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Development of Problem-Project Based Learning Model in Power Electronics Course

[1]David Setiawan, [2]Ganefri, [3]Krismadinata

[1]Department of Electrical Engineering, Faculty of Engineering, Universitas Lancang Kuning
[2,3]Department of Electrical Engineering, Faculty of Engineering, Universitas Negeri Padang
[*1]dsetia@unilak.ac.id, [2]ganefri_ft@yahoo.co.id, [3]krisma@ft.unp.ac.id

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Abstract

Lecturer-oriented learning will result in students becoming bound by material and time so that it can lead to boredom of learning for students. Development of learning models based on Problem-Project Based Learning begins with instructional problems oriented to lecturers and needs analysis in the Power Electronics course. Power Electronics is a theoretical course with material about the application of high power electronics or called power converters. Learning strategies in the Problem-Project Based Learning model use 4 stages, namely theory, simulation design, prototype and project. The products produced are Teaching Module Books, Problem-Project Based Learning Book Models and Teaching Guidebooks. The research design used in this study is the ADDIE model design, the first stage is to analyze the learning model used and the analysis of needs in the form of a questionnaire. The second stage is designing the product in the form of teaching module books, learning model books and study guides. The three products will be assessed by experts or validators, improvements are made based on suggestions and input from experts, the third stage is conducting limited trials, limited trials consisting of 9 students. The fourth stage is the implementation or expanded trials, as many as 65 students were divided into two experimental classes. The fifth stage is evaluation, based on the results of Aiken's V the values given by the validator are categorized valid, based on the average questionnaire value given to the user ie students and lecturers are categorized very practical, and based on comparison of learning outcomes namely pre-test and post-test are categorized effective.

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1. Introduction

According to Galbreath (1999) the learning approach used in the 21st century is a mix approach, which is a combination of learning approaches from lecturers, learning from other students and learning on oneself. Then also stated by Rusman (2012: 22) which states that there are differences between learning practices in the industrial century and the 21st century, the use of technology is an important part of bringing about changes in learning methods. Based on the explanation of the expert's opinion, there are differences between the learning practices of the industrial age with the learning practices of the 21st century / industrial revolution 4.0 which can be explained as follows: (1) procedures. Whereas in the knowledge age the paradigm for learning through projects and problems, inquiry and design, discovery and creation; (2) Although it has been stated as polarity, the differences in learning practices of the 21st century and the industrial age are considered as a continuum. Although it is now possible to find a method of crossbreeding between the 21st Century method and the method in the industrial age. The importance of work skills for students (Hendriyani,at al, 2020). The importance of learning competence in the XXI century (Verawadina, at al, 2020). Keep in mind in reforming learning, conventional methods are not completely lost, but are only used occasionally or rarely compared to new methods; (3) Learning practices in the 21st century are more in line with modern learning theory .; (4) In the 21st century it seems that the practice of learning depends on modern technology, but most of the characteristics of the 21st century can be achieved without utilizing modern technology; (5) Finally, this new learning paradigm provides great opportunities and challenges for the development of lecturer professionalism, both in pre-service and in-service training. In many ways, this paradigm illustrates the redefinition of the teaching profession and the roles played by lecturers in the learning process, (Hasan AM, 2003).

Thus, the learning model in the 21st century/ industrial revolution 4.0 experienced a paradigm shift that is learning that is not yet fully technology-based to technology-based, so educators are required to innovate in learning that is carried out in the classroom. The learning innovations carried out are useful for effective achievement of learning objectives.

Based on observations made at Lancang Kuning University, the learning process in the Power Electronics course, the learning material carried out so far is still limited to the explanation of concepts through lectures so that students seem unmotivated and become spectators. Judging from the media used, illustrations through drawings on the blackboard and slide presentations made by lecturers are still less attractive to students so students become bored in the learning process, this can be seen from the enthusiasm or enthusiasm of student curiosity in paying attention to lecturers' explanations, some are sleepy and there are also busy with other activities, such as doing other course assignments and some who play smartphone secretly in the learning process. This is according to the author makes students have difficulty in understanding the learning material provided, not to mention the number of times the learning process in class has to be delayed / not completed until the end because of meetings or other lecturer activities that cannot be abandoned and even learning is closed when not the red date due to disasters such as smoke. The optimal implementation of Power Electronics learning has not only been caused by factors lecturers and students, the authors suspect that the limitations of the learning strategies applied so far are not optimal causes of student learning processes. The learning strategy that has been used so far is the teacher-centered approach using lecture, question and answer and practice methods. This causes students to be bound by time in learning and cause boredom for students. Therefore there must be a solution to the problem, the development of the learning strategy implemented according to the author can improve the learning process, so the problem of the inability of students to take part in classroom learning with the problems outlined above is no longer a problem. Based on table 1 about student learning outcomes in the Power Electronics course in the even semester of the academic year 2017/2018.

Table 1: Student Learning Achievement in Power Electronics Even Semester Academic Year 2017/2018

Academic Year	Student Value code	Value Weight	Amount	%	Information
2017/2018	A	4	0	0%	Very Good
	B	3	15	21,43%	Good
	C	2	47	67,14%	Medium
	D	1	5	7,14%	Bad
	E	0	3	4,29%	Very Bad
	Total		70	100%	

Based on table 1 above, it can be seen that student learning outcomes in the Power Electronics course show that there is no single student who has a very good predicate, most of the predicate students are medium.

The optimal implementation of Power Electronics learning has not only been caused by factors lecturers and students, the authors suspect that the limitations of the learning model applied so far are not optimal causes of student learning processes. The learning model that has been used so far is a lecturer-centered approach using lecture, question and answer and practice methods. This causes students to be bound by time in learning and cause boredom for students. Therefore there must be a solution to the problem, the development of learning models implemented according to the author can improve the learning process so that the problem of the inability of students to take part in classroom learning due to time constraints and conventional learning models are no longer an obstacle.

2. Literature Review

Power Electronics is a branch of electronics that deals with the processing and regulation of electrical power carried out electronically (Rashid, M., 2008). Power Electronics is related to the processing or processing of electrical energy, i.e. changing electrical power from one form to another by controlling or modifying the shape of the voltage or supposedly using an electronic device (Singh, 2008). Some research results show that Power Electronics has developed well in theory such as developing teaching methodologies using mathematical equations, matlab / simulink and matlab functions in Power Electronics courses (Ndtoungou,A., 2011) or algorithm-based learning models for Optimal Power Flow (OPF) which involve power flow AC/ DC (Suresh Babu, B., 2015), several studies on learning models of Power Electronics from traditional to learning Power Electronics from a distance (elearning) even practice / experiments using web media (Gourmaj, Mourad - 2017, Malaoui, Abdessamad - 2017, Shun-Chung Wang -2008, Dudrik, J. - 2008, Bauer, P - 2007, Marques, Rui - 2008, Hurley, William Gerard - 2005 and Yasar Birbir – 2018). There are also developments in the learning of Power Electronics using simulation or virtual media Yalcin, Nedim Aktan -2016, Altintas, Ahmet - 2011, Miaja, Pablo F. - 2011, Bauer, P. - 2005, Javier Maseda, Francisco - 2013, Pănoiu, Caius - 2010, Bouketir Omrane - 2005, Tadrist, Nadia - 2012, Elmas, Cetin - 2010, Jabr, R. A. - 2006, Shamsul Aizam Zulkifli - 2014 and Syaoqi Muttaqin - 2016)or use a control system (Ramirez, Dionisio, 2009). But not a few also develop Power Electronics directly in the form of practice / experimentation (Brito, Marcelo R.S., 2014 and Duran, Mario J., 2013). Power Electronics Learning with experiments from long distances (Li, Bo., 2017, Guerra, H., 2016 and Michels, L. B., 2013).

While the development of Power Electronics learning models based on Project Based Learning (Zhang, Zhe, 2016, Bauer, Pavol, 2010, Rui Hong Chu,2008 and Darlan Sidi,2014), based on Problem Based Learning (Bauer, Pavol, 2010), based on Cooperative Jigsaw (Martinez-Rodrigo, Fernando, 2017), based on Interactive Learning (Case, John, 2009 and Minsung Kim, 2018), and product-based learning models (Mega Silfia Dewy, 2016). Problem Based Learning Model is a learning model with a student learning approach to authentic problems so that students can organize their own knowledge, develop higher skills and inquiry, independent students and increase self-confidence (according to Arends in Abbas, 2000: 13). Problem Based Learning or problem based learning includes asking questions or problems, focusing on interdisciplinary linkages, authentic inquiry, collaboration and producing work and demonstrations. Problem-based learning is not designed to help lecturers provide as much information as possible to students. Problem-based learning, among others, aims to help students develop thinking skills and problem solving skills (Ibrahim 2002: 5). Problem-based teaching requires students to produce certain products in the form of real work or artifacts and demonstrations that explain or represent the form of problem solving they find. The product can be a transcript of debates, reports, physical models, videos or computer programs (Ibrahim & Nur, 2000: 5-7 in Nurhadi, 2003: 56) Problem-based teaching is characterized by students working together with each other (most often in pairs or in small groups).

Working together provides motivation to sustainably engage in complex tasks and expand opportunities to share inquiry and dialogue and to develop social skills and thinking skills. According to Lepinski (2005) the stages of problem solving are as follows, namely: 1) delivery of ideas, 2) presentation of known facts, 3) studying problems (learning issues), 4) compiling a plan of action, (action plan) and 5) evaluation (evaluation).

From the references above, problem-based learning and projects in the Power Electronics course are very suitable to be developed.

3. Method

The procedure for developing a Problem-Project Based Learning (P2BL) learning model is carried out with 2 (two) patterns, namely:

1. The pattern of developing a Problem-Project Based Learning (P2BL) learning model is carried out by adapting the development (R&D) (Borg, W.R. & Gall, M.D. 2007) to 5 (five) main steps, namely: (1) preliminary research stage; (2) the stage of designing and developing a product; (3) expert validation and revision stages; (4) model testing and evaluation stages; (5) the final product implementation stage and report. .
2. The pattern of instructional design development or support system of the Problem-Project Based Learning (P2BL) learning model which is often referred to as a learning device includes; (1) Guidebook, (2) Learning Module, (3) Learning Evaluation Instrument and conducted with ADDIE models (Branch, R. M. (2009)).

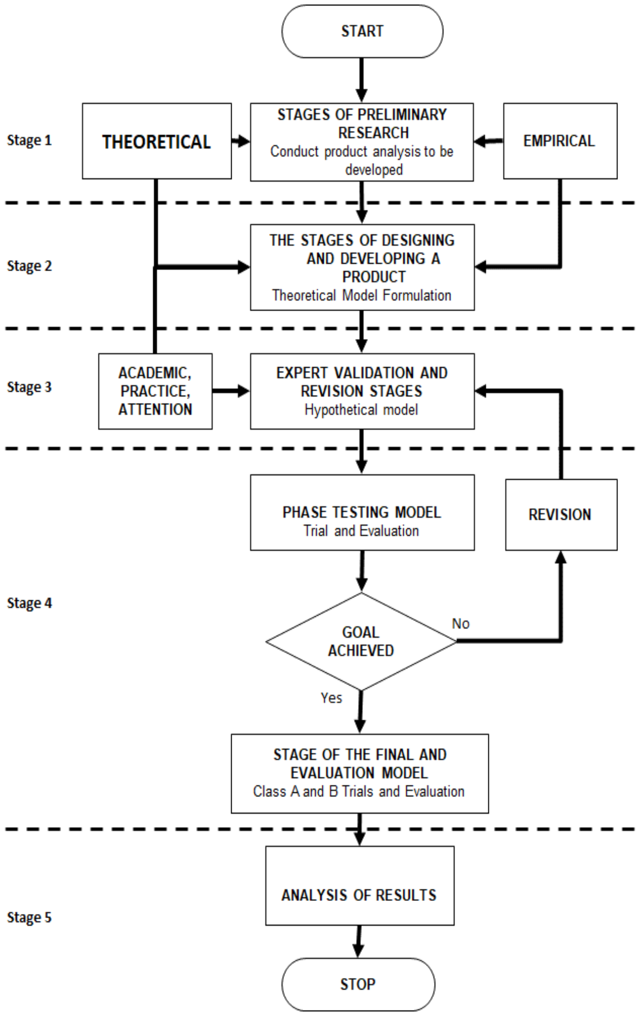

Figure 1: P2BL Model Development Procedure

In accordance with the above research flow, the development carried out in this study has the following procedures:

1. Stages (Preliminary Research)

The purpose of this stage is to obtain and gather information needed for model development. The information collected is done in the form of observations

(observations) about the existing model, identification of existing problems in the field and needs analysis. Need analysis, namely carrying out an analysis of the state of learning and competence about expertise in the current state (current state) then compared with the conditions of expectation (expectation). The gap (difference) between the current conditions and conditions of hope is used as a learning problem that will find a way out. Data collected from students using instruments designed in the form of a questionnaire. The questionnaire data is quantitative and analyzed using descriptive statistics. Preliminary research (analysis) is a process of defining what will be learned by students, namely conducting a needs analysis. Therefore, the outputs that will be produced are in the form of: 1) Initial learning activities, 2) Lecture Information and 3) Learning Implementation Stages (Designing and Developing and Designing Products)

In designing the conceptual model there are a number of things that need to be considered, including: 1) the participants who will be targeted, namely students, 2) infrastructure and supporting facilities, and (3) expected learning outcomes. Target participants or students related to their understanding of their goals and expectations in participating in learning, background knowledge and so on. Supporting infrastructure and facilities to support learning about Power Electronics such as adequate laboratories. While learning outcomes to determine the scope of teaching material and material tested and learning outcomes assessment framework. This development activity will require support, review and validation from experts, professional colleagues for improvement, so that sufficient time must be provided so that the initial product criteria can be met

2. Stages (Expert Validation and Revision)

At this stage, expert validation is used to assess and provide input on the model developed, whether the product is made suitable for use or not. Validation from experts (planned expert judgment) consists of four respondents. The respondents consisted of model development experts, learning experts, language experts and material experts. Validation was also carried out on learning devices in the form of syllabus, teaching materials and evaluation materials including instrument validation in the form of research questionnaires.

3. Stages (Model Testing and Evaluation)

The purpose of the development in this study is to meet the level of validity, practicality and effectiveness of the developed model. At this stage, trials and improvements continue to be made until they meet the criteria for a new learning model that is valid, practical and effective. Determination of the feasibility of the product being developed lies in the data of the results of trials conducted to be implemented in learning Power Electronics. Implementation of the P2BL Model in learning Power Electronics is carried out in class A students who are not working and class B students who are working. The effectiveness will be seen from the point of achievement of competence, namely the impact of increased learning achievement (cognitive, affective and psychomotor) and accompanying impact. The measurement instrument for the treatment model of the learning model will be processed with the appropriate statistics using the SPSS program.

4. Stages (Final Model and Evaluation of Final Model Implementation (Report)

At this stage the final model of the P2BL learning model is produced, which is an empirically tested model, so that it becomes a valid, practical and effective P2BL learning model.

4. Result and Discussion

Based on the problems in previous learning and the results of the questionnaire from the needs analysis filled by 65 students stated that they strongly agreed on the Problem-Project Based Learning (P2BL) based learning model developed. Problem-Based Project Based Learning (P2BL) developed is a Project Based Learning (PjBL) based learning model that starts from the problem, identifying the problem adopts the Problem Based Learning (PBL) syntax. The syntax of the Problem-Project Based Learning (P2BL) learning model developed is; (1) Presenting and defining problems; (2) Solving problems with design simulations and prototypes; (3) Make plans, schedule and work on projects; (4) Present project assignments and prepare reports; (5) Evaluation of work results and evaluation. Furthermore, the Problem Project Based Learning (P2BL) model that will be developed and its derivative products are discussed in a focus group discussion or also called a Focus Group Discussion (FGD). In the Focus Group Discussion (FGD), input is obtained that can be taken into consideration in revising the product Problem Model Project Based Learning (P2BL) developed. Based on the implementation of the FGD, 5 (five) experts or experts attended by 3 (three) experts or model experts, 1 (one) expert or language expert and 1 (one) expert or Power Electronics expert provided some input and suggestions for the P2BL model developed including its derivative products, after improvements have been made in accordance with the advice and input from experts or experts, then validation is carried out by experts on research products namely assessment instruments, P2BL model books, teaching manuals and module books teach. The results of testing the validity of research instruments, model books, module books and manuals and explanations we describe as follows:

1. The validity test results of the Research Instrument based on the assessment given by the validator are Valid with Aiken's V value of 0.892. The results of the Aiken calculations ranging from 0 to 1 and the number 0.600 can be interpreted to have a high enough coefficient, so that a V value of 0.892> 0.600 is stated in the valid category.
2. The validity test results of the P2BL model based on aspects of Support Theory, P2BL Model Structure, Model Syntax, Social Systems, Reaction Principles, Support Systems, Instructional and Accompaniment Impacts and

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Learning Implementation based on the assessment given by the validator are Valid with Aiken V's value of 0.923. The results of the Aiken calculation range from 0 to 1 and the number 0,600 can be interpreted to have a high enough coefficient so that the value of V 0.923> 0.600 is stated in the valid category.

3. The module validity test results based on the assessment given by the validator on the Content Feasibility Aspect, Presentation Aspect and Language Aspect are Valid with Aiken's V value of 0.861. The results of the Aiken calculation ranging from 0 to 1 and the number 0,600 can be interpreted to have a high enough coefficient so that the V value of 0.861> 0.600 is stated in the valid category

4. The validity test results of the Teaching Guide based on the assessment given by the validator on aspects of the concept model, Syllabus, SAP, Questions, assignments and assessments, Objectives, Material, Language, Physical Form and Benefits are Valid with Aiken's V value of 0.866. The results of the Aiken calculation range from 0 to 1 and the number 0,600 can be interpreted to have a coefficient high enough so that the V value of 0.866> 0.600 is stated in the valid category.

After all the research products have been declared valid, the next stage is limited trials, limited trials are carried out numbering 9 participants. Based on the learning outcomes, the pre-test and post-test scores obtained significant results, namely the learning outcomes increased with an average score of pre-test results was 32.22 categorized as bad and the average value of the post-test results was 78.33 categorized as good.

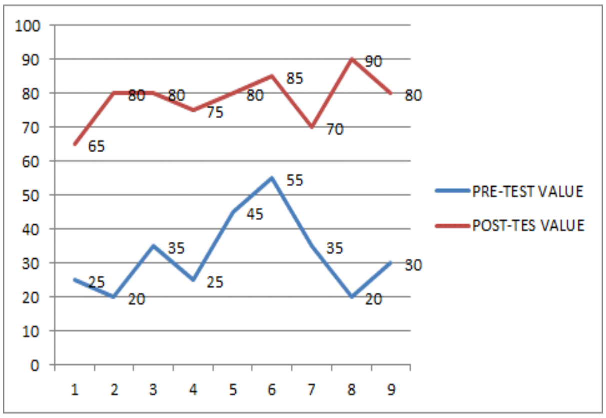

Figure 2: The learning outcomes of the trial class are limited

After a limited trial of 9 participants, an expanded trial consisted of 65 students and was divided into 2 classes, class A consisted of 28 students plus 9 students who were limited trial participants. While class B consists of 28 students. Before starting, students are given a pre-test first. After being put in place, they will be given a post-test. In addition to the post-test, students were asked to fill out questionnaires in the form of a needs analysis questionnaire, student assessment sheet questionnaire on the P2BL model applied, questionnaire evaluation sheet on teaching module books and questionnaire evaluation sheet on SAP used. In addition to students, lecturers as instructors are also asked to fill out questionnaires after P2BL-based learning is applied in the form of an assessment sheet questionnaire against the P2BL model applied, an assessment sheet questionnaire towards the Teaching Module book and an assessment sheet questionnaire towards the teaching guide. Based on the results of the practicality test on the questionnaire given, the following values and explanations are obtained:

1. The assessment given by three lecturers or observers at the Electrical Engineering Study Program at Lancang Kuning University against the P2BL Model includes: 1) Instructions for Using Problem-Project Based Learning Models, 2) Achievement of Competencies and Learning Objectives, 3) Student Responses, 4) Levels difficulties in implementing, and 5) Adequacy of Time is very practical with an average percentage of 97.04. All lecturers or observers strongly support the application of the P2BL model in the Power Electronics course

2. The assessment given by three lecturers or observers on the practicality of teaching guidelines includes: 1) Aspect Guidance, 2) Objectives and Indicators, 3) Syntax / phase 4) learning, 5) Learning Materials, 6) Learning Methods, 7) Time allocation, 8) Language, 9) Physical Form and Benefits, with an average percentage value of 97.78. From this grade point average it can be proven that the teaching guides made are very practical.

3. The assessment given by three lecturers or observers on the practicality of the teaching module includes several aspects, namely: Organization, Content Aspect, Writing Format and Language, the results can be seen in the Table, with an average percentage value of 96.67. From this average value it can be proven that the teaching module is very practical.

4. The assessment given by 65 students on the P2BL model on aspects: Instructions for Using the Model, Competency Achievement and Learning Objectives, Student Response, Difficulty in implementing and Time Sufficiency, with an average percentage value of class A is 90.32 and class B is 90.91, included in the category of very practical. From these results, it shows that student expectations are very high towards the applied P2BL model.

5. The assessment given by 65 students to the teaching module with an average percentage score of 89 and 90.05 in the very practical category. From these results it has been shown that modules can be used and can construct their understanding of the learning process.

6. Assessment given by 65 students to SAP with an average percentage value of 91.52 and 91.11 included in the category of very practical. From these results it has been shown that SAP can construct their understanding of the learning process.

While the results of the effectiveness test based on learning outcomes namely pre-test and post-test can be described as follows:

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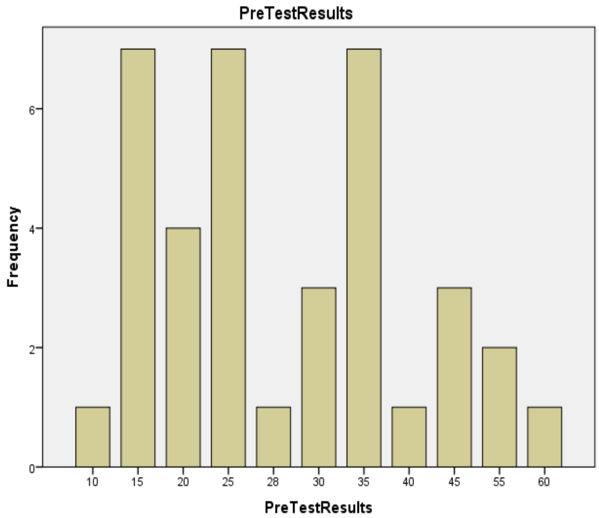
1. Based on Pre-Test data processing in class A based on Frequencies in Descriptive Statistics, the following results are obtained:

Statistics

		PreTest Results	PostTest Results
N	Valid	37	37
	Missing	0	0
Mean		29.14	77.57
Median		25.00	80.00
Mode		15[a]	80
Std. Deviation		12.501	7.784
Variance		156.287	60.586
Range		50	30
Minimum		10	65
Maximum		60	95
Sum		1078	2870

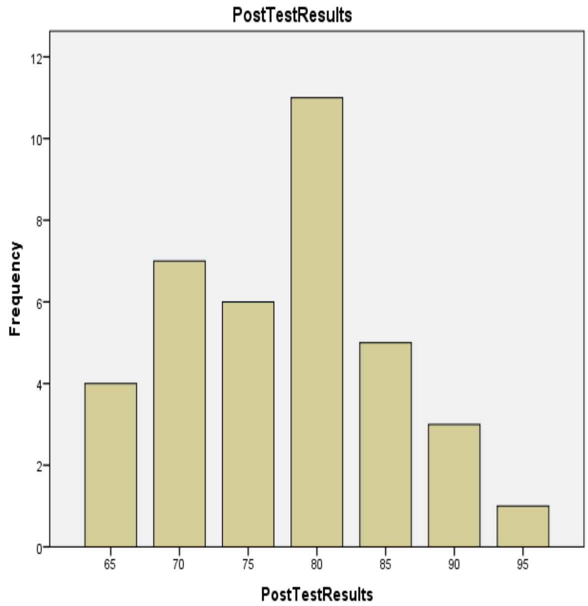
Based on the distribution of Class A Pre-Test scores with the total data of 37 students, the average value of the overall data is 29.14, the median value of the sorted data is 25, while the data that most often appear 15. Next to the size the distribution of statistical data is 12,501 and the square of the difference between each data against the average value is 156,287. For the highest score is 60 and the lowest score is 10, while the difference between the highest score and the lowest score is 50, and the total score is 1078. The distribution of Class A Post-Test scores with the total data of 37 students, the average value of the overall data is 77.57, the median value of the sorted data is 80, while the most frequently occurring data is 80. Furthermore, for the size of the distribution of statistical data of 7.784 and the square of the difference of each data against the average value is 60.586. The highest score is 95 and the lowest score is 65, while the difference between the highest score and the lowest score is 30, and the total score is 2870. The description of the distribution of Prestest A scores is based on the histogram as follows:



PreTestResults

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	1	2.7	2.7	2.7
	15	7	18.9	18.9	21.6
	20	4	10.8	10.8	32.4
	25	7	18.9	18.9	51.4
	28	1	2.7	2.7	54.1
	30	3	8.1	8.1	62.2
	35	7	18.9	18.9	81.1
	40	1	2.7	2.7	83.8
	45	3	8.1	8.1	91.9
	55	2	5.4	5.4	97.3
	60	1	2.7	2.7	100.0
	Total	37	100.0	100.0	

(a)



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PostTestResults

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	65	4	10.8	10.8	10.8
	70	7	18.9	18.9	29.7
	75	6	16.2	16.2	45.9
	80	11	29.7	29.7	75.7
	85	5	13.5	13.5	89.2
	90	3	8.1	8.1	97.3
	95	1	2.7	2.7	100.0
	Total	37	100.0	100.0	

(b)

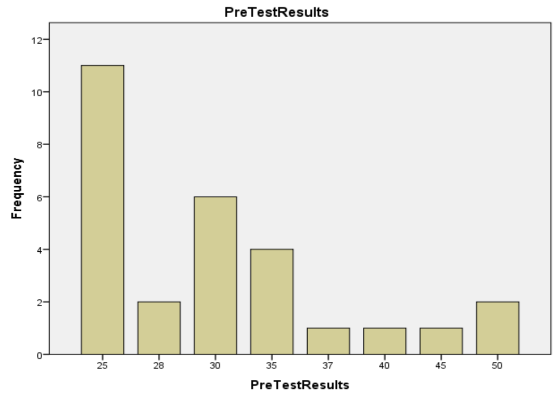
Figure 3: (a) Class A Pre-Test Graph and (b) Class A Post-Test Graph

2. Based on Pre-Test data processing in class B based on Frequencies in Descriptive Statistics, the following results are obtained:

Statistics

		PreTest Results	PostTest Results
N	Valid	28	28
	Missing	0	0
Mean		31.18	78.39
Median		30.00	80.00
Mode		25	75
Std. Deviation		7.498	6.094
Variance		56.226	37.136
Range		25	25
Minimum		25	65
Maximum		50	90
Sum		873	2195

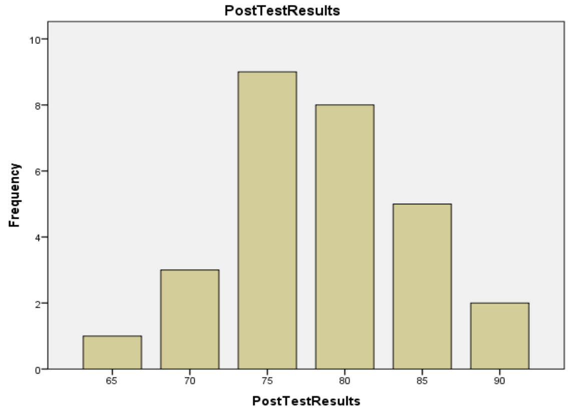
Based on the distribution of Class B Pre-Test scores with the total amount of data of 28 students, the average value of the overall data is 31.18, the median value of the sorted data is 30, while the most frequently occurring data is 25. Furthermore for the measurement the distribution of statistical data is 7,498 and the square of the difference between each data against the average value is 56,226. For the highest score is 50 and the lowest score is 25, while the difference between the highest score and the lowest score is 25, and the total score is 873. For the distribution of Class B Post-Test scores with a total of 28 students, the average value of the data overall is 78.39, the median value of the sorted data is 80, while the most frequently occurring data is 75. Furthermore, for the distribution of statistical data of 6.904 and the square of the difference of each data against the average value is 37,136. The highest score is 90 and the lowest score is 65, while the difference between the highest score and the lowest score is 25, and the total score is 2195. Figure 3 is the distribution of B Pre-test scores based on the histogram.



PreTestResults

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	25	11	39.3	39.3	39.3
	28	2	7.1	7.1	46.4
	30	6	21.4	21.4	67.9
	35	4	14.3	14.3	82.1
	37	1	3.6	3.6	85.7
	40	1	3.6	3.6	89.3
	45	1	3.6	3.6	92.9
	50	2	7.1	7.1	100.0
	Total	28	100.0	100.0	

(a)



PostTestResults

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	65	1	3.6	3.6	3.6
	70	3	10.7	10.7	14.3
	75	9	32.1	32.1	46.4
	80	8	28.6	28.6	75.0
	85	5	17.9	17.9	92.9
	90	2	7.1	7.1	100.0
	Total	28	100.0	100.0	

(b)

Figure 3. (a) Class B Pre-Test Graph and (b) Class B Post-Test Graph

3. Based on comparative data between Pre-Test and Post-Test of 65 students can be seen in Figure 4.

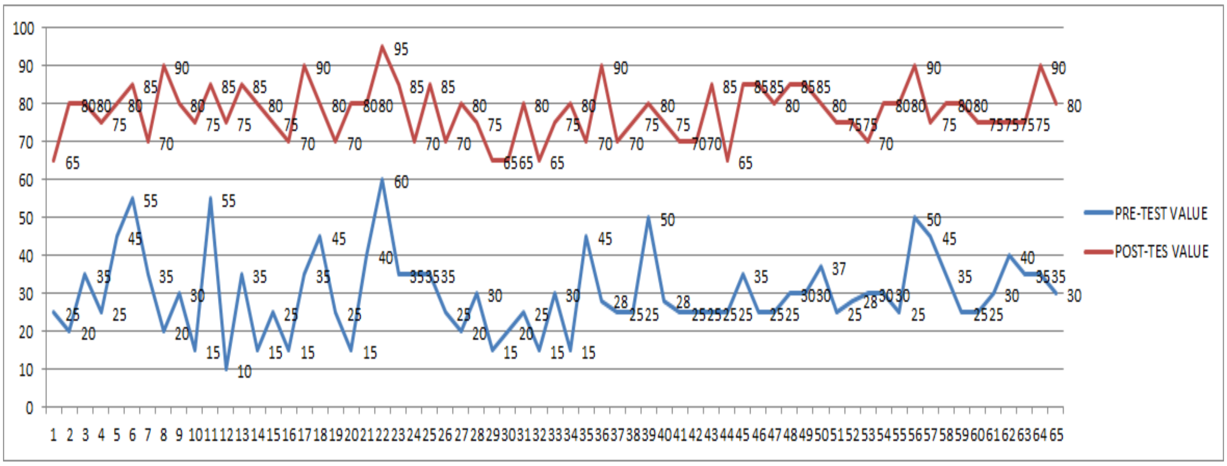


Figure 4: Comparison graph between Pre-Test and Post-Test

Based on the comparison chart of the pre-test and post-test values above, the results of the Post-Test value are higher than the results of the Pre-Test value. From these results it shows that the P2BL model applied to the Power Electronics course is very effective and has constructed students' understanding of the learning process and is able to improve student learning outcomes.

5. Conclusion

Based on the results of research conducted that the products produced in the form of learning model books, teaching manuals and teaching module books are valid, practical and effective, based on the results of the validity, practicality and effectiveness test. Learning (P2BL) is categorized as valid, while the practicality test results based on questionnaires to the responses of lecturers and students are categorized as Very Practical with the percentage according to the Lecturer which is 97.04% for the P2BL Model, 96.67% for the Teaching Module and 97.78% for the Guide Teaching, according to students namely 91.53% and 91.11% for SAP, 89% and 90.05% for the teaching module and 90.32% and 90.91% for the applied P2BL Model. Furthermore, based on the effectiveness test results the P2BL model developed is very effective for students based on student learning outcomes in the form of pre-test and post-test in both classes.

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