The Use of AC Simulator Problem Base Learning Approach for Control System Course

Abdul Malik Made[1(✉)] and Ambiyar[2]

[1] Department of Mechanical Engineering, Universitas Batam, Kepulauan Riau, Indonesia
malikmade@univbatam.ac.id

[2] Departmen of Technology and Vocational Education, Universitas Negeri Padang, Sumatera Barat, Indonesia

Abstract. Knowledge of refrigeration machines, especially Air Conditioners (AC) needs to be taught to master theory in class or Model Problem Base Learning (PBL). The problem that arises is the mastery of knowledge and skills in the form and mechanism of the control system on the latest cooling machines. In addition to these problems, student learning in the control system has not changed the old learning pattern into a learning pattern that refers to SN-DIKTI. The purpose of this study is to apply a student-centered learning model. The step of implementing this program is to study the curriculum and rps that are applied and then adjust to the Problem Base Learning (PBL) learning model. The Problem Base Learning development research method is used in changing from the conventional form of real problems using ac simulators equipped with control components in the main component parts, namely temperature, pressure, electric current controllers. The control equipment provides a problem indicator of the function of the main components of the cooling machine. The results of the learning model are evaluated by conducting a survey of learning outcomes carried out before and after the use of problem base learning (PBL) learning methods with a total result of an increase of 49.7% so that it can be concluded that the Problem Base Learning method can be used to improve student soft skills such as the ability to innovate, discipline, and the ability to convey ideas both in writing and orally. In addition, the PBL method can also support the learning outcomes of courses in particular and the achievement of study program competencies in general in accordance with the formulation in the KKNI qualification level.

Keywords: Problem Based Learning · Air Conditione · Simulator · Control System

1 Introduction

The learning process that refers to teacher-centered learning is still widely carried out which is not in accordance with 21st century learning which is also related to the national standard of Higher Education (SNDIKTI) No. 3 of 2020. The teacher-centered learning model is very tedious during the learning process. A lecture model that rarely relates to real problems that exist in everyday life will have a less attractive impact on students,

Ambiyar et al. (Eds.): ICTVET 2022, ASSEHR 747, pp. 3–13, 2023.
https://doi.org/10.2991/978-2-38476-050-3_2

which boils down to low activeness and learning outcomes obtained by students, so there is a need for a student-centered learning model to explore as widely as possible and build their own knowledge to make them more active and independent in learning activities, and the teacher functions as a facilitator who directing students to think critically, proactively discuss, and maximize their respective abilities. This problem requires a learning model that focuses on students, one of which is the Problem Based Learning (PBL) model [1, 2].

The Learning Model is a frame that describes from the beginning to the end of a learning process as well as Problem Based Learning (PBL) by involving students in solving problems with students acting as a center, it is hoped that the quality of graduates will be more creative, innovative, in facing the era of change abd 21, namely industry 4.0. Changes can be made that start from the frame of learning activities in higher education, namely the PBL model which has a broad impact on learning outcomes. The PBL approach in the control system course will solve the real problems that arise that are simulated through the simulator by going through the functions of the main components of the air conditioner related to temperature, pressure that occurs in the cooling machine system. The PBL model enhances innovative characters such as creative, disciplined, open and student collaboration [3, 4, 14, 15].

The application of the Project Base Learning Model in learning has been proven to improve students' critical thinking [16] which contributes to motivating graduates to study further as well as for graduates who have worked. Forming a character, critical thinking, cooperation, creative and communication skills in students are indispensable in the education system in Indonesia. The learning approach by collaborating real problems in the cooling machine with the system control course is expected to improve and accelerate student understanding related to system control learning outcomes. Increasing Competence with the PBL approach affects graduates who will have the opportunity to open entrepreneurship either as training or service or procurement of cooling machine installations so that it has a broad impact on society, the application of Problem Base Learning has its own characteristics or characteristics that distinguish it from other learning models, namely;

1. Using problems at the beginning of learning;
2. Problems associated with the real world still need explanation;
3. Perspectives on the problem are still compound;
4. Learning still requires new concepts in its discussion;
5. Demand independence in solving problems;
6. Utilizing sources of knowledge from many sources;
7. Collaborative, communicative, and cooperative learning models

Application of Problem Base Learning by following the syntax that has been used by previous researchers with the initial characteristics of problem submission as follows;

1. Student orientation on problems;
2. Organizing students to learn;
3. Guiding individual and group investigations;
4. Develop and present the work; and

5. Analyze and evaluate from the beginning to the learning outcomes

Problem Base Learning (PBL) models including learning models require authentic investigation, namely real solutions [7]. The PBL model guides students to decompose problem solving into several parts of activity and provides examples of the use of skills and strategies needed to solve learning problems with the guidance of lecturers. Flexible classroom conditions and oriented to investigation efforts by students both individual mapung in groups. Learning using the problem-based learning (PBL) model can increase activity and learning outcomes in solving real problems applied to AC simulators effective learning outcomes and result in students being active, enthusiastic and able to understand the material taught so that student learning outcomes increase [3–5].

2 Methodology

Research uses development methods (Research Development) to develop and produce products to overcome educational problems [6] This case 4.D methods starting from Define, Design, Development and dissemination. The learning model used is still a conventional model then developed into a Problem Base Learning model that uses an AC simulator to apply real problems that occur in the system control course which is connected to the achievements of course learners based on SN-DIKTI and which is equated with the reference of the Indonesian National Qualifications Framework (KKNI) which implements a juxtaposing framework for the qualifications and competencies of Indonesian workers, equalizing, and integrating the education sector with the training and work experience sector in a structure-adjusted employability recognition scheme in various employment sectors [7]. The activity of the teaching and learning process is supported by a cooling machine simulator, one of the results of the development product that has previously been validated by a team of experts.

2.1 Analysis of Research Sites

Batam University is one of the private universities in the Riau Islands, Batam city and has a Mechanical Engineering study program, one of the lessons from the running curriculum section is the Regulatory Engineering course, where the course is also related to other mesi courses that use system control or regulatory techniques such as machine tools, lifting and transport machines, production machines, cooling machines, however, the basic lab facilities owned by the study program have not provided machine simulators to apply control systems to machines aimed at accelerating and improving the learning outcomes of courses related to graduate competencies. The control system learning process has been carried out with a learning model using the Semester Learning Plan (RPS) which has not been updated due to limited insight so that the development of learning RPS control system courses is carried out.

Table 1. Solutions Problem

Partner Problems	Solutions	Outcome
Unavailability of Semester Learning Plans that support learning Control system based on SN-DIKTI	Designing and realizing Semester Learning Plan and control systems on AC simulators for PBL learning	Semester Learning Plan, teaching materials and ac simulator control system
Don't have a cooling machine simulator control scheme guidebook yet	Compile schema modules and work systems from the Semester Learning Plan -adjusted AC simulator control system	Semester Learning Plan, teaching materials and ac simulator control system
Conventional use in learning processes	Applying PBL to learning in the control system course	AC simulator control system module

2.2 Development Problems

Anticipating technological developments in machine control systems used in modern industry, related to the review of Semester Learning Plans (RPS) so that there is a compatibility with industry, linearly will also affect the application of learning based on SN-DIKTI which relates to equalizing KKNI qualifications, applying new learning patterns due to limited facilities and lecturers' insights in learning methods. In learning the system control course, students face problems:

1. Limited knowledge about system control
2. Teaching lecturers have not prepared teaching materials based on the Semester Learning Plan to deliver learning
3. Learning facilities on the system control matkuliah for problem base learning models are not yet available
4. There are no modules and books or learning media for learning system control
5. Lack of understanding of the application of the Base learning method

After analyzing the situation and problems faced in the learning of the system control course at the University of Batam, so that identification of problems and solutions carried out in solving these problems is carried out which is shown in Table 1.

3 Results and Discussion

3.1 Types of Problems

The learning model in the conventional control system course uses manual calculations that require a long time and have a high level of difficulty [8]. The Problem Base Learning (PBL) learning approach can be done with the following creteria:

1. Students solve problems by exploiting the knowledge they have;
2. Following RPS based on PBL syntax;
3. Meet the criteria set out in the PBL;
4. The problems used can be implemented through the AC simulator and other supporting components;
5. The use of the required learning process time based on RPS.

The requirements in learning the Control system in the use of simulators for mechanical engineering study program students are as follows:

1. Air Conditioner (AC) simulator is used in the learning process of the Control system course
2. Used in data retrieval for analysis of the system control function on the cooling machine.
3. The use of the control system in the AC simulator is easy to implement
4. The use of consumables is easy to obtain
5. The use of time in the process of data search practices according to RPS.
6. The use of the control system in the AC simulator can be observed and look for problems directly both individually and in teams so as to stimulate student creativity

The use of AC simulators in the PBL model learning approach based on RPS in the control system course. The emphasis of the problem is on the main components and equipment of the control system and the measuring device and the tempratur to be connected to the AC machine system as a source of problem data.

3.2 Design and Manufacture of Simulato Air Conditioners

The AC simulator system used in the process of purchasing the control system is designed like an Air Conditioner (AC) machine with the latest output model. Designing an AC Simulator openly (open cover), for ease of learning. As for the form of the AC Simulator design results can be seen in Figs. 1, 2, 3 and 4.

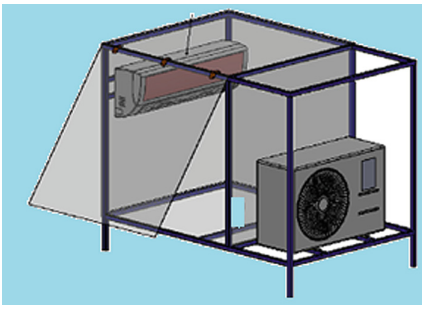

Fig. 1. Simulator Design

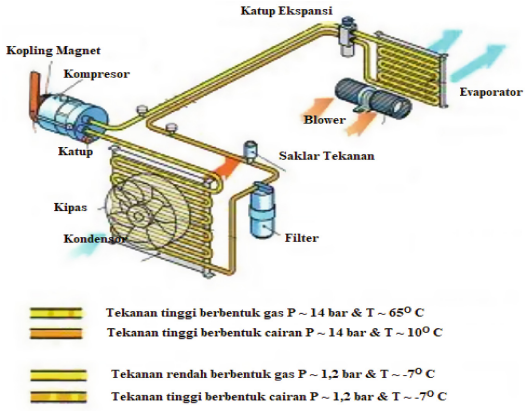

Fig. 2. Panel AC Split

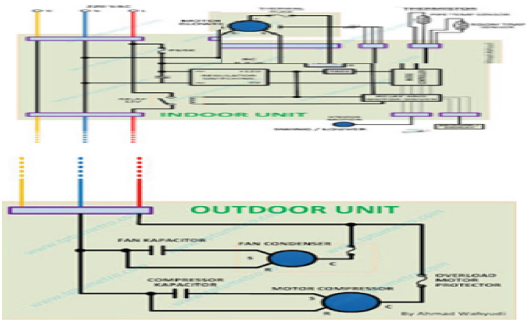

Fig. 3. Split AC Wiring Diagram and Control Components

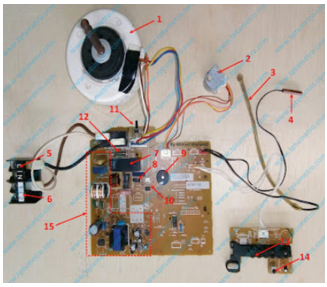

Fig. 4. Control Unit Electricity

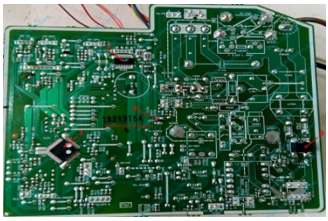

Fig. 5. Section under control unit

Description of the name of the electrical component of the control unit (module) ac split (Fig. 5):

1. Blower motor
2. Louve
3. Room temperature control/Sensor
4. Pipe temperature control/Sensor
5. Voltage source 220 VA
6. Outdoor electrical connection
7. Capacitor blower
8. Conductive pathways
9. Bell
10. Liaison (Optocoupler)
11. Switch (on off)
12. Fuses
13. Indicator light
14. Remote Signal Receiver

3.3 Preparation of Practice Guidelines

The implementation of PBL Learning is carried out by displaying and assembling the components of the Control system in the cooling machine simulator in groups and explaining the function of the system control components in the cooling machine simulator. After completion of the assembly, the function is tested to test the success rate through the measurement indicators that have been installed. Guide to the use of cooling machine AC Simulator is divided into two parts:

1. Cooling machine component parts and
2. Electrical and control parts

The electrical control system is taught with problems related to mechanical work functions caused by the work input of the control system, for example fans, blowers, compressors, which have a direct effect on the quality of machine work which we can observe through temperature control, pressure, electric current control. Problems that the control system can be solved by students include:

1. Measurement of electric current
2. Temperature control settings,
3. Fan control settings
4. Refrigerant media pressure measurement
5. ON-OFF Control Settings

The preparation of the curriculum based on SN-DIKTI in accordance with KKNI can be carried out based on the Higher Education Law No12 of 2012 and the National Higher Education Standards for which the preparation of CP is carried out through the following stages:

1. Determination of Graduate Profile (CPL) which is to determine the role of work ability that can be done by graduates in a certain field of expertise or field of work after completing their studies. Profile based on the results of a study of job market needs
2. Formulation of work skills or abilities derived from profiles involving stakeholders
3. Determination of a number of abilities (CP) must refer to the qualification level of KKNI, especially special work ability.

Based on the curriculum compilers who follow SN-DIKTI The learning outcomes to be achieved can be grouped upon;

1. Soft skills, students' self-character abilities such as communication, piety, good deeds, ethics, and responsibility
2. Hard skills, abilities in mastery of knowledge, relating to students' abilities to general skills and specific skills

3.4 Evaluation of Learning Outcomes

The use of questionnaires to assess the level of understanding of students with limited learning outcomes carried out before and after using the Problem Base Learning Model with an AC simulator approach where the number of students in grade 43 students from the recap results is tabulated in Table 2.

Student learning outcomes in the system control course are measured through questionnaires in Table 2. there is an improvement with the Problem base learning model by using an AC simulator in the system control problem approach. The total score of the questionnaire value before the implementation of Problame Base Learning was 71 while after the implementation of PBL, the score increased to 143. The increase in the score proves that the Problem Base Learning (PBL) Model will improve student learning outcomes and changes in learning characteristics in the form of ethical thinking, collaboration, communication, and creativity. As a result of the implementation of PBL. The results of this improvement are in line with previous research conducted by Janista W.J et al. (2021), by conducting a cyclical test on thinking skills and student learning outcomes, the average initial condition score of 69.3 increased to 76.21 in cycle I and increased again in cycle II, namely 82.19.

Table 2. Student Understanding level

Question	Very Understand		Understand		Not well Understand		Don't Understand		Total	
	Bf	af	Bf	aft	Bf	aft	Bf	Aft	Bf	aft
Does it understand the use of the Problem Base Learning (PBL) model?	-	1	2	4	7	9	9	11	18	25
Do you know the learning objectives of the Control System and can explain in the process of the Control system in real cooling machine simulation?	-	2	3	6	3	7	8	14	14	29
Do you know the function of the Control system?	1	3	4	11	5	9	6	4	16	27
Do you know the function of the electrical components of the system cooling?	1	1	2	8	2	11	2	16	7	36
Do you know the control system on the cooling machine?	-	10	7	8	3	7	6	2	16	27
									71	144

4 Conclusions

Learning with the Problem Base Learning (PBL) method is a student-centered learning model and requires a teacher-centered learning model. The PBL model is an alternative modern learning model that is in accordance with the demands of SN-DIKTI related to KKNI's literacy. Air Conditioner (AC) simulators are used in the application of PBL in

the control system course. The problem of the control system can be known by direct practice by using an AC simulator that increases understanding and analysis of the control system in real terms. Activities in the Problem Base Learning learning process are expected to be more active, critical, innovative, and have high group collaboration skills.

References

1. Yee. K. T (2022) at.al. Acceptance of problem-based learning by preclinical students from a public university and its impact on their learning. Research Journal of Pharmacy and Technology.Volume 15, Issue 4, https://doi.org/10.52711/0974-360X.2022.00271.
2. Yuliani. N.K, dkk. Penerapan Model Pembelajaran Problem Based Learning (PBL)
3. Untuk Meningkatkan Hasil Belajar Peserta Didik (2022) Jurnal Pendidikan dan Profesi Keguruan Vol 1(2) pp.82–91
4. Rahmadani "Metode Penerapan Model Pembelajaran Problem Based Learning (PBL)" (2019) Lantanida Journal, Vol. 7 No. 1
5. Assegaff, A. Uep Sontani, T (2016)." Upaya Meningkatkan Kemampuan Berfikir Analitis Melalui Model Problem Based Learning (PLB) "(2016) Jurnal Pendidikan Manajemen Perkantoran, Vol. 1, No. 1.
6. Putu Suardana "Penerapan Model Pembelajaran Problem Based Learning (PBL) dengan Metode Demonstrasi untuk Meningkatkan Hasil Belajar Permainan Tolak Peluru"(2019) Journal of Education Action Research, Vol. 3, No. 3
7. Al-Tabany, Trianto. "Mendesain Model Pembelajaran Inovatif, Progresif dan Kontektual" (2017) Jakarta: Kencana.
8. Warsono & Hariyanto. "Pembelajaran Akti" (2013) Bandung. PT Remaja Rosdakarya.
9. Ruseffendi, E.T. "Ruseffendi, E.T. 2005. Dasar-dasar Penelitian Pendidikan & Bidang Non-Eksakta Lainnya. Bandung: Tarsito.
10. Ali Akbar Jono "Studi Implementasi Kurikulum Berbasis Kkni Pada Program Studi Pendidikan Bahasa Inggris Di Lptk Se-Kota Bengkulu" (2016) Manhaj, Vol. 4, Nomor 1.
11. Muhamad Ali "Pembelajaran Perancangan Sistem Kontrol Pid Dengan Software Matlab" (2004) Jurnal Edukasi@Elektro Vol. 1, No. 1.
12. I G M Ngurah Desnanjaya et al. (2013), "Remote Holder Design for Controlling the Air Conditioner System" Prosiding Conference on Smart-Green Technology in Electrical and Information System Bali.
13. Made, A. M., Jalinus, N., & Waskito, W. (2022). Siklus Pengembangan Kurikulum Pendidikan Tinggi. Research in Technical and Vocational Education and Training, 1(2). https://doi.org/10.55585/rintvet.v1i2.18.
14. Lasaraiya, S., Kiram, J. J., Juhan, N & Daud, M. A.(2021) Effectiveness of Problem-Based Learning Approach in Mathematics Subject Among Lower Secondary Students of SMK Usukan, Kota Belud, Sabah International STEM Journal, Volume 2 No.1, June 2021, 26–35
15. Ramlan N (2020) Problem-Based Learning (PBL) Awareness among Academic Staffin Universiti Tun Hussein Onn Malaysia (UTHM) Journal of Linguistics and Education, 10 (1), 2020, 9–13
16. Janista W.J dkk, Model Problem Based Learning Untuk Meningkatkan Kemampuan BerpikirKriti s dan Hasil Belajar IPA Siswa. Jurnal Elementaria Edukasia Volume 4, No. 1, April 2021, 31–41