality media design is used as a learning medium in electro-pneumatic practical activities.

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