THE EFFECTIVITY OF INDUSTRIAL MICROBIOLOGY TEXTBOOK APPLICATION ON STUDENTS PROBLEM SOLVING SKILLS

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Abstract—The objective of this study is to find out the effect of industrial microbiology problem based textbook application on students problem solving skills. A quasi experimental research with pretest-posttest control group design was used in this study. The population of this study was 6th semester students of Biology department and 2 classes chosen as the sample by applying cluster random sampling technique. Experimental class was using industrial microbiology problem based textbook while control class was using conventional textbook. The instrument used to obtain the data was description test. The data were analyzed by using Mann-Whitney U-test. The ranked test scores of the two books were significantly different ($U = 89.5, n_1 = 21, n_2 = 21, p < 0.05$). $z = -3.296 < -1.96$ means the null hypothesis was rejected, suggesting that there is an effect of industrial microbiology problem based textbook application on students problem solving skills. The sum of ranks for industrial microbiology problem based textbook ($\sum R_1 = 582.5$) was larger than the sum of ranks for conventional textbook ($\sum R_2 = 320.5$). Therefore, it can be stated that industrial microbiology problem based textbook as a more effective textbook for problem solving skills of students.

Keywords: Industrial microbiology, problem based learning, textbook, problem solving skills

1. INTRODUCTION

Low quality of education in Indonesia became one of the obstacles that hinder the achievement of educational goals. It can be seen from the results of TIMSS (Trends in International Mathematics and Science Study) 2011 indicate that Indonesian students have not shown satisfactory achievement. In the field of science, Indonesia ranks 40 of 42 countries with score 406 which below the international mean score [10]. These results are consistent with PISA (Programme for International Student Assessment) 2012 where Indonesia ranks 64 of 65 countries with score 382 [11]. One of the factors causing low student achievement is the lack of problem solving skills in non-routine or high level questions. While students in Indonesia just got used to the routine questions on level 1 and level 2 [7].

In microbiology learning process, students tend to memorize the material without understanding and analyze it more deeply, thus experiencing difficulties in solving and finding solutions for the problems. At Ashland Community College, 89% of 147 summer school students get C in microbiology courses over a period of 6 years. With the same material and format of examinations, it is given to nursing program students and gets only 44% of the 62 students who can complete the course well [6].

Learning microbiology can be obtained from various sources, one of which is textbook. Textbook is one component of a learning system that plays an important role in helping students achieve learning objectives Mudlofir in [1], as proposed by Westbury in [9], "The textbook is, in fact, the heart of the school and without the ubiquitous text there would be no schools, at least as we know them ". This shows the important role of the textbook as the main means of conveying knowledge.

Learning science should be carried out with a problem-based learning because it can foster the ability to think, work, act and communicate scientifically as the life skill (BSNP in [5]. The absence of Applied Microbiology textbook-based problems, especially in Unimed, can impede the learning process of students [5]. Students are exposed to real-world problems by learning about critical thinking and problem solving skills, to acquire essential concept of the lecture material and help students develop skills in solving problems. [4].

To meet the learning needs of applied microbiology, especially in Industrial Microbiology, [5] have developed Industrial Microbiology problem based textbook. It is expected to improve the ability
of students in critical thinking and problem-solving skills as well as a positive influence in developing neither the scientific skills nor scientific attitude of students in improving learning outcomes. As time goes by, the references in industrial microbiology continue to grow. However, the effectiveness of testing this textbook has not been done.

2. METHODS

This research held in Universitas Negeri Medan during April 2016 with population of 6th semester students in Biology department. Two classes chosen as the sample by applying cluster random sampling technique. Experimental class was using industrial microbiology problem based textbook and control class was using conventional textbook in learning process. A quasi experimental research with pretest-posttest control group design was used in this study. The instrument used to obtain the data was description test that consist of some aspects including understanding the problem, devising a plan, carrying out the plan, and looking back. The test arranged based on indicators.

Pretest was given to the population to determine the samples with similar prior ability. Learning strategy used in experimental class is problem based learning (PBL) and conventional learning for control class. While applying PBL, students divided into some groups and present the industrial microbiology topics based on industrial microbiology problem based textbook. They also discuss the tasks and problems that found in the textbook and did the PBL worksheets. Postest was given at the last meeting to obtain the data. The data were analyzed by using descriptive analysis (mean, median, variance, and standard deviation) and inferential analysis to test the hypothesis using Mann-Whitney U-test.

3. RESULTS AND DISCUSSION

Postest results of problem-solving skills in experimental class was obtained the mean score 81.81 ± 12.25, while in control class was 67.79 ± 11.76 (Figure 1). It shows that students who use industrial microbiology problem based textbook have better problem-solving skills than students who use conventional textbook. The similar results are seen in the score for each topic (Table 1), where the highest percentage of problem solving skills is on the topic of tempe fermentation (86.73%) and the lowest percentage is on the topic of alcohol fermentation (78.36%). While in control class, where the highest percentage of problem solving skills is on the topic of tempe fermentation (79.30%) and the lowest percentage is on the topic of acetic and lactic acid fermentation (55.83%) (Table 2).

Figure 1. The effect of industrial microbiology problem based textbook application on students problem solving skills (*indicates significantly different from control class; Mann-Whitney U-test, p < 0.05).

Table 1. Posttest results of problem solving skills in experimental class

<table>
<thead>
<tr>
<th>No</th>
<th>Topics</th>
<th>Problem solving skills (%)</th>
<th>Mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>1</td>
<td>Tempe ferm.</td>
<td>90.24</td>
<td>87.14</td>
</tr>
<tr>
<td>2</td>
<td>Kombucha</td>
<td>89.52</td>
<td>76.07</td>
</tr>
<tr>
<td>3</td>
<td>Milk ferm.</td>
<td>87.98</td>
<td>80.00</td>
</tr>
<tr>
<td>No</td>
<td>Topics</td>
<td>Problem solving skills (%)</td>
<td>Mean score</td>
</tr>
<tr>
<td>----</td>
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<td>------------</td>
</tr>
<tr>
<td>1</td>
<td>Tempe ferm.</td>
<td>85.48 90.06 59.52 82.14</td>
<td>79.30</td>
</tr>
<tr>
<td>2</td>
<td>Kombucha</td>
<td>76.37 61.43 39.29 71.43</td>
<td>62.13</td>
</tr>
<tr>
<td>3</td>
<td>Milk ferm.</td>
<td>79.88 71.79 48.57 80.95</td>
<td>70.30</td>
</tr>
<tr>
<td>4</td>
<td>Acetic &amp; lactic acid ferm.</td>
<td>77.02 47.38 39.40 59.52</td>
<td>55.83</td>
</tr>
<tr>
<td>5</td>
<td>Alcohol ferm.</td>
<td>88.10 72.62 53.33 71.43</td>
<td>71.37</td>
</tr>
</tbody>
</table>

Mean score: 81.37 68.65 48.02 73.10 67.79

Note:
A = understanding the problem
B = devising a plan
C = carrying out the plan
D = looking back

The results of Mann-Whitney U-test indicated a significant difference between the two books ($U = 89.5$, $n_1 = 21$, $n_2 = 21$, $p < 0.05$). The sum of ranks for industrial microbiology textbooks ($\Sigma R_1 = 582.5$) was larger than the sum of ranks for conventional textbooks ($\Sigma R_2 = 320.5$). $z = -3.296 < 1.96$ then $H_0$ is rejected so that there is an effect of industrial microbiology textbook application on students problem solving skills. Moreover, the effect size was 0.5 indicates a high level of association between the use of textbooks. Therefore, it can be state that industrial microbiology problem based textbook as a more effective textbook to students problem solving skills.

Mann-Whitney U-test was used to test the hypothesis in which there are significant differences between the class using the industrial microbiology problem based textbook and class using conventional textbook. The results showed that students who used industrial microbiology textbook have mean score were classified as good (81.81%) and higher in problem-solving skills than students who use conventional textbooks whose mean score were classified as enough (67.79%). This conclusion also applies to the score of each topics, where the highest percentage on the topic of tempe fermentation (87.19%) and the lowest percentage on the topic of acetic and lactic acid fermentation (79.19%). Sequentially, the results of problem solving skills for each topics is tempe fermentation (87.19%), kombucha (81.19%), milk fermentation (81.62%), acetic and lactic acid fermentation (79.19%), and alcohol fermentation (79.86%).

In this study, there are four aspects of problem solving skills, namely (1) understanding the problem; (2) devising a plan; (3) carrying out the plan; and (4) looking back. The ability of students to understand the problem is in excellent condition with a percentage of 91.52%. This shows that students are able to identify and formulate the exist problems so that it is expected to find a proper solution to these problems. The ability to devising a plan is good (77.45%) which means that students can search for possible solutions to each problem. This stimulates students to think analytically, creative, and innovative in finding solutions. In solving the problem, the students refer to the references that exist and deduce information that has been obtained into a proper solution to solve problems. This ability is classified as enough with percentage of 68.02%, where students may have limited time in finding the appropriate reference so that the finding solution is not maximum yet. Once
the solution has been described, the truth and clarity of the answers should be re-examined. The ability to re-examine or looking back classified as very well with the percentage 90.24%. This indicates that students already has the confidence of the answers and continue to improve themselves to affirm their ability to solve a problem.

Students who use the industrial microbiology textbook more adept at solving problems, ranging from understanding the problem to find the right solution and re-examine the results obtained. In the process, they formed their own knowledge and can be summed up better. Students showed a positive response, encouraging them to be more active in discussion among friends or lecturer, able to solve the problems discussed in the group. This leads them to better understanding of microbiological material so that learning becomes more effective.

According with [8] which states that learning microbiology with PBL can improve problem solving skills and more active discussion. PBL also improve learning outcomes that can be seen from the value of N gain 25.90% with a low category, and there are significant differences between control and experimental groups. As well as [12], the use of problem-based digital book can improve the ability to solve problems, especially in low-ability students. Problem-based learning centered on the student and make learning more meaningful and effective.

[7] suggests that there is a difference between the mean score of learning outcomes of students who experience learning using problem-based teaching materials as the treatment to the mean score of learning outcomes obtained before students given the treatment on hydrocarbon material. The mean score of students learning outcomes who experience learning using problem-based teaching materials was 83.5 while students who did not experience learning using problem-based teaching material was 70.0. It can be concluded that the mean score of student learning outcomes after experiencing learning using problem-based teaching material is higher than the mean score obtained before the learning experience using problem-based teaching materials.

PBL change the educational paradigm of teaching into learning, emphasis on what students learn rather than what is taught by lecturer [2]. In this study, students are given the questions in the form of a problem that is described in industrial microbiology textbook. Students get learning through the process towards understanding and problem solving.

4. CONCLUSIONS

Based on the result of this research, it can be concluded that there is an effect of industrial microbiology problem based textbook application in improving students problem solving skills. Students who use the industrial microbiology textbook have better problem solving skills than students who use conventional textbook.

5. ACKNOWLEDGMENTS

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REFERENCES


