JURNAL PENDIDIKAN KIMIA
ISSN: 2085-3653| e-ISSN: 2549-3116

J. Pendidik. Kim 14(3): 174-179
DOI 10.24114/jpkim.v14i3.39935

Research Article

The effectiveness of analytical chemistry problem based learning model on student learning outcomes

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Received 11 November 2022 ♦ **Revised** 25 December 2022 ♦ **Accepted** 26 December 2022

Citation: Yusfiani, M., Lubis, A.R., Fuadaturrahmah, F., & Siregar, M.S. (2022). The effectiveness of analytical chemistry problem-based learning model on student learning outcomes. *Jurnal Pendidikan Kimia (JPKim)*, 14(3), 174-179. https://doi.org/10.24114/jpkim.v14i3.39935

Keywords

Analytical chemistry
Learning improvement results
PBL model
Learning outcomes

Abstract

This study aims to get a value of the effectiveness of students in learning analytical chemistry. The subjects carried out in this study were 30 Tanjungbalai Polytechnic students. The method used is to analyze the pre-test and post-test as well as data on the frequency distribution of the G factor. From the results of the study it can be concluded as follows 1). The value of the pre-test results showed that out of 30 students there was 1 person (3.33%) with the highest score with a score of 74. For 29 people (97.67%) were declared not to have passed because the score was below 74. 2). The standard deviation value is 6.33 with a variance of 40.110. 3). the posttest score of 5 people with the highest score of 90 with a percentage of 16.67%, and 83.33% showed a score below 90 and passed the PBL Chemistry Analysis lesson. The conclusion from the results of the increased learning outcomes in the analytical chemistry course was obtained that the g factor value was 0.56 in the moderate category and a percentage of 56.16% in the quite effective category.

Introduction

The learning process requires innovative thinking with the aim of increasing the level of quality education and is supported by the government and several parties in the education sector. Teaching materials are one of the basics for developing quality education to improve the quality of understanding in learning the teaching materials taught by the lecturer (Simbolon, 2022). To achieve success it needs support from the government to improve the quality of the curriculum and teaching materials (Harahap et al. 2022).

The latest form of learning development is the Problem Based Learning Model which applies student activity in solving problems and can be done independently or in groups through predetermined stages and times (Education and Culture, 2018). The word learning is a system that is neatly arranged to carry out the teaching and learning process for students in which there is a learning design that affects internal teaching learning outcomes to produce learning outcomes (Hermawansa, 2021). And the form of learning outcomes is a form of achievement from the learning process that is carried out where students are able to carry out and show changes in terms of knowledge. attitudes and ways of thinking of students (Sriamah et al. 2020). Learning strategies have an important role in learning analytical chemistry. For this reason, lecturers improve the theory and skills learning system in the form of practice as problem solving. So, the basis for choosing learning must be observed as one of the analytical chemistry learning strategies that will be able to improve students' problem-solving abilities is the Problem-Based Learning Model (PBL) in Table 1 (Simamora et al. 2017; Purba et al. 2018; Nasution et al. 2019).

The advantages of PBL include (1) training students to use reasoning in problem solving; (2) training participants to make hypotheses in problem solving based on simple business concepts; (3) training critical and

contextual thinking skills with real business problems encountered; and (4) training students to conduct trials in proving the hypothesis (Dewi, 2022; Nisa and Silaban, 2022). The PBL model is used in this study as a solution to solving analytical chemistry problems by using an approach in learning that helps students find problems from learning analytical chemistry in theoretical and practical learning so that they can find strategies that they have determined to make a solution decision (Lukman et al. 2019; Muti'ah, 2021; Nisa et al. 2022). After that, the problem will be presented in practice (Antara, 2022).

Table 1. Syntax of the Problem Based Learning model (modified from Simamora et al. 2017).

Phases	Teacher Activity	Students Activity
Phase 1 Student orientation to the problem	• Explain the purpose of learning. • Motivate students to be actively involved in solving the selected problem	• Be able to understand the scope of chemistry and chemical analysis and their role in learning theory and practice. • Can innovate in practice to find answers to a problem.
Phase 2 Organize students	• Help students define and organize learning tasks related to the problem	• Can limit and classify a problem by solving it with a specific method
Phase 3 Individual and group research guide	• Encourage students to gather appropriate Information to carry out experiments for explanations and problem solving	• Investigate the issues presented using the techniques employed to find solutions.
Phase 4 Develop and present the work	• Assist students in planning and preparing suitable works such as reports, models and sharing assignments with friend	• Prepare reports on analytical chemistry practice with the results of research conducted on each student using different methods
Phase 5 Analyze and evaluate the problem-solving proces	• Evaluate learning outcomes about the material that has been studied/ ask group presentation of the work	• The results of assignments and practice reports can be accounted for through presentations to lecturers

Learning about chemistry is a science that is closely related to the composition. structure and properties. changes. dynamics. and energetics of substances that exist in human life at the high school level (Pratama et al. 2017). Basically it has been applied which involves skills and reasoning to understand the chemistry (Lusiyana et al. 2019). Chemistry learning can be said to be a form of science category (Arifin, 2021). Where in learning begins with the basic concepts of science. develops. applies and draws conclusions from science learning (Susi and Yenti, 2020). However. in reality, what often happens in the field is still using conventional methods and explaining the material according to the module. So that these conditions make students less trained in understanding and developing the learning and it is difficult to be able to analyze and apply it in the form of chemical concepts in everyday life (Sandabunga and Anwar, 2021).

Learning analytical chemistry courses for the student level which is divided into theory and practice. of course. requires a learning development process to be able to harmonize theory and practice (Yusfiani, 2020). In this study, it is considered necessary to do which aims to see the extent to which students' improvement in analytical chemistry learning can be applied in theory learning and practicum for 1 academic year.

Method

General procedure

Instruments of data collection techniques taken in this study used the form of Pre-Test (Pre-Test) and Post-Test (Post-Test) questions. And then conduct interviews to students and also to teachers. The data analysis technique used descriptive statistical analysis. Descriptive Statistical Analysis is used to describe the characteristics of the score of the research sample.

Data analysis

Techniques Data analysis techniques in research conducted using Excel software. The data analysis in this study includes: (1) the value of the pretest and postet frequency distribution data for students; and (2) the value of increasing student learning outcomes using the N-Gain score formula (G factor). For the g factor formula used is as follows:

$$N - Gain = \frac{Posttest\ score\ -\ Pretest\ score}{Ideal\ score - Pretest\ score} \quad (1)$$

For the distribution of factor scores and the value of the effectiveness category is listed in Table 2.

Table 2. The score factor value and effectiveness category (Meltzer, 2002)

Distribution of Gain Score		
Criteria I	$g > 0.7$	High
	$0.3 \leq g \leq 0.7$	Medium
	$g < 0.3$	High
Category Effectiveness N-Gain		
Criteria II	< 40	Not Effective
	$40 - 55$	Less Effective
	$56 - 75$	Quite Effective
	> 76	Effective

Results and Discussion

The results of the research obtained from pre-test data and post-test data of students in the analytical chemistry course at the Tanjungbalai Polytechnic Campus. Based on the results of calculations from these data can be described as follows.

Pre-test result data

For the pretest results obtained before the application of learning is carried out in the analyst chemistry course at the Tanjungbalai Polytechnic Fisheries Product Processing Engineering Study Program. The results in Table 3 below explain that the frequency distribution value of the pretest value in the Chemical Analysis course.

Table 3. Frequency distribution value of pretest value of chemical analysis course

Intervals	Frequency	Percent	Valid Percent	Cumulative Percent
45	2	6.67	6.67	6.67
55	2	6.67	6.67	13.34
56	2	6.67	6.67	20.00
60	7	23.33	23.33	43.34
62	1	3.33	3.33	46.67
63	1	3.33	3.33	50.00
64	5	16.67	16.67	66.67
65	6	20.00	20.00	86.67
66	1	3.33	3.33	90.00
68	1	3.33	3.33	93.34
73	1	3.33	3.33	96.67
74	1	3.33	3.33	100.00

Result	Value
N	30
Min	45
Max	74
Range	29
K	5.907
P	4.909
Std. Dev	6.33
Variance	40.110

Table 3 presents the pretest values of experimental class students as comparisons before the application of the PBL learning model to do the essay test with 10 questions. From the results of the pre-test. the results showed that from 30 students there was 1 person (3.33%) with the highest score with a score of 74. For there were 29 people (97.67%) who did not pass because the score was below 74. The explanation in table 2 is contained in the form of Fig. 1.

Post test data

For the pretest scores obtained before the application of learning is carried out in the analyst chemistry course at the Fishery Product Processing Engineering Study Program. Tanjungbalai Polytechnic. The results in Table 4 below explain that the value of the frequency distribution of values posttest in chemical analysis course.

In Table 4 above explains that the posttest scores carried out from the experimental class present posttest scores for experimental class students after the application of the PBL learning model did an essay test with 10

questions and got 5 people with the highest score 90 with a percentage of 16.67% and 83.33% showed a value below 90. The standard deviation of the posttest value was 4.138. The explanation in table 2 is contained in the form of Fig. 2.

Table 4. Frequency distribution of posttest scores for chemical analysis courses

Intervals	Frequency	Percent	Valid Percent	Cumulative Percent
76	1	3.33	3.33	3.33
78	1	3.33	3.33	6.66
79	1	3.33	3.33	10.00
80	7	23.33	23.33	33.33
82	5	16.67	16.67	50.00
83	1	3.33	3.33	53.33
84	3	10.00	10.00	63.33
86	3	10.00	10.00	73.33
87	1	3.33	3.33	76.66
88	1	3.33	3.33	80.00
89	1	3.33	3.33	83.33
90	5	16.67	16.67	100.00

Result	Value
N	30
Min	76
Max	90
Range	14
K	5.907
P	2.370
St. Dev	4.138
Variance	17.126

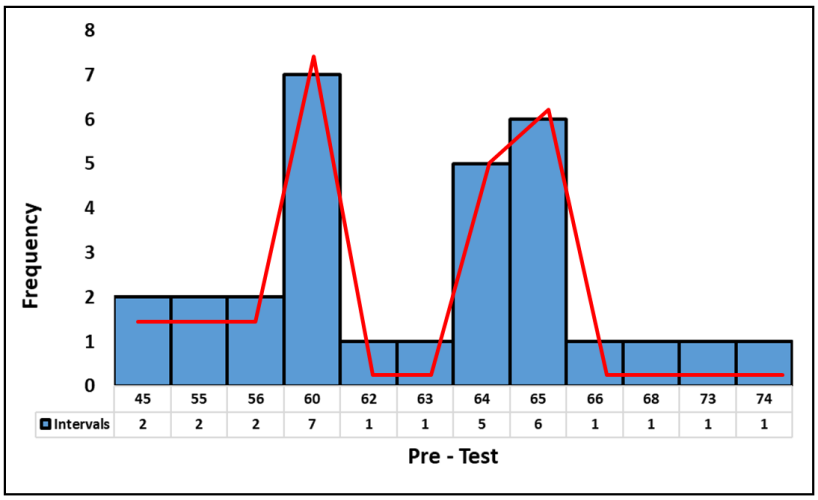

Figure 1. Graph of the pretest scores of experimental class students

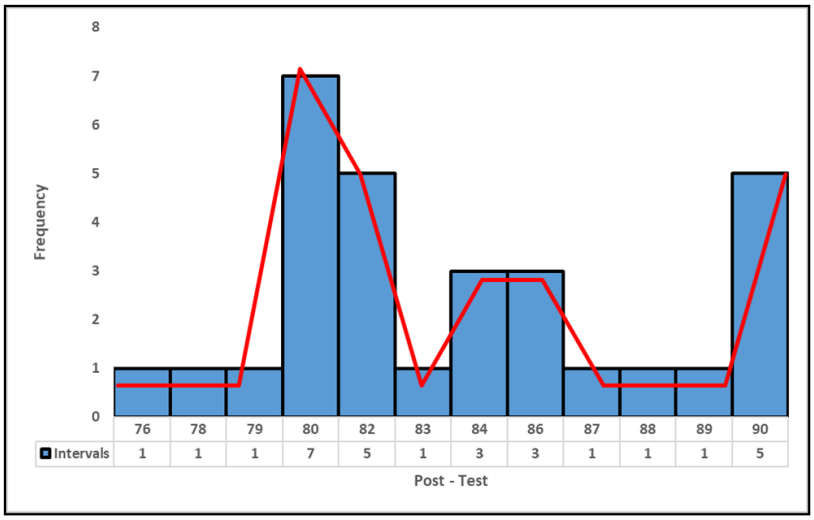

Figure 2. Graph of posttest scores of experimental class students

Improved learning outcomes (N-gain score test)

To determine the acquisition of learning outcomes, the N-Gain factor formula is used in formula 1. For the results of the gain score and the effectiveness category, the value of the calculations carried out in accordance with Table 1 above can be described in Table 5. From the description in table 5 shows the value of the pretest and posttest processes, the g factor value is 0.56 in the medium category and the percentage is 56.16% in the quite effective category.

Table 5. The value of learning improvement results

N	Pre-Test	Post-test	Value of Post - Pre	Ideals Score 100 Pre Test	N-Gain Score	N-Gain Score Percen
1	55	80	25	45	0.556	55.556
2	56	88	32	44	0.727	72.727
3	60	89	29	40	0.725	72.500
4	65	87	22	35	0.629	62.857
5	65	76	11	35	0.314	31.429
6	63	84	21	37	0.568	56.757
7	64	90	26	36	0.722	72.222
8	60	80	20	40	0.500	50.000
9	60	90	30	40	0.750	75.000
10	64	80	16	36	0.444	44.444
11	62	80	18	38	0.474	47.368
12	64	79	15	36	0.417	41.667
13	73	80	7	27	0.259	25.926
14	45	82	37	55	0.673	67.273
15	74	82	8	26	0.308	30.769
16	65	90	25	35	0.714	71.429
17	64	90	26	36	0.722	72.222
18	56	90	34	44	0.773	77.273
19	60	86	26	40	0.650	65.000
20	64	84	20	36	0.556	55.556
21	45	82	37	55	0.673	67.273
22	65	83	18	35	0.514	51.429
23	60	82	22	40	0.550	55.000
24	66	80	14	34	0.412	41.176
25	65	86	21	35	0.600	60.000
26	65	86	21	35	0.600	60.000
27	68	80	12	32	0.375	37.500
28	60	78	18	40	0.450	45.000
29	60	82	22	40	0.550	55.000
30	55	84	29	45	0.644	64.444
Ave	61.600	83.667	22.067	38.400	0.562 Medium	56.160 Quite Effective

Conclusion

The pre-test results show that out of 30 students, there is 1 person (3.33%) with the highest score of 74. There are 29 people (97.67%) who do not pass because the score is below 74. And the standard deviation is 6.33 with a variant value. 40,110. And the value of the Post Test is the score of 5 people with the highest score of 90 with a percentage of 16.67% and 83.33% showing a score below 90 and passing the PBL analysis chemistry lesson. The standard deviation value for the posttest is 4.138 with a variance of 17.126. While the

value of increasing learning outcomes in analytical chemistry courses. the g factor value of 0.56 is in the moderate category and the percentage is 56.16% which is quite effective.

Acknowledgment

The author would like to thank the Director of the Tanjungbalai Polytechnic who has assisted the authors in this research in the form of moral support to be able to complete this research.

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