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The development of power electronics training kits for electrical engineering students: A validity test analysis

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Abstract—This study discusses one of the stages of the research in the development of the Power Electronics Training Kits in the learning process of the Power Electronics Practicum for Electrical Engineering students, namely the validity test analysis. The validity of the Power Electronics Training Kits is divided into three aspects, namely design, media/laboratory equipment, and materials aspects. Each of these aspects was validated each by two validators who had expertise in these aspects. The instrument used in testing this validity was a validated questionnaire that had gone through the previous instrument validation process. The analysis was carried out using Aiken's V Analysis. Validity analysis results are interpreted with the product development validity interpretation table by Aiken's to obtain the validity category. The results showed the Training Kits is valid in all aspects both aspects of design, media/laboratory equipment, and materials. The design aspect gained a value of V = 0.89 with a valid category, the media/laboratory equipment aspect gained a value of V = 0.88 which means valid, and the material aspect gained a value of V = 0.94 with a valid category. Thus, it can be concluded that the Power Electronics Training Kits developed for the learning process of the Power Electronics Practicum for Electrical Engineering students is valid in the aspects of design, media/laboratory equipment, and materials.

Keywords: *Power Electronics Training Kits, Power Electronics Practicum, Validity Test*

I. INTRODUCTION

Learning media play a very important role in the implementation of the learning process. The selection and use of good learning media is one of the determining factors for the successful implementation of the learning process in order to optimise the achievement of learning objectives (Arsyad, 2013; Yanto, 2019). There are several types of media that can be used in the practical learning process, each with their own characteristics and advantages, and their selection requires adaptation to the characteristics of the material and the learning process to be applied. One of the learning media that can be used in the learning process is the training kit (Candra, Dewi, Yanto, & Hastuti, 2020; Sardiman, 2008).

A training kit is a practical learning medium in the form of a set of tools, materials, including measuring instruments, that are useful for simulating a particular circuit or experiment in a more practical form. With a more practical form that facilitates its use in the learning process. The use of a training kit must be adapted to the characteristics of the material and the implementation of the learning process. A Training Kit cannot be used for all learning processes. Therefore, when selecting and determining the Training Kit to be used in the learning process, it is necessary to analyse the characteristics of the material and the learning process. This is easier to do if the training kit to be used is the result of an in-house development, tailored to the needs of the learning process.

The Power Electronics Practicum is one of the practical learning processes of the students of the Department of Electrical Engineering, which in its implementation is an experimental learning process in the laboratory. The aim of this learning process is to produce students who are able to practise and analyse power electronic circuits that are widely used in today's daily activities. Such as rectifiers, inverters and other applications (Flåten, Bergna-Diaz, Sanchez, & Tedeschi, 2017; Yang, Pian, & Liu, 2019). Based on the characteristics of the material and the learning process of power electronics practicum, a practical learning media is needed that can properly support the implementation of the learning process in the laboratory, so that it can help the implementation of the learning process to achieve optimal learning objectives. One of the learning media that can be used as an alternative choice for this learning process is the training kit. This is due to the need for a practical learning media that is in accordance with the characteristics of the material and the learning process of power electronics practicum (Yanto, Astrid, Hidayat, & Islami, 2019; Yanto, Hidayat, & Hamdani, 2018).

In the development of this Training Kit, several important aspects need to be taken into account in its implementation, so that the products produced are truly in line with the characteristics of the material and the learning process. In this way, the developed training kit can be a good practical learning medium, especially in helping the learning objectives to the maximum (Sanaky, 2009; Yanto et al., 2018). By adopting the Four-D development research steps, there are at least 4 main phases of developing this Training Kit so that it can be used in the learning process, namely the Define, Design, Develop and Disseminate phases (Heinich, 2005; Trianto, 2009). The 4 phases are carried out to ensure that the product developed in the form of a training kit is a valid, practical and effective product that can be used in the learning process of power electronics apprenticeship (Yanto et al., 2018; Yanto, Sukardi, & Puyada, 2017).

One of the 4 phases of development is the development phase. This development phase is one of the most important phases in development research and consists of validation, product testing, practical testing and effectiveness testing. To ensure that the products developed are correct and in line with the learning material, and to ensure that the products produced meet the criteria as learning media, validity testing is required.

Validity testing is conducted after the product has been designed and manufactured, which serves to ensure that the resulting product is suitable for testing in the learning process of Power Electronics Practicum. Therefore, research was conducted on the analysis of validity testing of the Power Electronics Training Kit developed for the learning process of Power Electronics Practicum students at the Department of Electrical Engineering, Faculty of Engineering, Padang State University. The purpose of this research is to test and analyse the validity of the Power Electronics Training Kit before it can be tested for use in the learning process of Power Electronics Practicum.

Media in language can be interpreted as an intermediary tool, or a message from the messenger to the recipient of the message. The tool can be in the form of hardware (hardware) or software (software) (Choi et al., 2018; Paratore, O'Brien, Jiménez, Salinas, & Ly, 2016). Learning media, on the other hand, are all the things or components that exist in a person's environment that can act as intermediaries to convey knowledge or educational messages to that person, as well as influence and stimulate that person to learn. These components come in the form of both hardware and software. With simple media, it can be defined that the relationship between media and learning is media as an intermediary or delivery of messages or educational materials from teachers to students (Arsyad, 2013; Yanto et al., 2017).

Learning media in general serve to facilitate the delivery of learning material from an educator to students so that it can help teachers and facilitate student understanding in the learning process. Good learning media will be able to improve the learning process of students in the learning process, which in turn is expected to be able to improve the learning outcomes of students. The use of learning media will greatly enhance the effectiveness of the learning process and the delivery of information (messages and instructional content) at that time. (Hobbs, Trevisan, Johansen, Dorny, & Gabriël, 2019; Sardiman, 2008).

A tool in language can be interpreted as an intermediary or mediator of a message from the messenger to the recipient of the message. The tool can be in the form of hardware (hardware) or software (software) (Choi et al., 2018; Paratore et al., 2016). Meanwhile, learning media are all the things or components that exist in a person's environment that can be an intermediary to deliver knowledge or educational messages to that person, as well as influence and stimulate that person to learn. These components come in the form of both hardware and software. With simple media, it can be defined that the relationship between media and learning is media as an intermediary or delivery of messages or educational materials from teachers to students (Arsyad, 2013; Yanto et al., 2017).

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Training Kit is a type of learning media for practical learning process in the laboratory. Training Kit or commonly called Trainer Kit or Trainer is a set of tools and materials needed in the practicum learning process that are designed and made in such a way to become a complete unit so that it is more practical in its use (Arsyad, 2013; Singhato, Banjong, & Charoonruk, 2017). With this training kit, the practical learning process will be more practical and efficient in the use of learning time.

Training Kit in the practical learning process is usually used to simulate a specific circuit or experiment with the aim of proving theoretical material, which involves learning activities of students. The Training Kit used for each type of learning process also has its own differences according to the characteristics of the material and the learning process applied (Arsyad, 2013; Sardiman, 2008). The training kit developed in this study is a training kit used for the learning process of power electronics practicum students majoring in electrical engineering, named Training Kit Power Electronics.

The Power Electronics Training Kit is a set of power electronics practicum tools and materials that are designed and manufactured into a single unit, this equipment can be used to help simulate power electronics circuits based on the needs of the power electronics practicum learning process material such as, 1-phase and 3-phase half-wave uncontrolled rectifiers, 1-phase and 3-phase full-wave controlled rectifiers, 1-phase and 3-phase full-wave controlled rectifiers, 1-phase and 3-phase inverters, and voltage regulators (Candra et al., 2020; Yanto et al., 2019, 2018), 2020; Yanto et al., 2019, 2018).

II. METHODS

In this study, validity testing was carried out by validators who are experts in the field of learning media and power electronics learning materials. The validator will provide a validity assessment based on the provided validity tool. There are three aspects of validation, namely design aspects, media/lab equipment aspects and learning material aspects. Each aspect will be validated by two experts.

A. Research instruments

The research tool used is a product validation sheet developed on the basis of the validity aspects tested. In this study, the validity aspects are divided into three, namely design aspects, media aspects and material aspects. The design aspect is a validation aspect related to the correctness, cleanliness and suitability of the product design with the function of the developed product. The media aspect is a validation aspect related to the fulfilment of functions and criteria as a practical learning medium, including aspects of laboratory standardisation and the application of occupational health and safety principles in the laboratory. While the material aspect is a validation aspect related to the correctness and suitability of the training kit developed with the learning material, where this training kit will be applied. The validity tool grids are presented in Table 1.

Table 1. Instrument validity grid

No.	Aspects of validation	Indicators
1.	Design	a. Practical shape b. Prioritises health and safety principles c. Easy to use d. Layout and number of components according to the needs of the learning material
2.	The media aspect	a. Fulfilling the learning media function b. Houses learning materials c. High aesthetics d. Supports the learning process e. Clear instructions for use
3.	The material aspect	a. Aptitude for learning materials. b. Curriculum and SAP learning fit. c. Commoditisation of the learning process as a whole.

From Table 1 it can be seen that the validity instrument grid, based on the three main aspects of validation, consists of 12 sub-aspects. This grid is the basis for the preparation of the instrument. After going through the instrument validation process, the design aspect validity instrument consists of 14 validation items, the media aspect consists of 12 validation items, and the material aspect consists of 12 validation items. Each validation item is given a rating option and the rating scale used is a Likert scale.

B. Data analysis technique

The data from the validator's completion of the validity sheet is used as a reference for conducting data analysis. The validity data were analysed using Aiken's V validity analysis technique (Arikunto, 2008; Sugiyono, 2018).

$$V = \sum s / [n\ (c-1)\ ] \qquad (1)$$

This analysis test is performed for each aspect. The results of the analysis with Aiken's V for each validation aspect were then interpreted with the interpretation table of Aiken's V value to obtain the tested validity category (Arikunto, 2008; Candra et al., 2020; Sugiyono, 2018).

III. RESULTS

The validity data obtained from the validation sheet completed by the validator for each aspect was then analysed using a predetermined data analysis technique. This test is carried out separately for each aspect.

A. Validation of the design aspect

The design validation was carried out by two expert design validators. Validation assessment data are obtained after the validator has made an assessment by completing the validation instrument provided. This instrument was completed by the validator after direct observation and trial of the developed training kit. The results of this validation were then analysed using Aiken's V-analysis. The results of the analysis are shown in Table 2.

Table 2: Design validation analysis results

Item	Validator 1		Validator 2		ΣS	V	Category
	Score	S	Scocre	S			
1	5	4	4	3	7	0,88	Valid
2	5	4	5	4	8	1,00	Valid
3	4	3	4	3	6	0,75	Valid
4	4	3	4	3	6	0,75	Valid
5	5	4	4	3	7	0,88	Valid
6	5	4	4	3	7	0,88	Valid
7	5	4	5	4	8	1,00	Valid
8	5	4	5	4	8	1,00	Valid
9	5	4	4	3	7	0,88	Valid
10	4	3	4	3	6	0,75	Valid
11	5	4	5	4	8	1,00	Valid
12	5	4	4	3	7	0,88	Valid
13	4	3	4	3	6	0,75	Valid
14	5	4	5	4	8	1,00	Valid
Total	**66**	**52**	**61**	**47**	**99**	**12,4**	**-**
Ave.	4,7	3,7	4,4	3,4	7,1	0,89	Valid

Based on the analysis results in Table 2, it can be seen that the average V value obtained is 0.89 with a valid category, besides that of the 14 items validated based on the validity instrument, all items obtained a V value ≥ 0.75, which means valid. Thus, the developed Power Electronics Training Kit is valid in the design aspect.

B. Validation of the media aspect

Media validation was carried out by two validators who are experts in the field of learning media and laboratory equipment. Validation assessment data is obtained after the validator has made an assessment by completing the validation instrument provided. This instrument was completed by the validator after observing and trying out the developed training kit. The results of this validation were then analysed using Aiken's V-analysis. The results of the analysis are shown in Table 3.

Table 3. Media validation analysis results

Item	Validator 1		Validator 2		ΣS	V	Category
	Score	S	Score	S			
1	5	4	5	4	8	1,00	Valid
2	5	4	5	4	8	1,00	Valid
3	5	4	5	4	8	1,00	Valid
4	4	3	4	3	6	0,75	Valid
5	5	4	4	3	7	0,88	Valid
6	4	3	4	3	6	0,75	Valid
7	4	3	5	4	7	0,88	Valid
8	5	4	4	3	7	0,88	Valid
9	4	3	4	3	6	0,75	Valid
10	4	3	4	3	6	0,75	Valid
11	4	3	5	4	7	0,88	Valid
12	5	4	5	4	8	1,00	Valid
Total	**54**	**42**	**54**	**42**	**84**	**10,52**	**-**
Ave.	**4,5**	**3,5**	**4,5**	**3,5**	**7**	**0,88**	**Valid**

Based on the analysis results in Table 3, it can be seen that the average V value obtained with a valid category is 0.88. In addition, of the 12 items validated on the basis of the validity instrument, all items obtained a V value ≥ 0.75, which means valid. Thus, the developed Power Electronics Training Kit is valid in the aspect of media and laboratory equipment.

C. Validation of the material aspect

Material validation was carried out by two validators who are experts in learning materials, namely power electronics learning materials for the undergraduate level of the Department of Electrical Engineering. Validation assessment data is obtained after the validator has made an assessment by filling in the provided validation instrument. This instrument was completed by the validator after observing and trying out the developed training kit. The results of this validation were then analysed using Aiken's V-analysis. The results of the analysis are presented in Table 4.

Table 4. Material validation analysis

Item	Validator 1		Validator 2		ΣS	V	Category
	Score	S	Score	S			
1	5	4	5	4	8	1,00	Valid
2	5	4	4	3	7	0,88	Valid
3	5	4	5	4	8	1,00	Valid
4	4	3	4	3	6	0,75	Valid
5	4	3	5	4	7	0,88	Valid
6	5	4	5	4	8	1,00	Valid
7	5	4	5	4	8	1,00	Valid
8	4	3	5	4	7	0,88	Valid
9	4	3	4	3	6	0,75	Valid
10	5	4	5	4	8	1,00	Valid
11	3	4	4	3	7	0,88	Valid
12	5	4	5	4	8	1,00	Valid
13	5	4	5	4	8	1,00	Valid
14	5	4	5	4	8	1,00	Valid
Total	**64**	**52**	**66**	**52**	**104**	**13,02**	**-**
Ave.	**4,6**	**3,6**	**4,7**	**3,5**	**3,7**	**0,93**	**Valid**

Based on the analysis results in Table 4, it can be seen that the average V value obtained with a valid category is 0.93. In addition, out of the 14 items validated based on the validity instrument, all items obtained a V value ≥ 0.75, which means valid. Thus, the developed Power Electronics Training Kit is valid in terms of learning materials.

The results of the validity analysis of the three aspects of validation show that the Power Electronics Training Kit developed for the learning process of Power Electronics Practicum is declared valid in the aspects of design, media and also learning materials. The results of the average validation assessment of the three validation aspects are shown in Figure 1.

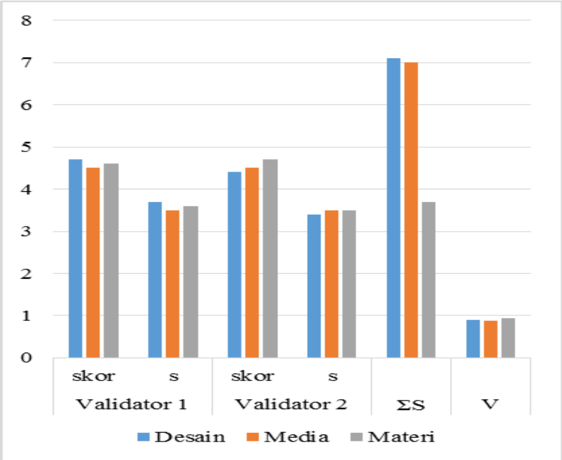

Figure 1. Graph of validity analysis of three aspects of validation

IV. Discussion

The Power Electronics Training Kit was designed and developed based on the analysis of student needs and learning materials in the Power Electronics Practicum learning process. The development process of the Power Electronics Training Kit must pass through several stages of testing as a requirement before the product can be applied in the learning process (Candra et al., 2020; Sukardi, Puyada, Wulansari, & Yanto, 2017). One of the most important in this testing is the validity testing stage, which is an assessment of the level of truth that is an indication of the feasibility of this training device to be applied to the learning process (Hobbs et al., 2019; Yanto, 2019). This is because before a product can be tested, validation testing must be carried out by experts who are in accordance with the validated aspects, this validation activity can be carried out repeatedly so that the results are obtained that the product is valid and can be tested.

The validity test phase shows that the Power Electronics Training Kit media is valid based on three validated aspects. The three aspects are design, media and material aspects. With the validity results of the three aspects, it can be used as a reference to make a decision that the Power Electronics Training Kit is valid and meets the criteria as a practical learning media for the learning process of Power Electronics Practicum students in the Department of Electrical Engineering. Furthermore, based on the research conducted by previous researchers, it is stated that once a product has been declared valid, field trials can be conducted to obtain other test data before the product can be used and applied regularly (Billett, 2004; Hamdani, Yanto, & Maulana, 2019; Singhato et al., 2017; Sukardi et al., 2017; Yanto et al., 2019, 2018).

V. Conclusion

Based on the results of the testing activities and the analysis of the results of the validity tests on the Power Electronics Training Kit, it can be concluded that the Power Electronics Training Kit as a whole is valid. Valid decisions are made based on the validity of the three main aspects of validation, namely media, design and material aspects. Thus, the Power Electronics Training Kit developed in the learning process of the Power Electronics Practicum for students of the Department of Electrical Engineering is valid in terms of design, media and power electronics learning material.

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