The use of inquiry cycle learning to enhance students
cognitive abilities on simple harmonic motion

D Hadianti1*, I Kaniawati1 and I Hamidah2

1 Department of Physics Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
2 Department of Mechanical Engineering Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

*hadianti.dini.dh@gmail.com

Abstract. The aim of this study was to get an overview of cognitive enhancement in the subject matter of simple harmonic motion of students who received inquiry cycle learning. There were 20 items test were given to 63 X-grade students from a senior high school in Pandeglang. Each item had five options and students had to choose the right one. Method used in this study was quasi experiment with the randomized pretest-posttest control group design. The result showed that implementation of inquiry cycle learning significantly can further enhance students' cognitive abilities (< ḡ > = 0.46) compared to conventional learning (< ḡ > = 0.2). From the hypothesis testing, student’s cognitive abilities using inquiry cycle learning was better than student’s cognitive abilities using than conventional learning.

1. Introduction
Cognitive abilities are very important for human especially students. Cognitive abilities is mental activity from the basic stage to the higher stage caused by thinking ability [1]. Cognitive abilities are classifying into two dimensional: cognitive process and knowledge. The cognitive process dimension contains six categories: remember (C1), understand (C2), apply (C3), analyze (C4), evaluate (C5), and create (C6). The knowledge dimension contains four categories: factual, conceptual, procedural, and metacognitive.

Based on observation result at a school in Pandeglang, Banten, students had low cognitive abilities. They had average 27 (scale 100) or they only can give 6 correct answers from 23 items. They needed learning strategy to enhance their cognitive abilities. One of research showed that physics cognitive competence and science process skill of students using scientific inquiry learning model based on conceptual change was better than using conventional learning [2]. Other study also showed that students who learn using the levels of inquiry learning model got the enhancement on science process skills [3].

Inquiry learning is an educational activity in which students are placed in the position of scientists gathering knowledge about the world [4]. A popular educational strategy advocated for acquiring deep knowledge is inquiry-based-learning [5]. Inquiry-based learning aspires to engage students in an authentic scientific discovery process. These individual units are called inquiry phases, and their set of connections forms an inquiry cycle [6]. Inquiry cycle learning can help students to learn actively. The learning process not only transfers knowledge from teacher to students, but also involves students directly. Then it will be more meaningful and train students to resolve problems. Pedaste et.al described the phases of inquiry cycle learning as follows [7].
In orientation, students were divided into several groups. Each group consists of 5-6 students. Teacher gave work sheets that contain a problem. The problems given were close to their life. Cognitive ability was trained in this phase is understand (C2).

Conceptualization is a process of understanding a concept or concepts belonging to the stated problem. Students discussed with their own group to get research questions and hypotheses. Cognitive abilities were trained in this phase are understand (C2) and analyze (C4).

When research questions and hypotheses are gotten, next phase is investigation. In this process, students with their group planned experiment to get data then analyzed. Student explored (design how data was generated), experimented (tested hypotheses), and interpreted data (made definitions of data that obtained and synthesized to new knowledge). When students discovered something new or wrong at the investigation phase, it can return to the conceptualization (can be done several times). In this phase, cognitive abilities were trained are understand (C2), apply (C3), and analyze (C4).

If orientation till investigation phases had been done, the next is conclusion. Conclusion was made based on data and evidence. They were asked to compare the conclusion with research questions and hypotheses that made in the conceptualization. Similar to investigation, if students discovered something new or wrong at the conclusion, it can return to the conceptualization. Cognitive abilities were trained are understand (C2) and analyze (C4).

The final phase in inquiry cycle is discussion. Students presented the result of research to other groups. They were trained to deliver information and communicate well not only with their own group, but also with the other groups. Discussion could be held in final phase or every phase. Understand (C2) and analyze (C4) were trained in it.

2. Method
Quasi experiment method with the randomized pretest-posttest control group design was selected to describe enhancement of cognitive abilities. There were one experimental class (contain 33 students) and one control class (contain 30 students). This study was held at a high school in Pandeglang, Banten. The instrument about simple harmonic motion was given to both classes is 20 items, where each item had five options and students had to choose the right one. So that, data was analyzed using gain normalized. Moreover, data was analyzed using Mann-Whitney test.
3. Result and Discussion

This research implemented inquiry cycle learning which consisted of 5 phases: orientation, conceptualization, investigation, conclusion, and discussion. First phase is orientation, where students divided into 6 groups. Furthermore, teacher gave apperception, motivation and demonstration about material will be learned. Teacher demonstrated spring vibration with different loads. Second phase is conceptualization, where teacher and students did question-answer activity and brought the hypothesis up.

Third phase is investigation, where students were given work sheet that contain problem. Teacher guided students in their experiment. At the first meeting, there were no groups repeated the learning phase, because they are not used to do that. At the second meeting, there was some groups repeated sub-phase (exploration-experimentation-interpreting data-exploration-experimentation-interpreting data), because step of experiment wasn’t same with the experiment. At the third meeting, one group also repeated the learning phase. They repeated from interpreting data to conceptualization, because data was gotten is not appropriate. Fourth phase is conclusion, where students were guided by teacher made conclusion based on hypothesis generation and interpreting data. Final phase or fifth phase is discussion, where students presented their findings to other groups, followed by question-answer activity between groups. In discussion, they also expressed how the learning took place as a reflection. Some of them said that they had difficulty following the learning. They were used to learning conventionally, but they were still happy with the learning that was applied.

Student’s cognitive abilities have enhanced in both classes. But, experimental class enhancement was higher than control class. It can be seen from normalized average gain score of student’s cognitive abilities (see Table 1). Enhancement of cognitive abilities also can be seen through cognitive process dimension (see Figure 2).

Table 1. Normalized average gain score of student’s cognitive abilities.

<table>
<thead>
<tr>
<th>Class</th>
<th>&lt;ḡ&gt;</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>0.46</td>
<td>medium</td>
</tr>
<tr>
<td>Control</td>
<td>0.2</td>
<td>low</td>
</tr>
</tbody>
</table>

Figure 2. Normalized Average Score of Cognitive Process Dimension

When the data was obtained, then normality and homogeneity was conducted, and its results are shown in Table 2.
Table 2. Normality of Cognitive Abilities

<table>
<thead>
<tr>
<th>Class</th>
<th>Kolmogorov-Smirnov(^a)</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>df</td>
</tr>
<tr>
<td>Control</td>
<td>.139</td>
<td>30</td>
</tr>
<tr>
<td>Experimental</td>
<td>.224</td>
<td>33</td>
</tr>
</tbody>
</table>

Based on the result of normality of cognitive abilities in Table 2, the significant value to the Kolmogorov-Smirnov was greater than 0.05 in control class and was lower than 0.05 in experimental class. It indicated that data wasn’t normal. Then, in order to get the effect of inquiry cycle learning to enhance student’s cognitive abilities, Mann-Whitney test by SPSS 23.0 was conducted, and its results are shown in Table 3.

Table 3. Statistic Test

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mann-Whitney U</td>
<td>189.000</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.000</td>
</tr>
</tbody>
</table>

Table 3 showed us that significant value wasn’t greater than 0.05, therefore indicated that student’s cognitive abilities using inquiry cycle was better than using conventional learning. Differences of cognitive abilities between experimental class and control class occur because of the different treatments have been given. Experimental class students played a role in the learning process, whereas control class students through the study with conventional learning. It was similar to Sahhyar result, the mean of physics cognitive abilities of students in experimental class was 72.97 and 54.97 in control class [8]. Students in experimental class did learning that gets the students involved directly. Students explore the concept by conducting discussions and demonstrations. Thus, they will remember what they experienced.

Inquiry cycle supported learning process very much. Almost every phase tries students to remember, understand, apply, and analyze. Some research findings that are relevant to this study, among others: the improvement of learning outcome is caused by implementing demonstration and experiment at the classroom [9], scientific inquiry method of teaching is significantly better than traditional lecture method of teaching for the subject of physics [10], and the inquiry-oriented general physics learning dynamic material is effective to increase the competence of general physics achievement, indicated by N-gain which are normalized by score of 0.67 [11].

Learning is a process, so it took time. In application, implementing new learning strategy to students is not always effortless. The effort level depends on student’s ability. As Masaaki said that efforts to improve skill for weak students is not sufficient to show qualified learning [12].

4. Conclusion
Generally, according to the results and discussion, it can be concluded that student’s cognitive abilities using inquiry cycle learning was better than student’s cognitive abilities using conventional learning. As for suggestion, further research can analyse the implementation of inquiry cycle learning for other competences, or enhancement student’s cognitive abilities using newest learning strategy.

5. Acknowledgments
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6. References


