

A Survey on the Basic Understanding of Simple Harmonic Motion among Physics University Students

Mohd Zaki Mohd Yusoff

School of Physics and Material Studies, Faculty of Applied Sciences, Universiti Teknologi MARA,
40450 Shah Alam, Selangor, Malaysia
zaki7231@uitm.edu.my

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Abstract: A survey was conducted on 24 students aged 20–23, representing 56.7% female and 33.3% male. Two groups were formed: industrial physics and education degree students. According to the survey, 95.8% of students were able to answer questions about oscillatory motion, phase constant, simple harmonic oscillator energy, and potential energy. However, some students still struggled with the concept of simple harmonic motion (SHM). The survey revealed that 41.7% of students found SHM: Introduction easy to understand, followed by the simple pendulum, mass-spring system, energy of the SHM, and phase angle. The most difficult topics were phase angle, SHM energy, and simple pendulum. There are many equations students need to remember when working on the phase angle and SHM energy. Students had problems in understanding sinusoidal graphs, misinterpreting period motion graphs, and solving restoring force calculations.

Keywords: Simple harmonic motion, pendulum, physics

Introduction

In a motion that is directly proportional to the body's displacement, a restoring force is known as simple harmonic motion (SHM). Applications including clocks, swings, musical instruments, bungee leaping, and hearing processes all depend on SHM. Vibrations, shock absorbers, and pendulums deliver brain messages, smooth rides, and shock absorption, where it is also involved in bouncing. Misconceptions and challenges are the primary obstacles that must be addressed in order to facilitate the effective learning of SHM concepts. Nugraha et al. (2019) showed that the average marks of 57.10% on SHM, with the most challenging concepts being the relationship between displacement, velocity, and acceleration (Dimas et al., 2018). Based on the previous reports, the comprehension of SHM among the students is low (Dimas et al., 2018; Somroob & Wattanakasiwich, 2017). The misconception of period motion graph, restoring force calculation are some of the issues encountered by the students (Somroob & Wattanakasiwich, 2017). Furthermore, the students are struggling with critical and creative thinking, with specific misconceptions affecting 14.6%, partial understanding at 36.8%, and sound understanding at 24.7% (Wardani, 2020). The researchers develop a feasible four-level diagnostic test instrument for identifying students' misconceptions about physics concepts (Tumanggor et al., 2020). The results showed different decision categories based on students' understanding, misconceptions, and lack of knowledge. The problem-solving laboratory (PSL) model is believed to be capable of enhancing students' understanding of SHM, improving their scientific work skills in formulating objectives, experimenting, using tools, and collecting data, as well as promoting cooperative and orderly group discussions, thus positively impacting senior high school physics learning in the laboratory (Iradat & Alatas, 2017). On the other hand, the employment of this

strategy requires more equipment and time to complete. The waves and optics course are the first topic for students who adopt this code on SHM.

Methodology

A total of 24 students participated in this survey, of which 56.7% were female and 33.3% were male. The age of the students involved in this survey is between 20 and 23 years old. All students were given a lecture and tutorial on this topic before this survey was carried out. To learn about students' understanding of SHM, a custom test will be implemented, which includes Programme Learning Outcome 1 (PLO1) and Programme Learning Outcome 2 (PLO2), as shown in Table 1. Questions from PLO1 will test the students' knowledge of SHM, and questions from PLO2 will test the cognitive characteristics of the student. Course Learning Outcome 1 (CLO1) requires students to explain the concepts, SHM laws, and theories. CLO1 will provide three levels of questions to students, namely, easy, medium, and high. However, for this study, basic comprehension questions, which comprise true/false questions, will be given to students.

Table 1. Programme and course outcomes for SHM

Topic	Programme Outcome	Course Outcome
Simple Harmonic Motion	1. Programme Learning Outcome 1 (PLO1) 2. Programme Learning Outcome 2 (PLO2)	1. Course Learning Outcome 1 (CLO1)

Table 2 shows a list of survey questions that have been distributed to students through Google Forms. The question is a fundamental question to each subtopic in SHM. Students have been exposed to the concepts of SHM in the classroom and trainings have been given to students before. The main purpose of this study is to identify students' answers on the concept of SHM and determine the problems experienced by students with regard to this topic. Then, the results of this study will be used to change the teaching strategy to a simpler one, and it will be implemented in the next semester. This study is also important to determine if the students can fully understand and comply with the expected learning outcomes. One of the learning outcomes for this topic is to comprehend the definition of SHM. All the questions are designed based on the lesson plan and course outcomes in the degree programme. The true/false question was created to aid the students in answering the questions. This way, students would not require more time to complete the questionnaire, as there are only two possible answers for each question. All the questions had been discussed during the lecture, and students are given sufficient time to understand the concept of SHM. Moreover, there are tutorials with answers provided in class. The level of questions is easy after taking into account all the basic fundamental of SHM and a random survey from examples on the internet. It is believed that students took less than 15 minutes to answer all questions; this may be attributable to the absence of critical thinking and scientific calculator required to answer the questions. Students are not allowed to discuss among themselves when answering these questions.

Table 2. True/false questions for SHM survey

<p>Oscillatory Motion: *</p> <p>A mass on a spring or pendulum moves back and forth over the same path about an equilibrium position.</p> <p><input type="radio"/> True</p> <p><input type="radio"/> False</p>	<p>Periodic : *</p> <p>This refers to a motion or process that does not repeat itself in equal time intervals.</p> <p><input type="radio"/> True</p> <p><input type="radio"/> False</p>
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<p>Simple Harmonic Motion: *</p> <p>An object moves with SHM when its acceleration is inversely proportional to its displacement and the same direction from equilibrium position 0.</p> <p><input type="radio"/> True</p> <p><input type="radio"/> False</p>	<p>Condition for Simple Harmonic Motion: *</p> <p>1) position of stable equilibrium. 2) energy dissipation occurs. 3) acceleration proportional to displacement.</p> <p><input type="radio"/> True</p> <p><input type="radio"/> False</p>
<p>Simple Pendulum: *</p> <p>Simple pendulum is a non-periodic mechanical system consisting of a wave-like bob suspended by a light string of length L.</p> <p><input type="radio"/> True</p> <p><input type="radio"/> False</p>	<p>Phase Constant: *</p> <p>The constant angle ϕ is called the phase constant (or initial phase angle) and, along with the amplitude A.</p> <p><input type="radio"/> True</p> <p><input type="radio"/> False</p>
<p>Energy of The Simple Harmonic Oscillator: *</p> <p>We assume:</p> <p>1) Surface is rough. 2) The system is isolated. 3) A massless spring</p> <p><input type="radio"/> True</p> <p><input type="radio"/> False</p>	<p>Potential Energy: *</p> <p>The spring's association is entirely dependent on its extent of stretching or compression.</p> <p><input type="radio"/> True</p> <p><input type="radio"/> False</p>
<p>Kinetic Energy: *</p> <p>The association with the block is entirely dependent on the speed at which the block is stopping.</p> <p><input type="radio"/> True</p> <p><input type="radio"/> False</p>	<p>The subtopic listed below is EASY to comprehend (Choose one) *</p> <p><input type="radio"/> SHM: Introduction</p> <p><input type="radio"/> Mass-spring system</p> <p><input type="radio"/> Phase angle</p> <p><input type="radio"/> Simple pendulum</p> <p><input type="radio"/> Energy of The Simple Harmonic Oscillator</p>
<p>The subtopic listed below is DIFFICULT to comprehend (Choose one) *</p> <p><input type="radio"/> SHM: Introduction</p> <p><input type="radio"/> Mass-spring system</p> <p><input type="radio"/> Phase angle</p> <p><input type="radio"/> Simple pendulum</p> <p><input type="radio"/> Energy of The Simple Harmonic Oscillator</p>	

Findings and Discussion

Table 3 shows the percentage of answers to the true/false questions, according to the topic to be studied in this study, where 95.8% of students was able to answer questions about Oscillatory motion, phase constant, Energy of The Simple Harmonic Oscillator, and Potential Energy. Meanwhile, on the question related to the Condition for SHM, it was found that some students still do not understand the concept of SHM. However, it depends on the level of questions provided in this study. The questions provided were in the form of basic concepts and no calculations were required. The purpose of these questions is to understand the students' basic knowledge of the subheading in the topic of SHM.

Table 3. True/false answer based on the topic

Topic	True (%)	False (%)
Oscillatory Motion	95.8	4.2
Periodic	12.5	87.5
SHM	25	75
Condition for SHM	54.2	45.8
Simple Pendulum	20.8	79.2
Phase Constant	95.8	4.2

Energy of the Simple Harmonic Oscillator	4.2	95.8
Potential Energy	91.7	8.3
Kinetic Energy	20.8	79.2

Figure 1 indicates the percentage of topics that students are most likely to comprehend SHM. Approximately 41.7% of students stated that SHM: Introduction was a subtopic that was easy to understand, followed by Simple Pendulum (29.2%), Mass-Spring System (12.5%), Energy of the SHM (8.3%), and finally, Phase Angle. The Introduction of SHM is easier to comprehend because there are not many graphs and formulas presented in this section. Most students are familiar with SHM because they have learned SHM from previous courses. In addition, students have learned the concept of the mass-spring system and what parameters are used to calculate the SHM performance.

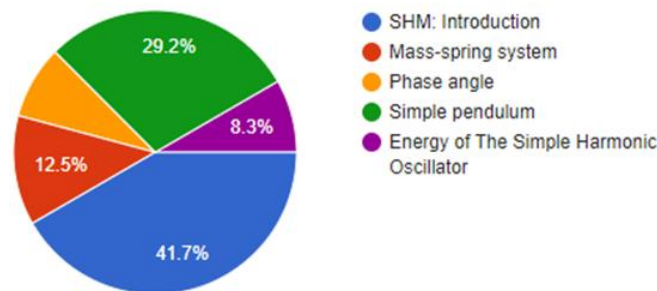


Fig. 1. Topics that are considered easy to understand

Figure 2 shows the most difficult topics for students to understand. Overall, 58.3% of students stated that Phase Angle is difficult to understand, while 37.5% is the energy of the SHM, and the rest is a Simple Pendulum. For Phase Angle, students need to understand the sinusoidal graph, where the angular displacement should be studied, and it can range from 0 to 2π . Besides that, the misinterpretation of period motion graphs and restoring force calculations are challenges for students (Somroob & Wattanakasiwich, 2017). For the energy of the simple harmonic oscillator, students need to understand the correlation between the potential and kinetic energies when the system containing mass and spring makes the movement. It was believed that the students were struggling with critical and creative thinking when studying SHM (Wardani, 2020).

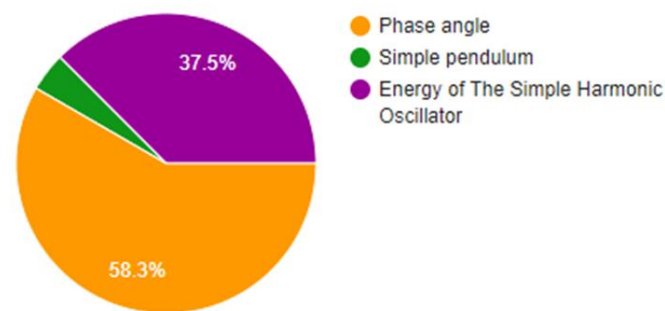


Fig. 2. Topics that are considered difficult to understand

Conclusion

As a conclusion, 95.8% of students can answer questions about oscillatory motion, phase constant, and energy of The Simple Harmonic Oscillator. However, some students still lack understanding of the Condition for SHM concept, indicating a need for further study on basic concepts. The study shows that 41.7% of students find SHM: Introduction easy to understand, followed by simple

pendulum, mass-spring system, energy of the SHM, and phase angle. Most students are familiar with SHM due to previous course learning and familiarity with its concept. Students find understanding phase angle and energy of a simple harmonic oscillator (SHM) challenging, with 58.3% finding it difficult and 37.5% struggling with period motion graphs and restoring force calculations. They struggle with critical and creative thinking when studying SHM, requiring understanding of sinusoidal graphs and potential-kinetic energies. The results of this basic survey will be used to develop a new effective way of learning to ensure all the students comprehend the basic concept of simple harmonic motion.

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