IMPLEMENTATION OF PROBLEM-BASED LEARNING MODELS SUPPORTED BY TRAINER RADIATOR MODULE FOR HEAT TRANSFER LEARNING

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Abstracts. The purpose of this study is to analyze the increase in student learning outcomes in heat transfer learning that is taught using a problem-based learning model assisted by the radiator trainer module. This type of research is classroom action research. The technique of collecting data uses a test of learning outcomes consisting of tests of cognitive learning outcomes and psychomotor domains. Data analysis method uses descriptive analysis. The results of this study indicate that there is an increase in student learning outcomes after being learned using a problem-based learning model assisted by the radiator trainer module. It is proven that when compared with individual and classical completeness criteria > 80 in the first cycle the percentage of students who entered the complete category was only 25%. While in the second cycle the percentage of students who entered the complete category increased to 88%. When compared between the percentage of learning outcomes in the first cycle and second cycle, there was a significant increase with a percentage difference of 63%. Thus it can be concluded that the problem-based learning model supported by the radiator trainer module can help students improve the learning outcomes of heat transfer courses.

Keywords: Classroom action research, problem-based learning model, radiator trainer module, and student learning outcomes.

Introduction

Education is one indicator that is widely used by several countries to measure the extent to which the country is progressing and developing. Countries that seriously pay attention to their education system will certainly continue to strive to produce skilled workers to be able to meet demands in the era of industrial revolution 4.0 as it is today, including Indonesia.

In Indonesia, the education system is one sector that always gets serious support and attention. This seriousness is proven by the existence of Law No. 20 of 2003 concerning the National Education System [1]. In law, education is defined as a conscious and planned effort to develop the potential of students to become religious, intelligent, noble, and skilled individuals.

Seeing from this support and attention, the education system in Indonesia should have developed better. However, in fact there are still some problems that need to be corrected. One of the many problems faced by educators is that there are differences in understanding regarding how to teach.

Generally, many educators know about various types of learning models. However, the problem is that some educators lack understanding in choosing and implementing learning models that are by the characteristics of the material and students. Therefore, some of them educators prefer to use the direct learning model without seeing the compatibility between the model and the learning topic.

The Department of Mechanical Engineering, Surabaya State University, is one of the departments in the Faculty of Engineering which massively strives to improve the quality of its education system. Some ideas are being developed so that the learning process is more directed and meaningful, such as fulfillment of learning facilities in each laboratory both in the form of media and learning modules.

But unfortunately, based on the results of interviews with students in the heat transfer class, it was found that lecturers still did not utilize the facilities optimally. Lecturers still tend to use the lecture method where the method is teacher center, so the learning process becomes monotonous and becomes boring [2].

Furthermore, the impact of this learning can be seen based on the acquisition of Unesa Mechanical Engineering S1 student learning outcomes in 2015/2016. Based on observations it is known that out of 83 students who teach heat transfer courses only 1% of students can get an A score. 42% of students get an A- score, 40% get a B + score, 11% get a B score, 2% get a D score, and 2% get E [3].

Referring to several existing problems, of course, there needs to be a smart solution so that the learning process can run better. There needs to be a change in the learning model that is generally used by lecturers. The learning model used must certainly be able to make students more active in the learning process, one of which is the problem-based learning model. The use of learning facilities in the form of modules and trainers should be used to the maximum extent possible so that the learning process becomes more meaningful [4].

The success of using a problem-based learning model that is supported by modules can certainly be known based on the results of several previous studies. Hamid, Aribowo, & Desmira (2017) conducted a study entitled "*Development of Learning Modules of Basic Electronics-Based Problem Solving In Vocational Secondary School*"[5]. The results showed that the basic electronic learning module based on the problem solving that was developed as a whole was declared feasible to use, with the results of the average validation of material categories including very feasible, and the average results of the media category

validation including very feasible. Readability belongs to the very feasible category and in terms of learning using modules is included in the very feasible category. The use of modules in the learning process is known to increase with the average value of student learning outcomes from 68.53 up to 80.24. The results of the t-test analysis revealed that $t_{count} = 11.76$ and $t_{table} = 1.69$ which means that student learning outcomes experienced a significant increase.

Other research was conducted by Yani, Sahriah, & Adiansyah (2017) entitled "*Developing Problem-Based Learning Module For Biotechnology Concepts*"[6]. The results of the study indicate that the modules developed are valid and practical to use. This module is also effective to be used in learning, PBL activities reach the "high" category, and improve students' cognitive learning outcomes.

Based on the results of several previous studies, it is known that student learning outcomes will increase if the model used in the learning process is a problem-based learning model which is then supported by the application of the radiator trainer module.

In this study the formulation of the problem under study, namely whether the implementation of a problem-based learning model supported by the radiator trainer module on heat transfer programs can improve the learning outcomes of Unesa's Mechanical Engineering Department students?

Method

Types of research

The type of research used is classroom action research conducted at the Heat Transfer Laboratory. This research was conducted to analyze the learning outcomes of students who teach heat transfer courses.

Research subject

The subjects in this study were TMB S1 Mechanical Engineering students in the odd semester of the 2016/2017 academic year with a total of 24 students.

Research design

The research design used refers to the Kemmis and Taggart models. In this model of

research conducted groove design cycle. The flow of research in each cycle includes planning, action, observation, and reflection as shown in Figure 1 (Kemmis & Taggart, 1988).

This research is planned to consist of two cycles. In each cycle, there are indicators of achievement as shown in Table 1.
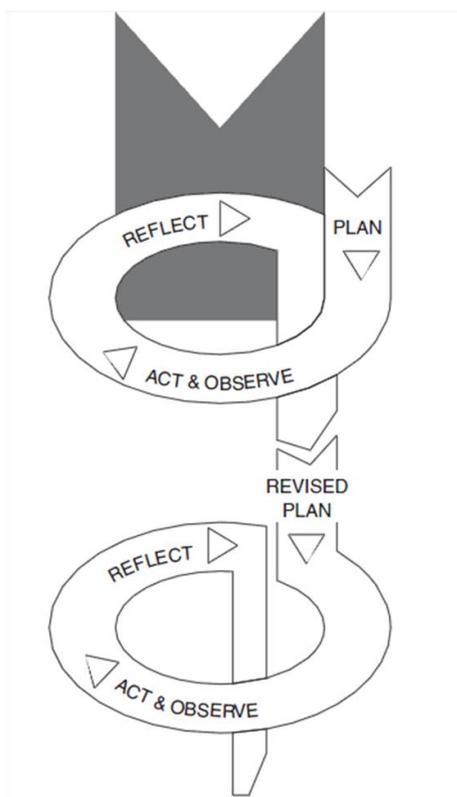

Figure 1. Kemmis and Mctaggart Model

Table 1. CAR Cycle Flow and Achievement Level

Cycle	Achievement level
I	- The application of problem-based learning models are supported by the trainer radiator module in heat transfer courses. - Observation of practicum processes and cognitive outcomes of learning outcomes. - Reflection, obtained several strengths, weaknesses during the learning process and planned the next learning process. - Indicators of success: - Knowledge of heat transfer material in learning activities 2 about experiments with variations in fluid mass flow rates. - Skills during practicum using radiator trainer media. - Individual and classical completeness > 80. If learning completeness does not reach the criteria, it will be continued in the next cycle.
II	- The application of problem-based learning models are supported by the trainer radiator module in heat transfer courses. - Observation of practicum processes and cognitive outcomes of learning outcomes. - Reflection, obtained several strengths, weaknesses during

Cycle	Achievement level
	the learning process and planned the next learning process.

- Indicators of success:
  - Knowledge of heat transfer material in learning activities 2 about experiments in fluid temperature variations.
  - Skills during practicum using radiator trainer media.
  - Individual and classical completeness > 80. If learning completeness does not reach the criteria, it will be continued in the next cycle.

Data Analysis Technique

Data on student learning test results were analyzed related to the level of mastery of standardized learning. In this case, the student learning outcomes are said to be complete or not if a student achieves learning outcomes completeness ≥ 80 by using the formula below.

$$Individual\ completeness = \frac{score\ obtained}{maximum\ score} \times 100$$

Results and Discussion

In this study, there are two indicators of success that become learning references, namely individual and classical completeness.

Students are categorized as fulfilling individual completeness if they can get 80 on cognitive and psychomotor aspects. Whereas, a class is categorized as fulfilling classical completeness if at least 80% of students fall into the complete category.

In cycle I and cycle II, students were taught by using a problem-based learning model supported by a radiator trainer module. Learning in the first cycle was held twice. The learning material is an experiment of variations in fluid mass flow rates. The student learning outcomes in the first cycle can be seen in Table 2.

Table 2. Learning Outcomes in Cycle I

No	NIM	MCC	Cognitive	Psychomotor	FS	Category
1	4031	80	58	76	67	NC
2	4033	80	71	85	78	NC
3	4034	80	86	83	85	C
4	4036	80	61	89	75	NC
5	4037	80	67	98	83	C
6	4038	80	75	82	78	NC
7	4040	80	75	82	78	NC
8	4041	80	63	78	70	NC
9	4042	80	63	98	81	C
10	4043	80	58	73	66	NC
11	4044	80	62	79	71	NC
12	4045	80	80	91	85	C
13	4046	80	64	87	76	NC
14	4047	80	65	83	74	NC
15	4048	80	55	65	60	NC
16	4049	80	75	79	77	NC
17	4050	80	63	92	78	NC
18	4051	80	75	95	85	C
19	4052	80	67	82	74	NC
20	4053	80	65	81	73	NC
21	4054	80	66	81	74	NC
22	4057	80	63	74	68	NC
23	4058	80	71	72	72	NC
24	4059	80	67	95	81	C
	Total		1615		1807	
		80			75	NC

If student learning outcomes in Table 2 are shown in the form of bar charts, the results can be seen in Figure 2.
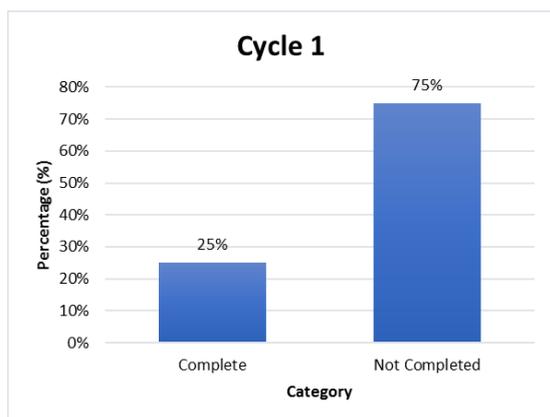

Figure 2. Comparison Diagram between Students Entering the Complete and Not Completed Categories in Cycle I

According to the data diagram in figure 1, we can know that classical completeness in cycle I is 25%. The percentage of graduation is still below the classical completeness criteria which are ≥ 80%. This happened because of the 24 students only 6 students received grades according to the minimum completeness criteria (MCC).

If we pay attention to the implementation of the first cycle, there are many shortcomings in several aspects. Therefore at the next stage, the researcher conducts a reflection. Reflection results include: (1) time allocation needs to be adjusted again so that the learning process can be more effective and efficient; (2) the demonstration process of radiator trainer media needs to be done more specifically so that it can attract students' interest in learning and the learning atmosphere becomes more conducive; (3) apply more forcefully to students who show a bad attitude; (4) emphasizes to students both individually and in groups to record material, the results of discussions, as well as practicum activities; (5) communicating to lecturers and colleagues to ask for advice so they can master the class well.

Based on the results of reflection in the first cycle, several improvements were made or improvements to the goal so that in the second cycle the learning process and conditions could run better.

As in cycle I, learning in cycle II was also held for two meetings. The material learned in this cycle is an experiment on variations in fluid temperature entering the system. The learning outcome data obtained in the second cycle can be seen in Table 3.

Table 3. Learning Outcomes in Cycle II

No	NIM	MCC	Cognitive	Psychomotor	FS	Category
1	4031	80	80	98	89	C
2	4033	80	82	75	79	NC
3	4034	80	81	95	88	C
4	4036	80	81	89	85	C
5	4037	80	75	90	83	C
6	4038	80	81	93	87	C
7	4040	80	81	95	88	C
8	4041	80	80	90	85	C
9	4042	80	80	90	85	C
10	4043	80	81	93	87	C
11	4044	80	81	90	86	C
12	4045	80	85	93	89	C
13	4046	80	80	95	88	C
14	4047	80	80	93	86	C
15	4048	80	80	78	79	NC
16	4049	80	81	93	87	C
17	4050	80	81	93	87	C
18	4051	80	81	93	87	C
19	4052	80	85	90	88	C
20	4053	80	79	89	84	C
21	4054	80	81	93	87	C
22	4057	80	81	93	87	C

No	NIM	MCC	Cognitive	Psychomotor	FS	Category
23	4058	80	76	82	79	NC
24	4059	80	80	88	84	C
	Total		1933		2049	
		80			85	C

If student learning outcomes in Table 3 are shown in the form of bar charts, the results can be seen in Figure 3.
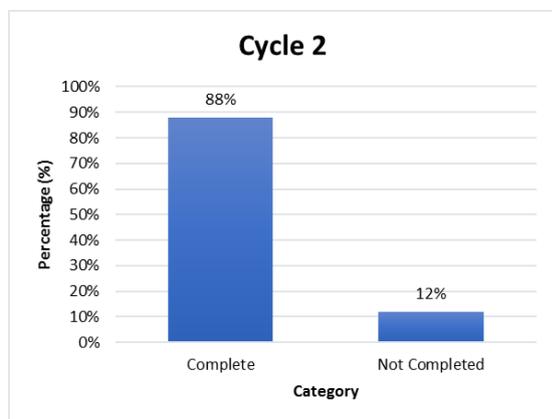

Figure 3. Comparative Diagram between Students Entering Complete and Not Completed Categories in Cycle II

Based on the data diagram in Figure 3, we can see that in the second cycle classical completeness was reached at 88%. This percentage has reached a value above the percentage of class graduation with a percentage value of $\geq 80\%$. In this cycle, there were 21 students who entered the complete category of a total of 24 students. When compared with the percentage in the first cycle, then the second cycle increased significantly with a difference of 63%.

Conclusion

Based on the results of the research that has been done, it can be concluded that the application of a problem-based learning model supported by the radiator trainer module on heat transfer learning can improve student learning outcomes. This is evidenced by the acquisition of student scores wherein Cycle I only 25% of students was able to achieve MCC. Then in the second cycle, it increased to 88%. The percentage difference between Cycle I and Cycle II is 63%.

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