The effect of research-based learning in a nanotechnology centre of excellence

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ABSTRACT: In order to develop the Centre of Nano Research and Advanced Materials at Universitas Negeri Malang in Indonesia, an appropriate learning method was required. Research-based learning was selected as satisfying the criteria to support teaching in this nanotechnology centre of excellence. The aim of this study was to determine the effect of using research-based learning. By statistically analysing test results from classes taught analysis using research-based learning, and those not using research-based learning, a *t*-test significance value of 0.015, which is less than 0.05, was obtained. From these results, it can be concluded that there is a significant difference between the results of learners who are taught using research-based learning and those not taught using research-based learning, with the former being the better.

INTRODUCTION

The Indonesian government supports maritime research and seven other research fields of the National Main Programme (PUNAS) as mandated by RPJMN 2015-2019, as well as the National Research Agenda (ARN) [1]. There are seven areas in PUNAS that consist of:

1. food and agriculture;
2. energy, renewable energy;
3. health and medicine;
4. transportation;
5. telecommunications, information and communications;
6. defence and security;
7. advanced materials.

These areas may be further divided into research themes. Nanotechnology is one such interdisciplinary research theme from the advanced materials area [2].

The Institute of Technology Bandung (ITB), Research Centre for Nanoscience and Nanotechnology, has been designated in Indonesia as a centre of excellence for nanotechnology [3]. The Universitas Negeri Malang, Malang, Indonesia, has prepared the criteria needed for a research and development (R&D) centre of excellence in nanotechnology, to be called the Centre of Nano Research and Advanced Materials.

Arguments to support the establishment of the pioneering Centre of Nano Research and Advanced Materials at Universitas Negeri Malang are:

1. There is an enormous need for advanced materials from six of the focus areas (see above) comprising food and agriculture, energy, health and medicine, transportation, information and communication technology, and defence [4].

2. Nanotechnology is an area of active and growing research with several international publications.

3. There are adequate laboratory facilities at Universitas Negeri Malang.

Criteria that must be met for the development of a centre of excellence consists of [1]:

1. The ability to absorb information and technology from outside, i.e. sourcing/absorptive;

2. The ability to develop demand-based research to an international standard, i.e. research and development;
3. The ability to disseminate international-standard research results, i.e. dissemination;
4. The ability to develop and preserve sustainable local resources, i.e. local resources development and sustainability.

To support these capabilities, an appropriate method of learning is required. An educator may choose from a variety of student-centred learning (SCL) methods or even develop a new learning model. Regardless, the method must pay attention to the basic elements, viz. students, teaching and study materials, facilities and learning media support [5].

Research-based learning is the SCL method appropriate for the Centre of Nano Research and Advanced Materials [6][7]. Hafsah states that research-based learning is one of a variety of student-centred learning methods [6][7].

Research-based learning was chosen, because learners are required to develop knowledge by exploration, while identifying and solving problems [8]. The activities undertaken by the learner are guided by the lecturer toward developing knowledge and improving skills [9]. This process of learning is useful for constructing essential skills in the 21st Century [10] and has a positive impact on the character formation of learners by promoting honesty, intelligence, capability, caring and resilience [11][12].

Research-based learning is a hands-on method of contextual learning that is problem-oriented and co-operative. It involves inquiry and discovery and is guided by the philosophy of constructivism [11][13]. A strategy of combining learning and research was provided by the Griffith Institute for Higher Education, Australia [14] and was adopted by Indonesia.

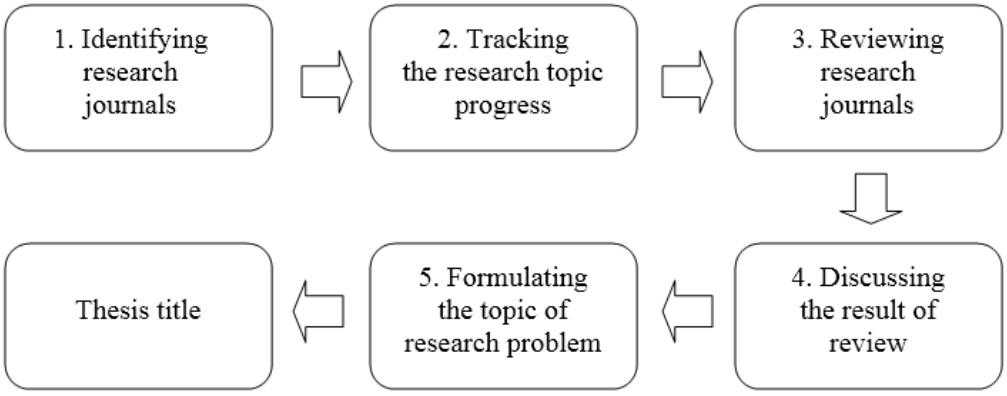

Figure 1: Research-based problem identification.

Figure 1 shows a systematic scheme for research-based problem identification that consists of:

1. identifying research journals;
2. tracking the research topic progress;
3. reviewing research journals;
4. discussing the result of the review;
5. formulating the research topic.

This scheme has a percentage agreement of 85.9% making it efficient for application in S1 Mechanical Engineering [15].

RESEARCH METHOD

This study aimed to determine the effect of research-based learning of basic courses in nanotechnology by comparing an experimental class taught using research-based learning (RBL) to a control class not taught using research-based learning (non RBL) [16].

The students were undertaking a Bachelor's degree in mechanical engineering. The results were analysed using a statistical *t*-test to determine the difference between the control class and the experimental class. If the *t*-test significance was greater than 0.05 then the null hypothesis, Ho, that there is no difference would be accepted, while if the significance was less than or equal to 0.05, then the hypothesis, Ha, that there is a difference would instead be accepted.

RESULTS AND DISCUSSION

The test was conducted using an experimental class and a control class. The experimental class had 31 students, while the control class had 39. Each class was divided into 15 groups. The results for the analysis capability test are shown in Table 1.

Table 1: Test results.

No	Control class *analysis* results	Experimental class *analysis* results
1	63	65
2	75	75
3	60	75
4	76	85
5	63	85
6	78	80
7	88	85
8	73	70
9	58	85
10	68	85
11	73	90
12	75	70
13	68	85
14	85	75
15	68	75

The tested hypotheses were:

- Ho: The ability of a control class on analysis is the same as the experimental class on analysis, i.e. there is no difference.
- Ha: The ability of a control class on analysis is not the same as the experimental class on analysis, i.e. there is a difference.

The class results were tested statistically using a *t*-test, with the outcome shown in Table 2 and Table 3. Class 1 refers to the class not taught using research-based learning, while class 2 was taught using research-based learning.

Table 2: Group statistics.

	Class	N	Mean	SD	Std. error mean
Analytical ability	1	15	71.40	8.626	2.227
	2	15	79.00	7.368	1.902

Table 3: Independent samples test.

		Levene's test for equality of variances		*t*-test for equality of means						
		F	Sig.	*t*	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Analytical ability	Equal variances assumed	0.114	0.738	-2.595	28	0.015	-7.600	2.929	-13.600	-1.600
	Equal variances not assumed			-2.595	27.332	0.015	-7.600	2.929	-13.606	-1.594

The statistical package for the social sciences (SPSS) software was used to calculate the results obtained t = -2,595 with df = 28 and a significance of 0.015.

The significance (2-tailed) was less than 0.05. Hence, it was concluded that the hypothesis Ha was accepted: that there is a significant difference, with the class taught using research-based learning being significantly better on the analysis test than the class not taught using research-based learning

CONCLUSIONS

The results of the *t*-test conducted on the test results of the control class not taught using research-based learning and the experimental class taught using research-based learning, obtained a significance value (2-tailed) of 0.015, which is

less than 0.05. Hence, it was concluded that the class taught using research-based learning was significantly better on analysis than the class not taught using research-based learning.

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