Developing media fire extinguishers light on vocational higher education

[1]Suyitno Suyitno, [2]Fajar Danur Isnantyo, [3]Dwi Jatmoko, [4]Fuad Abdillah, and [5]Ibnu Mubarak

*Abstract--*This study aims to: 1) determine the development of cutting aids for lightweight fire extinguishers to improve learning outcomes in the Occupational Health and Safety course, 2) determine the feasibility of cutting a lightweight fire extinguisher to improve learning outcomes in the Health course and Occupational Safety, 3) know the effectiveness of cutting aids for lightweight fire extinguishers to improve learning outcomes in the Occupational Health and Safety course. The method used in this research is Research and Development (RnD) using the Four-D device development model. In this development model consists of four stages namely: 1) Defining Phase, 2) Design Phase, 3) Development Phase, and 4) Disseminate Phase. Development is carried out based on several stages in accordance with the method used in this study. This development is appropriate to use after validation by media experts and material experts [20], [21]. This is reinforced by the trial of products and materials before the application of the research target has been carried out. The results of the application of the development carried out with a control class that does not use media get an average learning outcome of 66.80 and the experimental class that uses the media (carried out treatment) get a high average of learning outcomes of 84.80. Test tests get results 0, 00 which means less than 0.05, these results indicate that there are differences in learning outcomes. With this props cutting a lightweight fire extinguisher proven effective for improving learning outcomes in the course Health and Safety.

Keywords-- *Props, Cutting, Learning Outcomes*

I INTRODUCTION

The world of education in Indonesia tends to still not apply a culture of occupational health and safety. Inruru education which incidentally prepares to work [1], [2], [3], [4], will result in school graduates who are not yet competent. Especially schools based on vocational or specialization that are still not in accordance with the application of K3 culture. Many things must be improved from the world of education related to a culture of work safety and safety, from work safety knowledge, means of work safety, to being able to apply work health and safety. Of the things that must be addressed correctly related to occupational health and safety culture knowledge of work health and safety culture. However, the existing knowledge in learning in vocational schools related to

---

[1]Department of Automotive Engineering Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Purworejo, Indonesia, Email: yitno@umpwr.ac.id

[2]Department of Civil Engineering Education, Universitas Sebelas Maret, Surakarta, Indonesia, Email: *isnantyo@staff.uns.ac.id*

[3]Department of Automotive Engineering Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Purworejo, Indonesia. Email: dwijatmoko@umpwr.ac.id

[4]Faculty of Science and Technology at IVET Semarang University, Email: fuadabdillah88@gmail.com

[5]Department Pendidikan Teknik Mesin, Universitas Pendidikan Indonesia, Bandung, Indonesia. Email: barox82@upi.edu

occupational health and safety still tends to be limited to theory, so that in practice students do not understand properly about occupational health and safety. Existing learning is also not optimal for the application of K3 in schools. Schools are also not aware of the need for learning about appropriate OSH, many materials are only provided but without any direct application or practice. Though this is important for the continuation of the level of education namely the world of work. From K3 learning which only relies on theories, this will make students less interested in learning about K3. So this will impact on student learning outcomes, for that we need another method to make students interested in learning K3.

The K3 importance in education, especially vocational university base is preparing human resources that conscious will of Health and Safety at work which should have been applied in the world of education so that in the working world is not crippled in carrying out the K3. But in the world of education, students are still confused with the so-called K3 itself, besides learning that is less varied, monotonous learning so that there is no sense of interest of students in existing learning [19], [22]. Based on observations made by researchers at the University of Muhammadiyah Purworejo related to the Occupational Health and Safety subject, the results show that learning is still not effective or not as expected by students. From the problem of understanding the material presented , the interest in learning, to the unavailability of learning media for OSH courses that are not yet in line with existing learning, and learning outcomes that are not yet optimal.

Based on a preliminary study the researchers conducted on December 6, 2018 about learning activities in the Occupational Health and Safety course for 10 respondents who had conducted learning in the Occupational Health and Safety course by using a preliminary study questionnaire, the following results were obtained .

Table 1: Percentage of learning shortages

No	Indicator	Results
1	The material on occupational health and safety courses is lacking in the use of media.	34%
2	The level of understanding is still less related to the material	44%
3	Learning motivation is lacking	52%
4	Learning tends to be monotonous due to lack of media	32%
5	Enthusiasm for learning is lacking in material in the occupational health and safety course.	52%

Based on the analysis of the results of the study questionnaire respondents pendahualuan on learning related subjects Health and Safety at Work, the researchers developed a media *cutting* tool Fire Extinguisher to facilitate and improve learning outcomes of students in the learning of subjects Health and Safety at Work particularly in fire prevention material.

Based on an analysis of the results of the introductory study questionnaire on the responses of respondents related to the study of the Occupational Health and Safety course, the researcher developed the *cutting* media for Small Fire Extinguishers to facilitate and improve student learning outcomes in learning Occupational Health and Safety courses, especially in fire prevention material . Based on these conditions, it is necessary to develop media for learning so that learning can be more interesting and not monotonous, so students are motivated to learn [5] - [7] . In addition, students will more easily understand the material and reduce boredom while studying

so students are more active in learning. Researchers used the media of *cutting* tools for lightweight fire extinguishers so that students would more easily understand the components of lightweight fire extinguishers, component functions, how to use, and how to work light fire extinguishers by using the media of *cutting* tools for lightweight fire extinguishers. Researchers will focus on the media of teaching aids *cutting* a lightweight fire extinguisher will help learning so that the results of learning increases.

II RESEARCH METHOD

The research design used in this study is the development of *Four-D* devices [8], [9] . This method consists of 4 stages of development namely *Define*, *Design, Develop, Disseminate* Stages. This type of research data is using quantitative and quantitative data, then the data are analyzed statistically descriptive. Descriptive statistics are statistics used to analyze data in ways that describe or depict the data that has been collected as without meaning make conclusions or generalizations apply to the public [10], [11].

(1) Qualitative Data

Skinative data is used to analyze nontest data that can be obtained through comments, criticisms, suggestions obtained from questionnaires, interviews, and discussion of the expert test process.

(2) Quantitative Data

In this analysis quantitative data were obtained from score scores and then included in statistical tables from the results of the assessment of material experts, media experts, student response sheets to the media, and student learning outcomes. The analysis used is:

(3) To find the mean or average using the formula:

$$x = \frac{\sum x}{N}$$

X $\qquad$ = average value

$\sum x$ $\qquad$ = Sum of all values

N $\qquad$ = Number of students

(a) Normality Test , this test is used to determine whether the sample of this study is from a normal population or not. In this study using the *Kolmogorov –Smirnov* test . Test criteria are if p (significance)$> 0 , 05$ then the normal distribution and if p (sig) <0.05 then the distribution is not normal.

(b) Homogeneity Test , Homogeneity test is used to test whether the samples are from a homogeneous population or not. In statistical language, this test is used to find out the same variation or not.

(c) T-Test , test is used to compare the average learning outcomes of the experimental group and the control group.

III RESULTS

1) Expert Validation

Media Expert Validation Data, Media expert validation aims to measure the feasibility of the media to be developed with the assessment of media experts as input from the development of *cutting* media for light fire extinguishers [12], [13] , where the input will be used as a reference to improve the media (revision) before the next step namely development trials. The results of the validation of media experts regarding the development of *cutting* media for fire extinguishers are as follows:
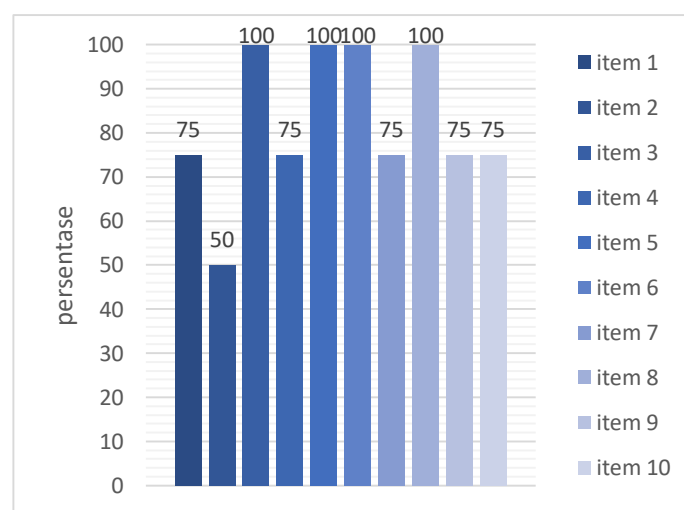

Figure 1: Media Expert Validation Result

Based on an analysis of 10 items validated by media experts, the evaluation criteria in the media aspect are as follows:

(1) Suitability of material and media displayed in the form of a stand, media experts answered "B" well, so that the score obtained was 3 with a percentage of 75%. Based on 75% data interpretation criteria, including good classification, because the media of *cutting* light fire extinguishers that were developed in accordance with the material in the study of the Occupational Health and Safety course.

(2) Completeness of the learning media in accordance with the material, media experts answered "C" enough, so the score obtained was 2 with a percentage of 50%. Based on the criteria of interpretation of 50% data, including sufficient classification. With the results of the assessment on item number two shows there are some completeness that are still considered lacking or there must be revision.

(3) The clarity of the media for *cutting* a lightweight fire extinguisher in accordance with the material, media experts answered "A" very well, so the score obtained 4 with a percentage of 100%. Based on the criteria of interpretation of data 100% including very good classification, because of instructions or information

about what is in the medium of *cutting* a fire extinguisher in accordance with the material in learning the subject of Occupational Health and Safety.

(4) The appearance of the design of the *cutting* media of the fire extinguisher was interesting, the media experts answered "B" well, so the score obtained was 3 with a percentage of 75%. Based on 75% data interpretation criteria, including good classification, because the appearance of the design of the *cutting* media of a fire extinguisher there is a description of the parts of the media.

(5) The media of *cutting* a fire extinguisher using attractive colors, media experts answered "A" very well, so the score obtained 4 with a percentage of 100%. Based on the interpretation criteria of the data 100% including the classification is very good, because the color used on the *cutting* media of the fire extinguisher is interesting and in accordance with the visualization in accordance with the material.

(6) The level of ease of use of learning media for *cutting* light fire extinguishers, media experts answered "A" very well, so the score obtained was 4 with a percentage of 100%. Based on the criteria of interpretation of data 100% including the classification is very good, because the application of *cutting* media fire extinguisher is very easy.

(7) The media of *cutting* a lightweight fire extinguisher is easy to carry, media experts answer "B" well, so the score obtained is 3 with a percentage of 75%. Based on 75% data interpretation criteria, including good classification, because indeed the selection of media that is suitable for the material and also because the medium of *cutting* a lightweight fire extinguisher is chosen based on a size that makes it easy for its users to carry.

(8) Completion of the composition of the media for *cutting* a small fire extinguisher, media experts answered "A" very well, so the score obtained 4 with a percentage of 100%. Based on the interpretation criteria of the data 100% including the classification is very good, because the completeness in the *cutting* medium for fire extinguishers has a lot of development but does not eliminate the information that already exists in the medium for *cutting* fire extinguisher.

(9) The form of *cutting* medium in a fire extinguisher is in accordance with the teaching aids in general, media experts answer "B" well, so the score obtained is 3 with a percentage of 75%. Based on 75% data interpretation criteria, including good classification, because the *cutting* media for fire extinguishers was developed as an easy tool in its application.

(10) The clarity of the media for *cutting* a lightweight fire extinguisher , media experts answered "B" well, so the score obtained was 3 with a percentage of 75%. Based on 75% data interpretation criteria, including good classification, because the media for *cutting* a lightweight fire extinguisher there is information that makes it easy for educators and students to easily understand.

Material Expert Validation Data, Material expert validation aims to measure the appropriateness of the material (test instruments and questionnaires) that will be developed with the assessment of material experts as input from the development of material in the *cutting* medium for light fire extinguishers, where the input will be used as a reference to improve the material (revision) before steps are taken then the development test. The results

of the material expert evaluation of the material for the development of *cutting* media for fire extinguisher are as follows:
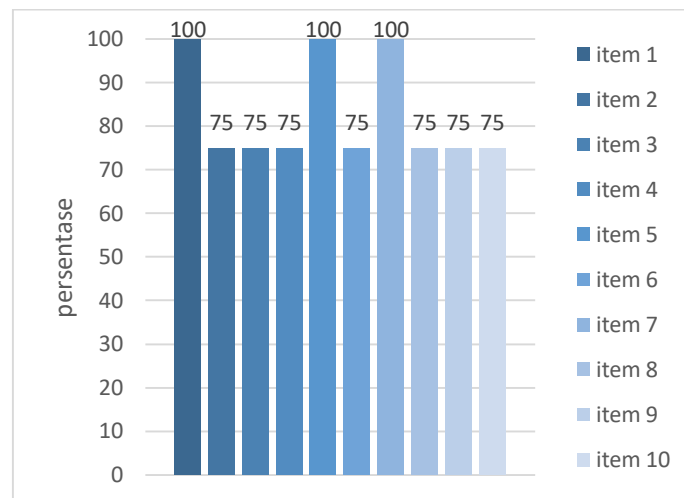

Figure 2: Validation results of material experts

Based on an analysis of 10 items validated by media experts, the evaluation criteria in the media aspect are as follows:

(1) Suitability of the media with the material, material experts answered "A" very well, so the score obtained 4 with a percentage of 100%. Based on 100% data interpretation criteria including very good classification, because the material contained in the RPS is in accordance with the media used.

(2) Completeness of learning media in accordance with the material, material experts answer "B" well, so the score obtained 3 with a percentage of 75%. Based on 75% data interpretation criteria, including good classification, because the available material is related to the completeness of the media developed.

(3) The clarity of the medium of *cutting* the fire extinguisher in accordance with the material, the material expert answered "B" well, so the score obtained was 3 with a percentage of 75%. Based on 75% data interpretation criteria, including good classification, because the media developed to adjust the material available in learning.

(4) Ease of students in understanding the material, material experts answer "B" well, so the score obtained 3 with a percentage of 75% based on 75% data interpretation criteria including good classification, because the material developed is simpler and makes it easier for students to accept it.

(5) The suitability of the material with the learning media for *cutting* fire extinguishers, material experts answered "A" very well, so the score obtained was 4 with a percentage of 100%. Based on 100% data interpretation criteria including very good classification.

(6) The level of ease of use of learning media for *cutting* small fire extinguishers, material experts answer "B" well, so the score obtained is 3 with a percentage of 75%. Based on 75% data interpretation criteria including good classification.

(7) Suitability of the media to achieve the expected goals, material experts answer "A" very well, so the score obtained 4 with a percentage of 100%. Based on 100% data interpretation criteria including very good classification.

(8) Learning media as a whole is easy to understand, material experts answer "B" well, so the score obtained is 3 with a percentage of 75%. Based on 75% data interpretation criteria including good classification.

(9) The form of *cutting* medium for a fire extinguisher is in accordance with the teaching aids in general, material experts answer "B" well, so the score obtained is 3 with a percentage of 75%. Based on 75% data interpretation criteria including good classification.

(10) Clarity of the media for *cutting* a lightweight fire extinguisher, material experts answer "B" well so that the score obtained 3 with a percentage of 75%. Based on 75% data interpretation criteria including good classification.   Here are the results of the development of cutting media fire extinguishers light :

Figure 3: The results of the development of cutting media fire extinguisher light fire

2) Development Testing (development testing)

(1) Trial of Instrument Results of Responses

Validity is an integrated evaluative assessment carried out by the assessor regarding the extent to which the empirical and rational theoretical evidence supports the accuracy of inference and action based on test scores or other assessments [14] . Researchers validate the instrument using SPSS, researchers used *rtabel* 50 = 0.279, because it refers to the number of respondents surveyed. Following are the validation data:

Table 2: Validation of Response Instrument Results

No	*Rxy*	*r table* N = 50	Information
1	0.518	.279	Valid
2	.487	.279	Valid
3	0.598	.279	Valid
4	0.440	.279	Valid
5	0.582	.279	Valid
6	.493	.279	Valid
7	.623	.279	Valid
8	.681	.279	Valid

9	.707	.279	Valid
10	0.427	.279	Valid

From the data obtained it is calculated that the *r count* is greater than *rtable* that is 50 = 0.279, then the results of the acquisition of each question item listed in table 14 shows that the instrument is valid.

Reliability shows that an instrument can be trusted enough to be used as a data collection tool . Researchers conducted instrument reliability testing using the SPSS application with r table 50 = 0.279 to adjust the number of respondents used. The reliability results can be seen in the following SPSS output table :

Table 3. Instrument rebility results

Cronbach's Alpha	N of Items
.741	10

From the calculated instrument reliability results and based on table 3 (reliability coefficient values), the calculated reliability results are classified as high and reliable.

(2)   Comparative Learning Outcomes of Control Classes and Experiment Classes

The results of the comparison of learning outcomes of the control class and the experimental class are as follows:

Table 4: Comparison of control and experimental class learning outcomes

Statistical Indicator	Control class	Experimentation Class
Amount	1670.00	2120.00
Average	66.80	84.80
Highest Scores	80.00	100.00
Lowest score	55.00	65.00
Statistical Indicator	**Control class**	**Experimentation Class**
Standard Deviation	6.59	7.96
Mode	60.00	85.00
Median	65.00	85.00
N	25	25

Based on table 22, there is a comparison of learning outcomes from the average indicator between the control class at 65.80 and the experimental class at 84.40. To find out the differences in learning outcomes between the control class and the experimental class the normality test, homogeneity test and t test [15] are used . The results of the calculations are as follows:

Table 5: Test results for normality of learning outcomes.

Learning outcomes		Kolmogrov Smirnov (a)		
		Statistics	df	Sig.
Class	Control	169	25	.064
	Experiment	152	25	.132

Based on the results of the normality *test* (*test of normality*) of the two classes get results above 0.05 with the control class 0.064 and the experimental class 0.132. From the SPSS results above, it can be concluded that the data are normally distributed.

Table 6: Homogeneity results

Levene Statistics	df1	df2	Sig.
.037	1	48	847

Table 7: *One-way ANOVA*

	SuM of Square	df	Mean Square	F	Sig.
Between Groups	4050.00	1	4050.00	75,701	0.00
Whitin Groups	2568.00	48	53,500		
Total	**6618.00**	**49**			

The results of the SPSS program output on the *one-way ANOVA were* obtained in the *Homogeneity 6 of variance test* section, obtained p significance = 0.847, the data was said to be homogeneous if p significance> 0 , 05 . The data shows that both groups have the same or homogeneous variants .

Table 8: T test of control and experimental classes

Class	The mean	N	Std. Deviation	Std. Error Mean
Control	66,8000	25	6.59545	1.31909
Experiment	84,8000	25	7,96869	1.59374

According to the table that shows that the mean value between the control class 66.80 and the experimental class 84.80, the results show that the difference in results between the control group (without the use of media) and the experimental class (with the media), where the results of the experimental class higher than the class control.

Based on the description of the results of the research described previously, the stages of developing instructional media are based on the development of the 4D model. Where in the development of the 4D model consists of 4 stages, namely stage of definition, stage of design, stage of development, and stage of deployment. After doing the four stages the results obtained in the form of learning media *cutting* aids fire extinguisher.

In the first phase of the definition phase, in the first stage is known medium of learning developed in the plan pembeajaran half related to the achievement of learning and subjects containing about fire prevention. Results of analysis of students based on preliminary studies conducted by researchers, students are able to participate in learning but the expected learning outcomes of students are not in accordance with what is expected and from these results students also show that the media used in learning is not as expected. It is necessary to conduct training on the use of APAR to employees or at a minimum to the person appointed as a fire surveillance officer . In the case

of media selection, it also examines the research that has been carried out, which is where the development of media to assist learning needs to be carried out [16] - [18].

Furthermore, in the *design* stage carried out the design related to instruments and media that will be used in this development. The instruments are arranged based on test standards by following the *C1-C6 taxonomy* reference and statistical tests in the SPSS program which include validity, reliability, difficulty levels and different power . The selection of instructional media is made based on reference to teaching aids in general, by using a fire extinguisher with a *volume of* 2,5 kg. In the selection of instructional media used by researchers refers to the competencies or materials that exist in learning Occupational Health and Safety. Next, the researcher makes a preliminary design of the media that will be used with the aim of making a model that is in accordance with the material or competencies taught in the Occupational Health and Safety course.

The development stage, at this stage there are two stages, namely the validation stage and development trials. Validation in this development there are two things that become the object of validation, namely media and material. Media validation carried out by media experts got a score of 33 out of a maximum score of 40 with a percentage of 82.50% included in either classification. Material validation was also carried out to validate instruments (tests and questionnaires) and material. Material experts give a score of 33 out of a maximum score of 40 with a percentage of 82.50% included in either classification. Furthermore, after the validation is carried out, it continues to the revision of the media and material in accordance with the advice of experts.

The development phase of the trial is carried out by taking data from small groups related to students' responses to learning using the medium for *cutting* fire extinguishers . The number of respondents in the small group is 10 respondents. The results of the small group test get a score of 345 with a maximum score of 400 and are presented at 86.25% which is included in the good classification.

In the final stage of the research trial, a two-step data retrieval was used, the correspondent fills in the questionnaire related to media and questions to find out the correspondent's learning outcomes. Questionnaire student responses given to 25 correspondents get a score of 759 with a maximum score of 1000 and a presentation of 75.90% which is included in the good classification. Furthermore, the learning outcomes data are divided into two learning outcomes namely the control class without using media with the number of correspondents 25 students who get a total score of 1.670 with an average of 66.80 and the results of the experimental class using learning media teaching aids *cutting* a lightweight fire extinguisher get score of 2.120 with an average of 84.80. From the results of the two classes there is a comparison, where the experimental class that uses the medium of *cutting* tools for lightweight fire extinguishers is higher than the control class that does not use the medium for learning of tools for *cutting* the light fire extinguisher.

The last is the *dissemination* phase, this stage is carried out by socializing learning media to semester 2 students, precisely class B, which is held on Tuesday, May 21, 2019 at 08.21 which is located in lecture hall A4 on the 3rd floor of Muhammadiyah University, Purworejo. The company uses APAR for the classification of fires A, B, C in accordance with regulations. There are still many APARs that do not have instructions on how to use them and there is no security for APAR that is vulnerable to being uprooted in the company [19] . From the results of research that has been done related to Light Fire Extinguishers (APAR), there are many Light Fire Extinguishers

which have no instructions for use or safety. Based on the results of research and studies related to the research that has been done, shows that media tool props *cutting* fire extinguisher feasible and valid to be used as a medium of learning in the subject of Health and Safety.

IV CONCLUSION

The development of *cutting* aids for lightweight fire extinguishers has been validated by media experts who received a score of 33 with a maximum score of 40 and a presentation of 82.50% which included a good classification. The results of the second class to learn to learn to be an indicator that the use of media props *cutting* extinguisher fire light plays a role in learning. This is evidenced by the comparison of learning outcomes between the control class that gets an average value of learning outcomes 66.80 and the experimental class that gets an average value of 84.80 learning outcomes. The t test results also indicate that there are differences between the two control class and experimental learning outcomes. This is indicated by the value of sig . (2-tailed) which is smaller than 0.05 which is 0.00, so there is a difference between the dick class and the experimental class. Thus it can be stated that the learning media is feasible to use and is better than the previous media.

REFERENCES

1. M. Jüttler, A. Jüttler, S. Schumann, dan F. Eberle, "Work or university? Economic competencies and educational aspirations of trainees with hybrid qualifications in Switzerland," *Empir. Res. Vocat. Educ. Train.*, vol. 8, no. 1, hlm. 6, Des 2016, doi: 10.1186/s40461-016-0032-1.

2. S. Suyitno, J. Dwi, S. Arif, dan P. Aci, "Trainer Stand Instructional Media of Wiring System for Kijang Car to Improve Student Achievement in Vocational Higher Education," *Jour Adv Res. Dyn. Control Syst.*, vol. 11, no. 11, 2019, doi: 10.5373/JARDCS/V11SP11/20193126.

3. M. Nurtanto, H. Sofyan, P. Pardjono, dan S. Suyitno, "Development model for competency improvement and national vocational qualification support frames in automotive technology," *Int. J. Eval. Res. Educ. IJERE*, vol. 9, no. 1, 2020, doi: https://doi.org/10.11591/ijere.v9i1.20447.

4. D. Allan, "Dealing with disaffection: the influence of work-based learning on 14–16-year-old students' attitudes to school," *Empir. Res. Vocat. Educ. Train.*, vol. 6, no. 1, hlm. 10, Des 2014, doi: 10.1186/s40461-014-0010-4.

5. R. Mayefis dan S. Barat, "Development of Android Based Mobile Learning Media on Computer Assembly at a Vocational High School," *Int. J. Innov. Creat. Change*, vol. 11, no. 4, hlm. 347–361, 2020.

6. U. Mulbar, "The development of metacognition-based learning media for the industrial electronics field in a vocational high school," *World Trans. Eng. Technol. Educ.*, vol. 15, no. 1, 2017.

7. P. Pardimin, N. Arcana, dan D. Supriadi, "Developing Media Based on the Information and Communications Technology to Improve The Effectiveness of The Direct Instruction Method in Mathematics Learning," *J. Educ. Gift. Young Sci.*, hlm. 1311–1323, Des 2019, doi: 10.17478/jegys.592636.

8. I. K. Suartama, P. Setyosari, S. Sulthoni, dan S. Ulfa, "Development of an Instructional Design Model for

Mobile Blended Learning in Higher Education," *Int. J. Emerg. Technol. Learn. IJET*, vol. 14, no. 16, Agu 2019, doi: 10.3991/ijet.v14i16.10633.

9. S. Suyitno, *Metodologi Penelitian Tindakan Kelas, Eksperimen, dan R & D*. Alfabeta, 2018.

10. S. Thiagarajan, *Instructional Development for Training Teachers of Exceptional Children: A Sourcebook [By] Sivasailam Thiagarajan, Dorothy S. Semmel [and] Melvyn I. Semmel*. Council for Exceptional Children, 1974.

11. B. Sawitri, S. Amanah, A. Saleh, dan A. V. S. Hubeis, "Development of Learning Modelsfor Paddy-Rice Farmers in Under- DevelopedAreain Indonesiathrough Strengthening Capacity and Independence," *Int. J. Adv. Sci. Technol.*, vol. 29, no. 03, hlm. 11, 2020.

12. Z. S. Dhahir, P. Hussein, dan S. M. Mangj, "Develop an Electronic Testing System Using Artificial Intelligence," *Int. J. Adv. Sci. Technol.*, vol. 29, no. 3, hlm. 11, 2020.

13. H. E. A. Tinsley dan S. D. Brown, *Multivariate Statistics and Mathematical Modeling*. Academic Press, 2000.

14. M. Nurtanto, D. Widjanarko, H. Sofyan, Rabiman, and M. B. Triyono, 'Learning By Creating: Transforming Automotive Electrical Textual Material Into Visual Animation As A Creative Learning Products (CLP)', *Int. J. Sci. Technol. Res.*, vol. 8, no. 10, pp. 1634–1642, Oct. 2019, Accessed: Jan. 18, 2020. [Online]. Available: http://www.ijstr.org/paper-references.php?ref=IJSTR-1019-22932.

15. G. Gunawan, A. Harjono, L. Herayanti, dan S. Husein, "Problem-Based Learning Approach with Supported Interactive Multimedia in Physics Course: Its Effects on Critical Thinking Disposition," *J. Educ. Gift. Young Sci.*, hlm. 1075–1089, Des 2019, doi: 10.17478/jegys.627162.

16. S. Suyitno, "Pengembangan Multimedia Interaktif Pengukuran Teknik untuk Meningkatkan Hasil Belajar Siswa SMK," *J. Pendidik. Teknol. Dan Kejuru.*, vol. 23, no. 1, hlm. 101, Mei 2016, doi: 10.21831/jptk.v23i1.9359.

17. S. Suyitno dan S. Syakirun, "Pengembangan Media Pembelajaran Audio Vidio Pada Motor Bakar 4 Langkah untuk Meningkatkan Prestasi Belajar," *J. Pendidik. Surya Edukasi*, vol. 4, no. 1, hlm. 19–34, Jun 2018.

18. L. Firdani dan B. Kurniawan, "Analisis Penerapan Alat Pemadam Api Ringan (APAR) Di PT . X Pekalongan," *JKM E-J.*, vol. 2, no. 5, hlm. 300–308, 2014.

19. M. Nurtanto, P. Pardjono, Widarto -, and S. D. Ramdani, 'The Effect of STEM-EDP in Professional Learning on Automotive Engineering Competence in Vocational High School', *J. Educ. Gift. Young Sci.*, vol. 8, no. 2, pp. 633–649, Jun. 2020, doi: 10.17478/jegys.645047.

20. Z. Arifin, M. Nurtanto, W. Warju, R. Rabiman, and N. Kholifah, 'The TAWOCK Conceptual Model for Content Knowledge for Professional Teaching in Vocational Education', *Int. J. Eval. Res. Educ. IJERE*, vol. 9, no. 3, Apr. 2020, doi: 10.11591/ijere.v9i3.20561.

21. R. Rabiman, M. Nurtanto, and N. Kholifah, 'Design and development E-learning system by learning management system (Lms) in vocational education', *Int. J. Sci. Technol. Res.*, vol. 9, no. 1, pp. 1059–1063, 2020.

22. R. Rabiman, W. Widarto, M. Nurtanto, and N. Kholifah, 'Stem education: Vocational teacher's perspective of 21st century', *Int. J. Psychosoc. Rehabil.*, vol. 24, no. 6, pp. 9887–9893, 2020, doi: 10.37200/IJPR/V24I6/PR260985.