

Do students have sufficient knowledge of physics to take marine biology courses?

Dios Sarkity^{1,*}, Elfa Oprasmani¹, Bony Irawan², and Putri Dwi Sundari³

¹Biology Education Department, Universitas Maritim Raja Ali Haji, Tanjungpinang, Indonesia

²School of Curriculum, Teaching and Inclusive Education, Monash University, Melbourne, Australia

³Institute for Science Education and Communication, University of Groningen, Groningen, Netherlands

Abstract. Physics and biology are two branches of science that have many connections. In marine biology courses, students must have a good basic concept of physics. The purpose of this study was to determine whether students' physics knowledge is sufficient to follow marine biology lectures. This study is a quantitative descriptive study. The study was conducted in May 2024 in the Biology Education study program at Raja Ali Haji Maritime University involving 27 students in their third year of study. Data collection was carried out by testing and analyzing descriptively. The results of the study showed that students did not have sufficient knowledge of physics to be able to follow marine biology courses. This is indicated by the problems found by students in solving questions related to the Effect of the position of the earth, moon, and sun on sea tides, the relationship between salinity and density of seawater, the specific heat of seawater, and the impact of global warming on increasing temperature and rising sea levels. Therefore, action is needed to strengthen the basic concepts of physics of biology students so that when taking biology lectures related to physics, students will be able to understand them well.

1. Introduction

Physics and Biology are part of the same branch of science, namely natural science. Physics and biology are related to each other, although in its application, physics uses a much more mathematical approach than biology. How students see the relationship between the two depends on the implementation of the learning carried out [1], such as carrying the concept of integrated science by integrating physics, biology and chemistry in one topic [2–4]. The relationship between physics and biology shows that in studying biology, a good basic understanding of physics concepts is required [5–8].

Although physics and biology have many connections, many students majoring in biology have problems understanding physics concepts. Biology material integrated with physics is difficult material for biology students, so a special learning medium is needed to help them understand [9]. This problem is often found in first-year students, who experience problems in understanding basic physics concepts such as kinematics [10–12]. In general, students have

* Corresponding author: diossarkity@umrah.ac.id

difficulty studying subjects that are not their field of study [13] like biology students studying physics. Some of the research results published in [14] show that biology students experience difficulties with topics related to physics, such as the relationship between several biological materials and the concept of energy.

One of the biology courses that shows the relationship between biology topics and physics is marine biology. The results of the study showed that density affects the distribution of marine biota [15]. In addition, the ebb and flow influenced by gravity [16] also affect the distribution of marine biota [17,18]. Apart from this, the problem of global warming can be explained well through physics [19–21] and also affects the size and population of biota [22–24]. Because seawater has a high specific heat capacity, its temperature tends to be maintained/stable, making the sea a comfortable habitat for various marine biota [25]. Changes in seawater temperature will affect the metabolic and respiratory functions of marine biota [26]. The relationship between physics and biology is still very much present in the topics in marine biology courses.

Since there are many connections between physics and biology in studying marine biology, this indicates the importance for students to have a good understanding of basic physics concepts in order to be able to follow marine biology lectures. Students are expected to be able to link physics concepts with biology concepts through this lecture. All students who take marine biology courses must have completed general physics courses. The question is, do students understand enough about basic physics concepts related to marine biology material? This is important to measure at the beginning of the lecture to find out to what extent students have basic physics knowledge capital in order to be able to follow marine biology lectures well. Therefore, the researcher conducted a study to answer the problem formulation "Do students have sufficient physics knowledge to follow marine biology lectures?"

2. Methods

This research is a descriptive study. The approach used in this study is a quantitative approach. This research was conducted in May 2024 at the Biology Education Study Program, Raja Ali Haji Maritime University. This study involved 27 students in their third year of college. Data collection was carried out by testing. The outline of the research instrument is as follows.

Table 1. Research instrument grid

No.	Indicators
1	The influence of the position of the earth, moon and sun on sea tides.
2	Relationship between salinity and density of sea water
3	Specific heat of sea water
4	The impact of global warming on increasing temperatures and rising sea levels.

The data was analyzed descriptively by grouping students' answers into several answer categories.

3. Results and Discussions

The results of this study will be described for each question indicator with the following details.

3.1 Description of the results of the first indicator

The first indicator of the research instrument is the influence of the earth's position to the moon and sun on the ebb and flow of sea water. To measure students' understanding of this first indicator, the questions given are shown in Figure 1.

The ebb and flow of seawater are influenced by the position of the earth in relation to the moon and the sun. True or false? provide an explanation

Figure 1. Questions for indicator-1

In this question, the correct answer is "True" because the ebb and flow of seawater are influenced by the position of the earth in relation to the moon and the sun, which can be explained well through the concept of gravity [16,27]. In answering this question, most students chose the correct answer, and very few had the wrong answer, as shown in Figure 2.

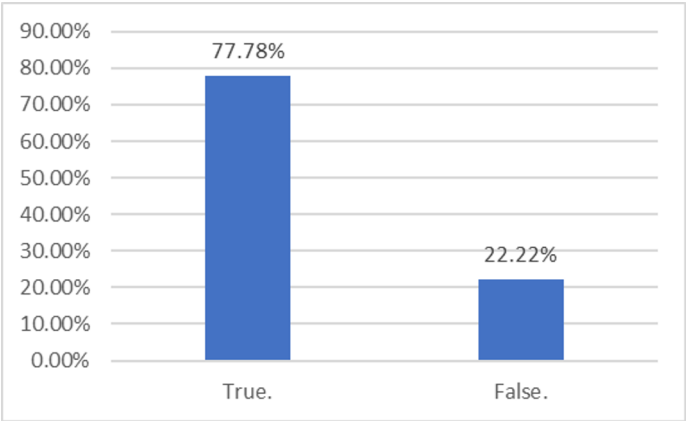


Figure 2. Percentage of students who chose the answers “True” and “False”.

Although 77.78% (21 students) chose the correct answer, the reasons given by the students were not related to the concept of gravity. The reasons given only seemed to repeat the statement given in the question. Of the 21 students, only 3 students gave reasons using the concept of gravity while the other students only gave answers based on their experiences so far. In the example answer shown in Figure 3, although the student had stated that during the full moon the sea water would rise, the student did not state the concept of gravity in his answer.

Sea tides are greatly influenced by the position of the earth relative to the moon and sun. Ancient people used to see the tides by looking at the moon. If the moon is full or full moon then the sea water is high

The ebb and flow of seawater are influenced by the position of the earth to the moon, and the sun is true. Because if in the southern part of the earth, it is high, then in the northern part, it will recede. Because the earth is round. Therefore, the flattening of seawater is not the same. Then usually on a full moon, we will see the sea water rise

Figure 3. Example of incorrect reasons in answering indicator question 1.

These results indicate that students are still weak in understanding the concept of gravity, which is related to the ebb and flow of sea water. This is in line with several research results that show problems in understanding concepts that are often found in students in kinematics material, one of which is on the topic of gravity [28,29,29]. This is important to be addressed immediately, especially for attending marine biology lectures. As is known, the ebb and flow of seawater affect the growth of marine biota [30,31]. So, in this indicator, the relationship between physics and biology is very clearly visible.

3.2 Description of the results of the second indicator

The second indicator of the research instrument is the relationship between salinity and seawater density. To measure students' understanding of this concept, questions are given, as shown in Figure 4.

The smaller the salinity of seawater,
the greater the density of the seawater.
True or false? provide an explanation

Figure 4. Questions for indicator-2

In this question, the correct answer is "Wrong". Simply put, density is determined by dividing the mass by the volume of the object [32,33]. The greater the salinity of seawater, the greater its density [34,35]. This is because seawater with high salinity has a higher salt content, so with the same volume, seawater with higher salinity will have a greater mass than seawater with lower salinity. Based on the answers given, most students chose the answer "True" as shown in Figure 5.

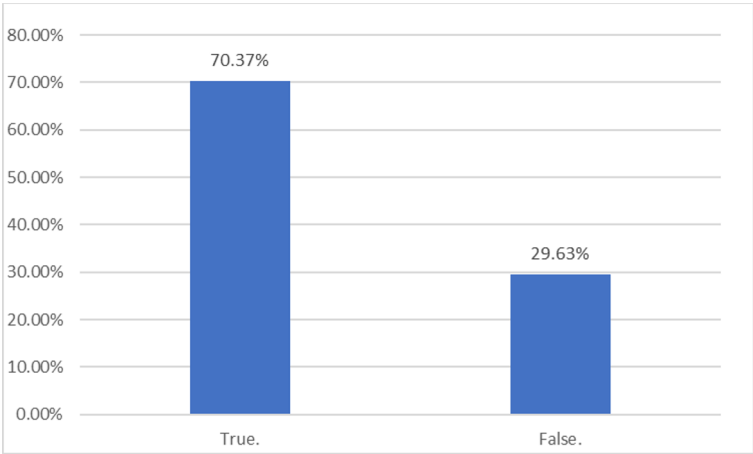


Figure 5. Percentage of students who chose the answers “True” and “False”.

Based on the picture, it can be seen that most students, namely 70.37% (19 students), chose the wrong answer. Although 29.63% (8 students) of students chose the right answer, none of them gave a reason for using the concept of density correctly. In the answer to this question, there is no unique answer that can be highlighted because students tend to only rewrite the statement or state the opposite. For example, students who state it is wrong will give reasons such as "because the greater the salinity of seawater, the greater the density".

Likewise, students who answer "Correct", then the students only state the reason by restating the sentence in the question, such as "Correct, because the greater the salinity of seawater, the smaller the density". From this answer, it can also be seen that students do not really understand the concept of density as found by several research results [36–38]. This problem must, of course, be resolved in order to be able to do marine biology properly. The density of seawater affects the distribution of marine biota [39–41].

3.3 Description of the Third Indicator Results

The third indicator of the research instrument is the specific heat of seawater. To measure students' understanding of the concept of the specific heat of seawater, the following questions were given in the collection of research data (Figure 6).

In summer, even though the air feels hot, the seawater temperature can feel much cooler. What are the characteristics of seawater that allow this to happen? Explain!

Figure 6. Questions for indicator-3.

In the question above, the answer should be related to specific heat [42] which is owned by sea water. With the same heat supply, the air will increase in temperature faster than sea water, because the specific heat of sea water is greater than the specific heat of air [43]. This is also compounded by the very large amount of sea water, where 70% of the earth's surface is covered by sea water [44]. Based on the answers given, none of the students gave an answer by giving a reason using the concept of specific heat of seawater. Some students actually connected it with density or with other reasons as shown by several examples of student answers below (Figure 7).

Sea water has a large density, so in summer, it will be difficult to raise the temperature of seawater. Then at night, the hot air in the sea will rise so that the wind from the land will blow towards the sea.

Because seawater has a very large density, so seawater is able to absorb solar heat. Because sea water is a regulator of temperature and climate is also influenced by sea water.

Figure 7. Example of an incorrect student answer to indicator question 3.

These results show that students need to study more deeply about specific heat because several research results also show that many students experience problems related to this topic [45–47]. This concept is important to study, especially in relation to the ocean as a buffer for the world's climate [48,49]. In addition, this concept is related to how the temperature of seawater increases along with the absorption of heat, and it is related to the specific heat of seawater.

3.4 Description of Indicator Results-4

The fourth indicator of the research instrument is the Impact of global warming on increasing temperatures and rising sea levels. Related to the impact of global warming on increasing sea temperatures and rising sea levels, it can be explained through the concept of temperature, heat, and expansion. Global warming causes an increase in the average temperature on earth [48,49]. One of the impacts is also felt by sea water, where the large amount of heat absorbed by sea water causes the sea water temperature to increase [50–52]. The increase in sea water temperature of course causes sea water to rise, which causes the sea level to rise even further [53,54]. In addition, sea level rise is caused by melting ice in the polar regions [55,56]. To measure students' understanding of this concept, the questions shown in Figure 8 were given.

Several research shown that the impacts felt on seawater due to global warming are increasing seawater temperatures and increasing sea levels. Try to explain how global warming can cause this.

Figure 8. Questions for indicator-4

Based on the answers given by students, the percentage of students who gave correct answers was much less than the percentage of students who gave incorrect answers. This can be seen in Figure 9 below

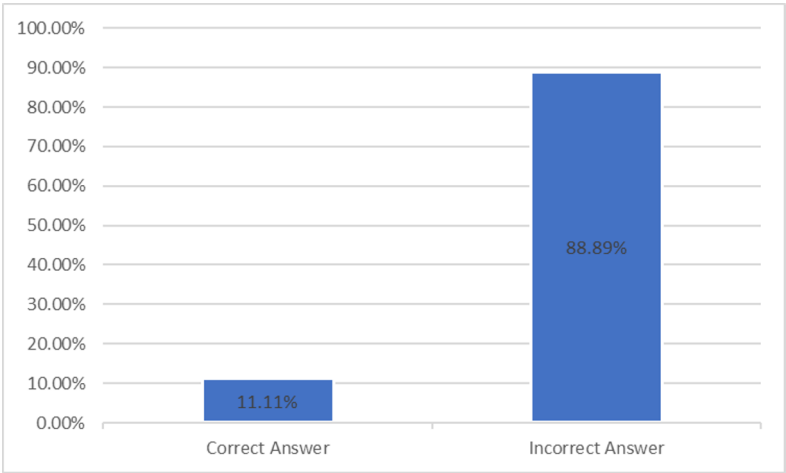


Figure 9. Percentage of students who gave correct answers and incorrect answers.

From Figure 9, it can be seen that only 11.11% (3 students) gave the correct answer. This means that there are 24 students who gave incorrect answers. Judging from the reasons given, students who gave incorrect answers focused on the causes of global warming, not on why global warming can cause an increase in sea water temperature and an increase in sea level. Some examples of students' answers that are not quite right in answering questions for indicator 4 can be seen in Figure 10.

Global warming can cause increasing sea water temperatures and high sea levels themselves because it is caused by the gravity of our earth which is close to the sun or atmosphere so that this can happen. Global warming can also occur due to irresponsible human actions towards the oceans

Global warming can occur starting from the temperature of the sun shining on the earth's surface and this hot temperature rises to the surface of the earth so that on land it feels hotter because the sea water temperature overflows even though in the sea it is much colder, this is what is called global warming.

Figure 10. Example of an incorrect student answer to indicator question 3.

From Figure 10, it can be seen that, apart from not being able to explain the reasons why global warming can cause an increase in sea water temperatures and sea levels, this answer also indicates that students do not fully understand global warming well and this has also been found through other research. [57–59]. Global warming has many negative impacts, one of which is on the distribution of marine biota [52,60].

4. Conclusion

Based on the research conducted, it can be concluded that students do not have sufficient knowledge of physics to be able to follow marine biology courses. This is indicated by the problems found by students in solving questions related to the Effect of the position of the earth, moon, and sun on sea tides, the relationship between salinity and density of sea water, the specific heat of sea water, and the impact of global warming on increasing temperature and rising sea levels. Although students are in their third year, where students have taken general physics courses, it turns out that problems in understanding various physics concepts are still found. Therefore, an action is needed to strengthen the basic concepts of physics of biology students so that when taking biology lectures related to physics, students will be able to understand them well.

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