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Creation of Engineering Drawing Learning Modules Using Datum Plane Media in Improving Students' Competence in Automotive Engineering Skills at SMK Negeri 55 Jakarta

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ABSTRACT

The aim of this research is to determine the feasibility and effectiveness of the engineering drawing module using datum plane media to strengthen students' knowledge about projections on objects. This research uses the 4D research method developed by S. Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel in 1974 which consists of 4 stages, namely Define, Design, Develop and Disseminate. Data was collected through interviews, questionnaires and pre-test and post-test. The subjects of this research were students majoring in automotive engineering at SMKN 55 Jakarta 2023/2024 academic year class x semester 1 with a sample size of 30 students from a population of 3 classes in total 103 students. The research began with Define, namely defining the need for difficulties in students' understanding of reading and drawing projections by observing and interviewing teachers who teach technical drawing. Furthermore, from the observation data obtained, the researchers looked for solutions to the problems faced by automotive vocational school students with modules that use datum planes, so the researchers designed the required modules and datum planes. At the Developing stage, the researcher's design is validated by material experts and media experts, their criticism and suggestions are used as input for revising the media created. Finally, the Disseminate media stage, which had been validated and revised, was used on 30 students from SMKN 55 Jakarta, carried out a pre-test and post-test and obtained an average result for the entire pre-test sample of 45.33 and post-test of 68.17.

Keywords: *Making Engineering Drawing Modules, Basics of Making Modules, Engineering Drawing Projections*

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INTRODUCTION

Currently, the industrial world is entering the era of Industry 5.0, not only the automation found in Industry 4.0 but also more complexity towards artificial intelligence (AI) technology so that it is easier for humans and machines to collaborate with each other (Matuszak Justyna, 2022). Collaboration or mutual interaction between humans and machines use communication that machines understand and humans can learn.

Communication between machines and humans uses digital codes that have been perfected in the form of software. Now it is inevitable that the use of software has spread to all areas of work which were previously only studied in computer and programming departments, now all scientific disciplines use software that is tailored to their needs. In the manufacturing and assembly industry, communication tools are needed from every line, from purchasing, machining, assembling to marketing. The communication tool between lines is technical drawings, the purchasing department must be able to read drawings of what components or materials must be prepared according to the dimensions and characteristics of the material, technical drawings are very important in the machining section for the accuracy of the shape and dimensions of the objects being made and so on.

The Director General of Vocational Education, Mr. Wikan Sakarinto, said there are five minimum requirements so that link and match between vocational education and the industrial world can occur (Kemdikbud, 2020). He explained, (1) creating a link and match between vocational and industrial worlds is the creation of a joint curriculum. Where the curriculum must be synchronized every year with industry. (2) the industry is obliged to provide teachers or guest lecturers. The minimum teaching from lecturers and guest teachers is a minimum of 50 hours per semester. (3) providing internships to vocational students and vocational students from jointly designed industries. Mr. Wikan said that his party requires an internship of at least one semester. Don't suddenly let the industry only be invited to do internships and take it for granted, it wasn't designed (together) from the start. (4) competency certification. According to Mr. Wikan, competency is very important for vocational graduates. Certificates are needed to show the competency level of vocational graduates. (5) commitment to absorb vocational school graduates by industry. The link and match package up to the join level that we designed is developing a teaching factory. So that teaching industry is included in the curriculum

In the independent curriculum for the Basics of Automotive Engineering subject for the Technical Drawing sub-lesson at the end of phase E, students are able to draw basic techniques, including introduction to various drawing tools, standardization in drawing, as well as practice drawing and reading technical drawings, and determining location. and position of automotive components based on manual drawings (kemdikbud, n.d.).

Table 1. Learning competencies that students must achieve at the end of each phase

Phase	Class/Level
Foundation	Early Childhood Education (PAUD)/RA
A	Class I-II SD/MI/Package A/equivalent
B	Class III-IV SD/MI/Package A/equivalent
C	Class V-VI SD/MI/Package A/equivalent
D	Class VII-IX SMP/MTs/Package B/equivalent
E	Class X SMA/SMK/MA/MA Vocational/Package C/equivalent
F	Classes XI-XII SMA/MA/Package C/equivalent and Vocational School/MA 3 (three) year program; And Classes XI-XIII Vocational School/MA 4 (four) year program

Technical drawing lessons are only available in class 10, semester 1 and in the Basics of Automotive Engineering subject, which of course only requires a small number of study hours, whereas the role of knowledge of technical drawing is basic and very important.

METHOD

In further development, research and development of 4D and ADDIE models are often used in research and development of teaching materials such as modules, worksheets and textbooks (Mulyatiningsing Endang, 2011). Therefore, researchers chose to use the 4D method developed by Thiagarajan et al (1974). The 4D model consists of 4 stages, namely: Define, Design, Develop and Disseminate, based on this model the researcher then does:

Define is the first stage of defining development requirements which can also be called needs analysis. There are 5 activities at this stage, namely : (1) Front and analysis with the results of interviews with teachers who teach technical drawing, researchers can make an initial diagnosis of module needs. (2) Learner analysis, observation looks at the characteristics of students from observations conveyed by teaching teachers and directly seeing teaching and learning activities. (3) Task analysis by looking at learning outcomes and main tasks that students can achieve. (4) Concept analysis by analyzing a new concept using a technical drawing module with a datum plane and its steps. (5) Specifying instructional objectives by formulating learning objectives with modules using a datum plane so as to obtain the desired change in understanding from students.

Interviews are used as a data collection technique when researchers conduct preliminary studies aimed at finding the problems to be researched (Sugiyono, 2017).

RESULT

Table 1. Results of interviews with technical drawing teachers at SMKN 55 Jakarta

No	Question	Interview result
1	What needs are needed to improve understanding of projection in technical drawing subjects?	Projection modules and visual aids in understanding projections/views on technical drawings
2	What level of understanding of the module content is required?	The level of understanding of the content of this module is at a basic level
3	What sources of enrichment material are needed?	The source material contained in this module must be relevant, with reference to existing enrichment/training modules
4	What kind of material and job sheet content does the module require?	The content of the material and job sheets contained in this module must be in accordance with the Datum Plant teaching aids and the basics of determining projections in technical drawing.

Design is a design stage which is divided into 4 activities, namely: (1) constructing criterion-referenced tests during observations can determine the basic criteria for understanding projections that students need. (2) media selection according to the characteristics of the students, a module with a datum plane is selected which will be used as media (3) selection format to make teaching easier, carried out using audio-visual with a projector, module and datum plane model (4) initial design by carrying out appropriate learning steps The plan is that during the face-to-face meeting, a pre-test will be carried out first, after that they will provide an explanation and will be given the opportunity to read the module and see and practice the use of the datum plane. The shape of the datum plane is as in the image below.

A datum is a theoretically perfect point, axis, line, plane, or combination thereof. A datum specifies the origin from which the location or geometric characteristics of a part's features are determined. These points, axes, lines, and planes exist in a structure of three intersecting perpendicular datum planes known as the datum reference frame (Cogorno, 2020)

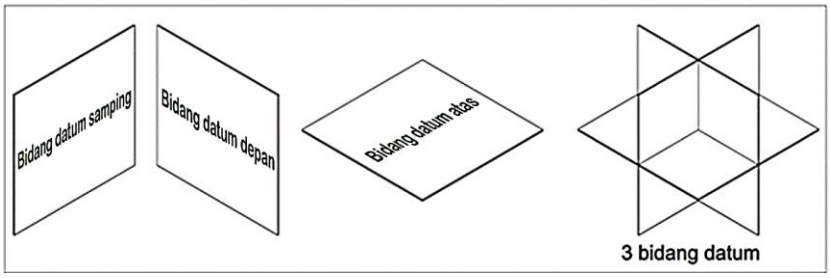

Figure 1. Datum plane

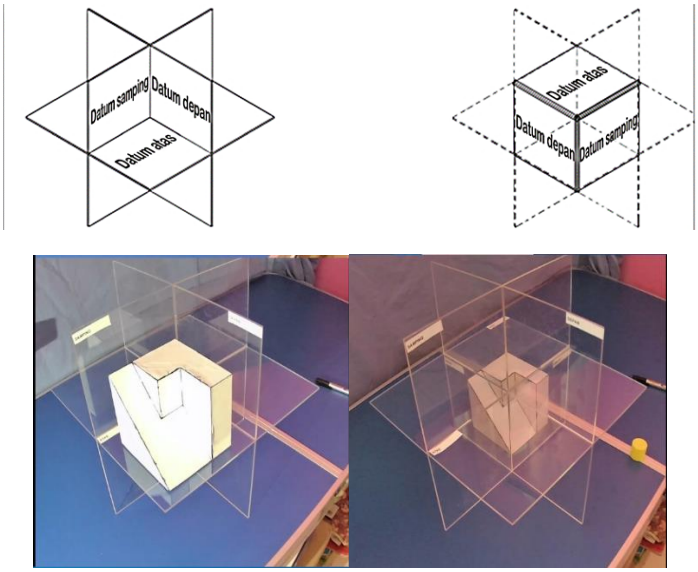

Figure 2. Use of European (left) and American (right) projection datum planes

Develop is the stage where the researcher receives input and revisions by carrying out steps, namely: (1) Validation of the model by experts, in this case the researcher creates a validated questionnaire consisting of 2 material experts and 1 media expert. (2) Revised the model based on input from experts, there are several shortcomings such as the addition of questions for each chapter and interactive questions for each point. A questionnaire is a data collection tool that contains a number of questions or statements that must be answered by the research subject (Mulyatiningsing Endang, 2011)

The instrument in the form of a questionnaire is measured using a Likert scale. The Likert scale is a question that shows the respondent's level of agreement or disagreement(Wiratna Sujarweni V, 2020). From the validation results, an average score of

3.045 was obtained by material expert lecturers, an average of 3.9 by material expert teachers with appropriate recommendations with notes and an average of 3.87 by media experts with appropriate recommendations with notes.

Table 2. Likert scale

Alternative Answer	Value
Strongly Agree / Sangat Setuju (SS)	4
Agree / Setuju (S)	3
Less Agree / Kurang Setuju (KS)	2
Disagree / Tidak Setuju (TS)	1

Disseminate is the final stage after the module has been revised and then implemented on the actual target. During implementation, a measurement of the achievement of the objective was carried out to determine the effectiveness of the module developed by conducting a pre-test and post-test by providing teaching using the module between the two tests. The pre-test and post-test that were carried out at SMKN 55 Jakarta were obtained as shown in the following table:

Table 3. Pre-test and post-test results

No.	L/P	Pretest	Post Test	Class	No.	L/P	Pretest	Post Test	Class
1	L	45	70	X TSM	16	L	45	60	X TKR 1
2	L	40	65	X TSM	17	L	30	50	X TKR 1
3	L	50	80	X TSM	18	P	65	80	X TKR 1
4	L	35	65	X TSM	19	L	45	60	X TKR 1
5	L	45	95	X TSM	20	P	40	65	X TKR 1
6	L	50	85	X TSM	21	L	20	60	X TKR 1
7	L	15	60	X TSM	22	L	60	65	X TKR 2
8	L	35	95	X TSM	23	L	70	75	X TKR 2
9	L	40	45	X TSM	24	L	30	60	X TKR 2
10	L	15	75	X TSM	25	L	65	70	X TKR 2
11	L	45	60	X TKR 1	26	L	80	85	X TKR 2
12	L	60	85	X TKR 1	27	L	50	80	X TKR 2
13	P	70	85	X TKR 1	28	L	45	45	X TKR 2
14	L	50	55	X TKR 1	29	P	35	45	X TKR 2
15	L	65	85	X TKR 1	30	L	20	40	X TKR 2
						$\sum$=	1360	2045	X TKR 2
						$\bar{X}$=	45.33	68.17	

DISCUSSION

Discussion of Module Feasibility Test

The feasibility of the module is assessed by material experts, media experts, and Class X vocational school students. The assessment is carried out using a questionnaire with several questions. The questionnaire consists of four answer choices which are then converted into the categories Very Eligible, Eligible, Not Eligible, and Not Eligible as stated in the data analysis. Aspects assessed by material expert lecturers, material expert teachers, media expert lecturers and trial respondents include aspects: learning outcomes and objectives, learning materials, design for using modules in learning, learning design, appearance, characteristics, material and appearance.

In the module feasibility test, which was carried out using a questionnaire instrument for material expert lecturers, material expert teachers, media expert lecturers and respondents (trial participants), the results were obtained:

Table 4. Validation Results of Material Experts, Media Experts and Participants

No	Name	Position	Likert Scale Average Results	Criteria
1	Drs. Adi Tri Tyassmadi, M.Pd	Material Expert Lecturer	3.05	Worthy
2	Warta Lesmana, MT	Material Expert Teacher	3.9	Very Worth It
3	Dra. Ratu Amalia Avianti, M.Pd	Media Expert Lecturer	3.87	Very Worth It
4	Trial Participants	Participant	3.72	Very Worth It
Overall Criteria			**3.63**	**Very Worth It**

Discussion of Module Effectiveness

To test the effectiveness, statistical tests are carried out by first carrying out statistical requirements tests, namely determining whether the data to be processed is parametric or non-parametric data. Parametric data, if the data has a normal and homogeneous spark plug distribution, then a t test can be carried out on the data sample, in addition to the Wilcoxon test.(US Supardi, 2014).

Normality test

Table 5. SPSS Normality Test Results

Tests of Normality							
	Class	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistics	df	Sig.	Statistics	df	Sig.
Mark	Pre Test	.123	30	,200*	,968	30	,499
	Post Test	.116	30	,200*	,956	30	,246
*. This is a lower bound of the true significance.							
a. Lilliefors Significance Correction							

Hypothesis

H_0: Data is normally distributed

(Sign) $\alpha > 0.05$

H_1: Data is not normally distributed

(Sign) $\alpha < 0.05$

Based on statistical tests using SPSS for the normality test, it can be seen that the probability value is 0.200 > 0.05, so H_0 is rejected, which means the sample is normally distributed.

Homogeneity Test

Table 6. SPSS Homogeneity Test Results

Test of Homogeneity of Variance					
		Levene Statistics	df1	df2	Sig.
Mark	Based on Mean	,000	1	58	,993
	Based on Median	,004	1	58	,948
	Based on Median and with adjusted df	,004	1	56,394	,948
	Based on trimmed mean	,000	1	58	,996

Hypothesis

$H_0 : \sigma_1 = \sigma_2$: Homogeneous data

(Sign) $\alpha > 0.05$

$H_1: \sigma_1 \neq \sigma_2$: Data is not homogeneous

(Sign) $\alpha < 0.05$

σ_1 = Pretest Average

σ_2 = Posttest Average

Based on statistical tests using SPSS for the homogeneity test, it can be seen that the significant value is 0.993 > 0.05, so H_0 is accepted, which means the sample has the same significant variance or is homogeneous.

T test

In accordance with the statistical requirements test with normality and homogeneity tests, the data in this study is parametric data so that processing can be carried out using the T test.

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre Test - Post Test	-22.83333	16.17167	2.95253	-28.87194	-16.79473	-7,733	29	,000

Hypothesis:

H_0: $\mu_a = \mu_b$: There is no difference in the data
(Sign) $\alpha > 0.05$
H_1: $\mu_a \neq \mu_b$ There are differences in the data
(Sign) $\alpha < 0.05$
μ_a = Pretest Average
μ_b = Post test Average

Based on statistical tests using SPSS for the Independent Sample T Test, it can be seen that the Sig. (2-tailed) 0.000 < 0.05, then the results of using the technical drawing module using plant datum media show a significant difference between conventional teaching using this module. So, it can be concluded that H_0 is rejected, which means that the use of the technical drawing module using plant datum media is effective in increasing students' understanding.

CONCLUSION

From a series of research conducted on modules and media datum planes, validation results obtained an average score of 3.045 by material expert lecturers, an average of 3.9 by material expert teachers with appropriate recommendations with notes and an average of 3.87 by media experts with Worthy recommendation with notes. The average pre-test result was 45.33 and the post-test result was 68.17, taken from a sample of 3 classes with 10 students randomly selected from each class.

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