

# Graph Comprehension of Simple Harmonic Motion and Understanding among Japanese University Students

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**Abstract.** A computer-based test was conducted for Japanese university students to clarify their understanding of the graph of simple harmonic motion (SHM). The survey questions were based on the previous studies by P. Wattanakasiwich *et al.* with an eye-tracking system. Although the survey method was completely different, the results for Japanese university students showed a shape close to the Gaussian distribution. In addition, since similar survey results were obtained, the survey problem of SHM could be validated.

## 1 Introduction

Physics deals with the laws of natural phenomena, and there are various ways of expressing them. One of the difficulties for learners of physics is understanding this variety of expressions, which not only allows learners to understand that one phenomenon can be expressed in various ways, but also allows them to freely translate into different expressions. The purpose of this study is to clarify learners' difficulties by focusing on simple harmonic motion (SHM), which requires understanding of physical phenomena in a graphical representation.

## 2 Research Method and Research Subjects

In previous studies by P. Wattanakasiwich *et al.* [1] [2], the authors created a multiple choice a computer-based test (CBT) that expresses physical phenomena related to simple harmonic motion (SHM) using graphs and formulas, and used an eye-tracking device to solve the difficulties of learners. The purpose of this study is to use a Japanese translation of this survey problem, and conduct a survey mainly for first-year university students in science who do not specialize in physics and compare it with the results in the previous studies in Thailand. The subjects of the research are 139 students in the department of chemistry and 100 students in the department of mathematics who are taking introductory physics based on calculus. Classes were held separately in the two departments, but the same professor taught them.

Due to the COVID-19 pandemic, it was not possible to conduct a face-to-face survey using an eye-tracking device, so we decided to conduct a survey online using Google Forms. However, from the viewpoint of fraud prevention such as leaking problems and solving problems with friends, the investigation time was set to 20 minutes and problems were presented at random. We also explained that although points will be added to grades by taking the survey, the points will not change depending on the grade. The survey was conducted after the sixth round (May 2021) of 15 (90 minutes per round) in the first semester of 2021. Since SHM was not dealt with in class, it falls under the pre-test classification.

## 3 Results

Of 239 students, 204 participated in the survey. Regarding their high school course history, 158 students took both basic physics and physics, and 23 students took only basic physics; three

students did not take either courses, and 20 students did not answer the questionnaire. The 12 survey questions were each scored with one point. Here, in order to exclude differences between high school course history. Fig. 1 shows the results for 158 students who took basic physics and physics. The horizontal axis is the score, and the vertical axis is the number of students. The average score was 5.2 points.

The results of this study were compared with the previous study, as shown in Fig. 2, with the question on the horizontal axis and the correct answer rate on the vertical axis. Here, some results were not posted because it was not mentioned in the previous study or because of our original problem.

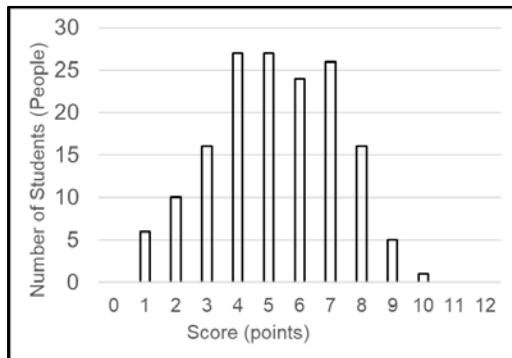


Fig. 1 Score distribution (n=158)

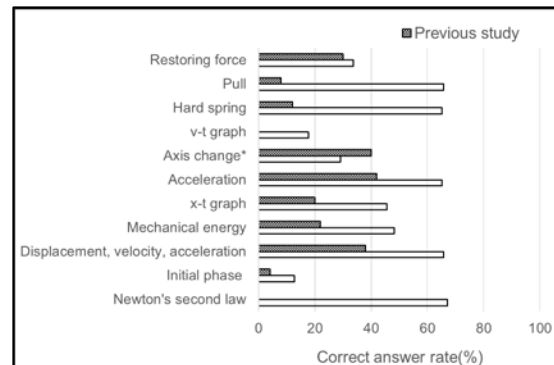


Fig. 2 Correct answer rate (n=158)

Firstly, regarding understanding of SHM in graph representation, it is not possible simply to compare with the previous one. Since the percentage of correct answers was higher overall in this study result, except for question 5 (Axis change\*), which changed the question options, we consider that the survey method has contributed significantly.

Looking at the percentage of correct answers in this study and previous one, the tendency in the percentage of correct answers is similar, except question 2 (Pull) and 3 (Hard spring). Considering that the distribution of the correct answer rate in this study resembles a Gaussian distribution, it is considered that the survey problem of the previous study is appropriate as a problem to investigate graph comprehension in SHM.

#### 4 Summary and Remarks

From the results of this survey on understanding SHM graphs among university students who are taking introductory physics based on calculus, many questions tend to be similar to the results of previous studies in Thailand. In the future, in order to clarify the understanding of graphs and formulas, we would like to clarify how to understand the SHM graphs where learners can write equations and draw graphs by conducting a survey using an eye-tracking device.

#### Acknowledgements

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#### References

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- [2] P. Wattanakasiwich, GIREP-ICPE-EPEC-MPTL, Hungary 1–5 July 2019.