An Attempt on the Support for Self-Teaching in the Elementary Physics Education

Yuichi Anada, Hokkaido Information University, Japan

The European Conference on Technology in the Classroom 2015
Official Conference Proceedings 2015

Abstract
As the percentage of students enrolling in universities reaches more than 50% in Japan, a lot of Japanese university takes on students who do not have a sufficient basic level of academic ability. As to the education of physics, not a few students are a lack of basic concepts and basic knowledge of physics. In this study, an effect of a review test on academic ability of physics in class was examined for the students of our university. The review test is implemented in learning management system, Moodle. The course investigated in this study is an elementary physics course offered for second-year students. This course is optional and offers a lecture once a week throughout one university year. The total number of students who chose this course is approximately 100. The review test is composed of two parts: one is a part of formulation of a concept of physical phenomena and another is a part of understanding of equations and symbols. During the review test, students have to refer to the text, their notes and other reference materials. It takes approximately 15 min. As a result of several years’ trial, the effect was in evidence in the term examination.

Keywords: elementary physics course, university, review test, basic concept, basic knowledge, Moodle
Introduction

The percentage of students enrolling in universities has increased gradually and it reached approximately 50% in Japan [1]. Under this situation, a lot of Japanese universities take on students who do not have a sufficient basic level of academic ability. Namely, there is a lack of high school level knowledge and skills, autonomy, endurance and so on. Additionally, regarding the education of physics, a lot of students lack of a basic understanding of concepts and basic knowledge of Physics. Private universities have this tendency remarkably. In Japan, private universities accounts for about 75% of all universities [1]. Therefore, a lot of private universities accept a considerable number of such students. In Japan, the issue of the improvement of academic achievement of university students is an important problem.

Increase in the percentage of students enrolling in universities is not an issue only in Japan but also in other countries. In United States, United Kingdom, France and Germany, it is over about 40% [2]. In Korea, it exceeds 90% [2]. This tendency is common in nations with advanced economy. The issue of the improvement of academic achievement of university students will be a serious problem for many nations. In United States, a lot of universities have grappled with such difficult problem for many years [3]-[5].

On the other hand, it is often said that active learning methodology induces deep understandings and stimulates students’ spontaneous willingness to learning. Many teachers try to adopt the active learning to their classes recently. However, basic knowledge is necessary to bear fruits. Even if the active learning is adopted in the class with so many students who lack of basic knowledge, it is not expected big fruits. In such class, fixing the basic knowledge is prior to the active learning.

This study is an attempt on the support for self-teaching in the elementary physics education. It aims fixing the basic concepts and basic knowledge of physics for the students who do not have enough autonomy and endurance. For this purpose, a review test was introduced in the class of elementary physics course in our university. The review test was originally introduced in our university in the year of 2005 [6]. As a result of several years’ trial, the effect was in evidence in the term examination. In this study, the review test is implemented in learning management system, Moodle, with the view of improving the effect of the review test more.

Progress of teaching in classes

Proceeding of classes in semesters is shown in Figure 1. The elementary physics course is composed by two subjects of Physics I and Physics II. The former includes Mechanics and Electromagnetism and is available in first semester. The latter includes Thermodynamics and Optics and is available in the second semester. This course is offered for the second-year students of Hokkaido Information University. Students can take both of the subjects or one of these. The contents of both the
subjects are elementary physics as liberal arts subjects. One semester is composed of 15 classes and it takes 90 min for each class. In the semester, the class is offered once a week. Almost all students forget the contents of lecture. The review test is offered at the beginning of the class to remind students of the contents of one week before. In the class, short quiz is offered approximately every 20 minutes and homework is offered. However, it was confirmed that the review test is the most effective for fixing memory [6]. Quiz is considered to be effective to help their understanding of the concept of the law of physics.

![Figure 1: Proceeding of Physics I and Physics II in the semesters](image)

**Review Test**

The review test is composed of two parts. One is a part of meaning of terms. It reviews formation of a concept of the laws of physics and comprehension of physical phenomena. Another is a part of reviewing formulae and symbols. The review test is originally paper-based form. Students submit a mark card entered with their answer. An example of the mark card and the review test is shown in Figure 2 and Figure 3 respectively. During the review test, students have to refer to the text, their notes and other reference materials because the aim of the review test is recall the memory of the previous lecture. It takes approximately 15 min for students to grapple with the problems including collection time of the mark card. The paper-based review test was introduced in 2005. The effect appeared immediately as explained in the previous paper [6]. The effect has been confirmed in the average mark of the term examination of the class. The average marks increased 10 points on the bases of 100 points in Physics I and 25 points in Physics II on average. The verification of the effect of the review test has been continued up to the present [7] [8]. The good effect has been kept.
Figure 2: Mark card used in paper-based review test
Physics II The 6th Review Test

<table>
<thead>
<tr>
<th>Department</th>
<th>Class</th>
<th>Student ID</th>
<th>Name</th>
</tr>
</thead>
</table>

Chose the suitable answer from the CHOISES.

<table>
<thead>
<tr>
<th>Internal energy of ideal gas</th>
<th>1</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>The 1st law of thermodynamics</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Principal of a heat engine</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>State quantity</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

[CHOISES: Meaning of terms]
1. The law which means the work is equal to the heat.
2. The fundamental quantity representing the amount of material. It is counted by the unit of Avogadro number.
3. Internal energy a system increases if the heat or the work is took out from the system.
4. The ability of working which occurs by keeping a distance between the attracted objects.
5. The internal energy of the ideal gas is inversely proportional to the absolute temperature.
6. The internal energy of the ideal gas is proportional to the absolute temperature.
7. Internal energy of a system increases if the heat or the work is given to the system.
8. Taking out the work from a system by using thermal expansion of material.
9. The energy necessary for heating a material of 1 g by 1°C.
10. The relationship between the volume, the temperature and the pressure.

[CHOISES: Formuiae, Symbols]
1. \( Q \)
2. \( PV = nRT \)
3. \( AU = Q + W \)
4. \( U \)
5. \( U = \frac{3}{2} NkT \)
6. \( W \)
7. \( V \)
8. \( T \)
9. \( J \)
10. \( N_4 \)

Figure 3: An example of paper-based review test
Change of Medium of Review Test

In this study, the medium of the review test is changed from paper-based form to Moodle which is a kind of the learning management system in e-learning. Purpose of the change from the paper-based form to the Moodle-based system is summarized as follows:

1. Immediate marking
2. Reflection
3. Accumulation and analysis
4. Reduction of teacher’s burden

Regarding the 1st aim, in the paper-based review test, in fact, the immediate marking and the return of it to the students is difficult, even though the reading device of mark card is used. Even if the earliest case, the return will be one week later. In the Moodle, the review test is marked immediately. As the students are able to check their results then and there, they make reflection naturally. In the Moodle-based review test, for the sake of urging the students to make reflection, a function of writing their reflection is implemented. It concerns with the above 2nd aim. In the 15 minutes of the review test time at the beginning of the lecture, students solve the problems and write their reflection on the review test system on the Moodle. As mentioned in the 3rd aim, the results of the review test are accumulated automatically in the Moodle-based review test system. Therefore, it is easy to analyze the results. Finally, the 4th aim is reduction of teacher’s burden. It does not mean negligence. Faculty members are very busy on their many kinds of work, for example, many lectures, marking of homework, many meetings and affairs of faculty and university, and so on. The reduction of burden ensures a sufficient time for faculty members to educate students. A screen shot of the interface and the source code of the review test are shown in Figure 4 and Figure 5. TeX [9] is used in the part of equations and symbols.
The number of the review test transferred from the paper-based to Moodle-based is 22 for Physics I and 25 for Physics II. The number of questions is 6 at minimum and 10 at maximum per each review test.
Results of Attempt

The effect of the Moodle-based review test is discussed below by comparison with that of the paper-based review test. The students were classified into two groups. One is the group A whose students are second year and another is the group B whose students are third and fourth year. Before 2013, the students of both groups took the paper-based review test but in 2014, the students of the group A took the Moodle-based test and the students of the group B took the paper-based test. The reason is that all of the first and second year students of our university have iPad which is lent by the university in 2014, but others are not. Consequently, students are able to take the Moodle-based review test in a normal classroom. The snapshot of the classroom is shown in Figure 6.

The students of both groups took a pretest and a posttest at the beginning and the end of the semester in 2014. The results of these tests are summarized in Table 1. The Average marks, the standard deviations and number of students are entered in this table. $G$ is a gain of the posttest over the pretest as defined by a next equation.

\[ G = \frac{\text{post} - \text{pre}}{\text{full} - \text{pre}} \]

Here, pre is the average mark of the pretest in the class and post is that of the posttest. full is a perfect score, that is 50 points. We can see from the Table 1 that there is a good effect of learning because G value is ca.40% at maximum and ca.20% even at minimum.

Table 1: Results of Pretest and Posttest

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pre</td>
<td>post</td>
<td>G</td>
<td>pre</td>
</tr>
<tr>
<td>Group A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>10.5</td>
<td>27.8</td>
<td>0.44</td>
<td>8.7</td>
</tr>
<tr>
<td>SD</td>
<td>6.7</td>
<td>11.3</td>
<td></td>
<td>6.3</td>
</tr>
<tr>
<td>no.Cand.</td>
<td>54</td>
<td>54</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>Group B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>10.5</td>
<td>26.3</td>
<td>0.40</td>
<td>10.1</td>
</tr>
<tr>
<td>SD</td>
<td>5.7</td>
<td>11.8</td>
<td></td>
<td>4.1</td>
</tr>
<tr>
<td>no.Cand.</td>
<td>22</td>
<td>22</td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

Subsequently, it is investigated whether there is a difference between the Moodle-based group A and the paper-based group B. Figure 7 shows a ratio $G$ of group A (GA) to $G$ of group B (GB) for the class of Physics I. The number of the candidate students at the end of semester is from ca.70 to ca.110 in depending on the year.
The ratio GA/GB is around 1.0 before 2013 but it increased up to about 1.6 in 2014. As described above, the group A and the group B took the paper-based review test though the group A took the Moodle-based review test in 2014. From this result, it is considered that the characteristics called the immediate marking and the reflection of the Moodle-based review test achieved a good effect on fixing the basic knowledge and the basic concept of elementary physics.

However, regarding Physics II, the good effect is not clear as shown in Figure 8. The interpretation of this result is as follows. Physics II is also optional subject as same as physics I and the students should just take one of them. Normally, the great majority of the students takes Physics I. It is obvious from the registration number of students: approximately 100 for Physics I and 40 for Physics II. Therefore, it is considered that the students who take Physics II have an interest in study more than Physics I. This might be the reason why there is not difference between GA and GB in 2014 in Physics II.
Conclusion

The review test in class is useful as support for self-teaching in elementary physics class in our university. In this study, the medium of the review test is transferred from paper to Moodle in order to improve the effect of this test. The effect was investigated by using the pretest and the posttest. As a result, it is considered that the improvement of the test achieved good effect on fixing the basic knowledge and ensuring the understanding of the basic concept of physics. In the Moodle-based review test accumulates the reflection data. We may obtain useful intelligent from these data by doing the cluster analysis.

Acknowledgment

This work is supported by MEXT KAKENHI Grant Number 25350291.

References


Contact email: anada@do-johodai.ac.jp