Can sound waves in computer simulation lower students’ misconceptions? Analysis of reduction and change

Achmad Samsudin, Dendy Mohammad Fauzi, Andi Suhandi, Suharto Linuwih, Masrifah Masrifah, and Bayram Coştu

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Abstract

This study aims to identify reduction and change in students’ misconceptions about sound waves after using sound wave in computer simulation (SWiCS). This research is an explanatory sequential mixed methods design. The participants are 25 students from 11 grade [11 lanang (males) and 14 wadan (females)] with purposive sampling from one school in Karangkobar, Banjarnegara, Central Java. A multi-tiered instrument was used consisting of 20 questions. The reduction of students’ misconceptions was analysed using percentages with three categories, namely sloping, currently, and steep. While the changes by codification, which are categorised as good change (GC), bad change (BC), and no change (NC), and other distributions were analysed using Rasch analysis. The average students’ misconceptions are reduced by 88% (steep). Meanwhile, the changes in misconceptions moved towards GC (56%), BC (32%), and NC (12%). The SWiCS can decrease students’ misconceptions on the sound waves and change conceptions for the better.

Keywords: Sound waves in computer simulation (SWiCS); misconception; reduction and changes
1. Introduction

Sound wave in physics education is an important theme fixed in education curricula. In Indonesia, the sound wave possessions are an accentuated theme for all stages. At the high school level, the concept of sound waves is one of the most difficult concepts to learn. In fact, 77.7% of the students had difficulty with the concept of sound waves (Tuada & Suparno, 2021). This condition hinders the improvement of the quality of students. Meanwhile, Indonesian students generally understand questions, do simple arithmetic and measure factual knowledge in everyday contexts, but do not yet have the skills to integrate information and draw conclusions. This is because the learning system is only directed at the ability to think at a lower level. This conclusion is supported by the fact that the secondary school grading system only tests lower order thinking skills, such as memorising only. An example is a learning system that only teaches the application of formulas without analysis and without learning how to solve complex problems. Another issue, which affects students’ skills to absorb sound wave concepts, is having too many complex equations without explanation, thus the potential for misconception. This is reinforced by several researchers who state that there is a misconception in sound waves (Barniol & Zavala, 2016; Eshach et al., 2018; Umar et al., 2021; Volfson et al., 2020).

In sound waves, students’ misconceptions happen because they are included in microscopic material, which cannot be observed by the five senses directly (abstract). One of the misconceptions about sound waves is that students think that sound is a material, not a transmission of energy (Linder & Erickson, 1989; Mazens & Lautrey, 2003; Pössel, 2020; Wittmann et al., 1999). This misconception appears because the sound is not seen directly, giving rise to a wrong perception of sound. Finding students’ barriers to understanding concepts is a necessary step, significantly assisting teachers in their efforts to design effective learning environments (Eshach, 2014; Galili & Hazan, 2000; Hrepic et al., 2010). In addition to that, students already have initial concepts that are obtained based on their daily experiences (Houle & Michael Barnett, 2008; Ozkan & Selcuk, 2016; Volfson et al., 2020). But the initial concepts are not following scientific concepts. Misconceptions can be corrected through the arrangement of mental models known as the conceptual change process (Kaniawati et al., 2021; Laurenty et al., 2021; Podschuwert & Bernholt, 2018; Samsudin et al., 2015; Surtiana et al., 2020). Posner et al. (1982) suggested that changing students’ conceptions require certain situations, namely students must be dissatisfied with the existing concepts and new concepts must be understandable, reasonable and helpful. These situations can be created through a learning process.

The learning process can be carried out in various ways depending on the objectives. In this case, the use of methods and media can be taken into account to reduce and change students’ misconceptions into better conceptions. One method that can be used is the predict-observe-explain (POE) method. Previous studies reveal that the use of POE strategies can help students to change conceptions (Coştu et al., 2012; Furqani et al., 2018; Purwanto et al., 2019; Samsudin et al., 2017). Learning media can utilise media that integrate with technology in the form of interactive multimedia (Kaniawati et al., 2021; Siahaan et al., 2020; Suhandi et al., 2017; Susilowati et al., 2021). The first principle of learning with interactive multimedia is to integrate various media components. The use of interactive multimedia components depends on the development needs and the material being developed. Interactive multimedia has five components, including 1) text, which are words or sentences that describe the material or instructions for using the media; 2) graphics, which are pictures, photos and charts/diagrams for illustration; 3) video: which is the simulation of real objects, an overview of an activity; 4) animation, which is moving images or live images to simulate a phenomenon; and 5) audio, which is the back sound, narration, sound effects or conversation (speech).
(Indah Septiani et al., 2020). The second principle of learning with interactive multimedia is navigation and interactivity. Interactive multimedia contain links that allow interaction between users and media, including navigation that facilitates users to operate or direct their learning and can provide feedback to them (Hamidi et al., 2011). One of the interactive media that can be used is the Wolfram Mathematica software (Ceberio et al., 2016; MacCallum, 2018; Musyrifah et al., 2021).

Wolfram Mathematica is a computer simulation developed by Stephen Wolfram. Wolfram Mathematica is an integrated system for performing computational techniques. This software can display information in the form of writing and images of objects that can move. Thus, students can understand the learning delivered through moving objects. All the content contained in this software (interactive multimedia) are coded and can be adapted to the needs of learning physics, not only on sound waves. However, in this study, Wolfram Mathematica was used to develop sound waves in computer simulation (SWiCS). The scheme of the combination of learning media (SWiCS) and learning strategy (POE) is shown in Figure 1.

Figure 1. Integration of SWiCS in POE strategy

Figure 1 shows the use of SWiCS in a POE strategy. The use of text and video is determined at the predict stage. However, as a whole, text, video, graphics, animation and audio are all part of SWiCS. Then, at the observe stage on POE, SWiCS is used for experiments. It is finally entered the explain stage, which is simultaneously seen on SWiCS. The description of the computer simulation used can be seen in Figure 2.

Figure 2. Description of the integration of SWiCS in POE strategy
Based on Figure 2, there are five important parts in the interactive Wolfram Mathematica multimedia: 1) the variable settings tab displays variables that can be varied; 2) the experimental data panel shows the data panel obtained; 3) the picture/animation panel displays the pictures or animations related to the experiment being carried out, making it easier for students to understand physics concepts; 4) the graphics display a graph of the experimental results; and 5) the audio section does not display the sound button on some media, but it is included in the media and will play automatically.

1.1. Framework

Based on the previous explanation, the SWiCS in the POE strategy was used in an effort to reduce and change students’ misconceptions for the better. In this research, we created a framework to map how this can happen. The framework in this research can be seen in Figure 3.

Figure 3 shows that the learning process is carried out using the SWiCS and POE. The implementation is expected to improve students’ conceptions which were previously divided into several types of conception categories. The results will then be analysed based on the decrease in students’ misconceptions, as well as their changes during the learning process.

1.2. Purpose of the study

The aim of this research is to identify reduction and change in students’ misconceptions about sound waves after using the SWiCS. This research has implications for the world of education, especially in the part of learning media in the form of computer simulations, especially in the simulation that was developed, which became the novelty in this research. The model is simple and easy to use and is the main point in this simulation, so that users will not be confused in operating it. Thus, the use of SWiCS in learning is expected to help teachers or tutors in the field in conveying a concept, especially in abstract physics studies.

2. Method and material

2.1. Research method

This research is a mixed method, using explanatory sequential mixed methods. Mixed methods research involves collecting quantitative and qualitative data, combining two forms of data, and using different plans (Creswell, 2014). Quantitative data were used to determine the reduction in students’

misconceptions after using SWiCS, while qualitative data were used to identify the process of changing misconceptions.

2.2. Participants

The participants are 25 students from 11 grade [11 lanang (males) and 14 wadon (females)] from one school in Karangkobar sub-district, Banjarnegera district, Central Java. Lanang and Wadon is a term for male and female, respectively, in Javanese. Figure 4 shows the location of the participants in this study.

![Figure 4. Karangkobar sub-district, Banjarnegera district, Central Java (Google map)](image)

The selection of participants was carried out using a purposive sampling technique, namely the determination of the sample using certain criteria that have been set on the object in accordance with the research objectives. The considerations include students who experience the most misconceptions about sound waves and have laptops or the like to use when opening SWiCS.

2.3. Instrument

A multi-tiered instrument consisting of 20 questions [characteristics of sound waves (7), Doppler effect (4), string (4), and organ pipe (5)] was used in this study. Multi-tier in this study is the multiple choices of four tiers. Tier 1 is a concept question; Tier 2 is the level of confidence in the Tier 1 answer; Tier 3 is the reason for the answer in Tier 1; and Tier 4 is the level of confidence in the Tier 3 answer. The examples of multi-tier questions used are shown in Figure 5.
2.4. Data collection process

In general, quantitative and qualitative data were collected with the same instrument. However, data processing for quantitative was carried out by calculating the values obtained to find the value of decreasing misconceptions. Meanwhile, qualitative data were carried out by means of codification, which will then be discussed in the Data Analysis section. Thus, the results obtained will be in accordance with the aim of the research. The data are taken from students’ answers on multi-tiered instruments about sound waves, during the pre-test and post-test. All participants took up the pre-test and post-test. After taking the pre-test, participants took up online learning for 3x2 hours of lessons using SWiCS and POE strategies. After the online learning was completed, participants took up the post-test.

2.5. Data analysis

Quantitative data were analysed using percentages for students’ misconception reduction (SMR) as in Equation 2. Meanwhile, qualitative data were analysed based on the codification that had been made to see the movement of changes in misconceptions that occurred in students. The stages regarding this data analysis are mentioned below.

1. Scoring of the results of the pre-test and post-test, as well as tabulating the CRI scores, of each student and categorising them based on students’ conceptions is presented in Table 1.

Table 1. Conception category and score

<table>
<thead>
<tr>
<th>Category</th>
<th>Answer</th>
<th>CRI on answers</th>
<th>Reason</th>
<th>CRI on reason</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding (U)</td>
<td>True (1)</td>
<td>≥3</td>
<td>True (1)</td>
<td>≥ 3</td>
<td>3</td>
</tr>
<tr>
<td>Partial understanding (PU)</td>
<td>True (1)</td>
<td>≥3</td>
<td>True (1)</td>
<td>≤ 2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>True (1)</td>
<td>≤2</td>
<td>True (1)</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>True (1)</td>
<td>0-5</td>
<td>False (0)</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>False (0)</td>
<td>0-5</td>
<td>True (1)</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>False (0)</td>
<td>≥3</td>
<td>False (0)</td>
<td>≤ 2</td>
<td></td>
</tr>
<tr>
<td>No understanding (NU)</td>
<td>False (0)</td>
<td>≤2</td>
<td>False (0)</td>
<td>0-5</td>
<td>1</td>
</tr>
<tr>
<td>Misconceptions (M)</td>
<td>False (0)</td>
<td>≥3</td>
<td>False (0)</td>
<td>≥ 3</td>
<td>0</td>
</tr>
<tr>
<td>Encodable (E)</td>
<td>If not filling one or more items (level)</td>
<td>(empty)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Calculate the percentage of misconceptions in the pre-test and post-test using Equation (1).

\[
\% \text{ Misconception (in pretest or posttest)} = \frac{\text{Sum of students misconception}}{\text{Sum of students}} \times 100 \tag{1}
\]

3. After the percentage of misconceptions during the pre-test and post-test is obtained, the reduction of misconceptions will be calculated based on the equation adapted from N-gain (Hake, 1998). However, because of the equation for the misconceptions’ reduction, there is a modification to the equation which can be seen in Equation (2) regarding SMR. The results are then categorised as 1) sloping (SMR ≤ 30%); 2) currently (30% < SMR ≤ 70%); and steep (70% < SMR).

\[
\text{SMR} = \frac{\% \text{ Pretest} - \% \text{ Posttest}}{\% \text{ Pretest}} \tag{2}
\]

4. After the results of Equation (2) are identified, the next step is processing qualitative data. The qualitative data were analysed by mapping changes in students’ misconceptions during the pre-test and post-test. The possibilities that can occur can be seen in Figure 6.
3. Results

The results of the SMR calculation show that the reduction in students’ misconceptions occurs for all questions. There are 20 misconceptions that occur. The reduction can be seen in Figure 7.

![Figure 7. Reduction of students' misconceptions](image)

Figure 7 shows that most students’ misconceptions during the pre-test occurred in question 8 (52%) and the least occurred in questions 5, 12 and 15 (8%). Meanwhile, during the post-test, students’ misconceptions mostly occurred in question 1 (8%) and the least occurred in questions 4, 5, 7, 11, 12, 15, 17, 19 and 20 (0%). The overall result of SMR can be seen in Table 2.

<table>
<thead>
<tr>
<th>No</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>SMR</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>32%</td>
<td>8%</td>
<td>75%</td>
<td>Steep</td>
</tr>
<tr>
<td>2.</td>
<td>24%</td>
<td>4%</td>
<td>83%</td>
<td>Steep</td>
</tr>
<tr>
<td>3.</td>
<td>20%</td>
<td>4%</td>
<td>80%</td>
<td>Steep</td>
</tr>
<tr>
<td>4.</td>
<td>20%</td>
<td>0%</td>
<td>100%</td>
<td>Steep</td>
</tr>
<tr>
<td>5.</td>
<td>8%</td>
<td>0%</td>
<td>100%</td>
<td>Steep</td>
</tr>
<tr>
<td>6.</td>
<td>16%</td>
<td>4%</td>
<td>75%</td>
<td>Steep</td>
</tr>
<tr>
<td>7.</td>
<td>28%</td>
<td>0%</td>
<td>100%</td>
<td>Steep</td>
</tr>
<tr>
<td>8.</td>
<td>52%</td>
<td>4%</td>
<td>92%</td>
<td>Steep</td>
</tr>
</tbody>
</table>
Table 2 shows that there are 18 questions that fall into the steep category. The least decrease occurred in questions 10 and 16, which was 67%. This happened because in the post-test there were still 4% of the students who had misconceptions. Meanwhile, the rest are in the currently category. The highest decrease in student misconceptions occurred in questions 4, 5, 7, 11, 12, 15, 17, 19 and 20. The decrease that occurred was 100%. That is, the students in question no longer have misconceptions and because there is no post-test, students who have misconceptions become 0%. Thus, the overall average reduction in misconceptions is 88% in the steep category. For every misconception on the problem, the fruit is identified as a whole. Changes in misconceptions for each question can be seen in Table 3.

Table 3. Students’ misconceptions change during pre-test and post-test

<table>
<thead>
<tr>
<th>No</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>SMR</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good Change (GC)</td>
<td>Bad Change (BC)</td>
<td>No Change (NC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>U</td>
<td>PU</td>
<td>NU</td>
</tr>
<tr>
<td>1</td>
<td>S01, S03, S07, S09, S12, S19, S21, S23</td>
<td>S23 1 Student (13%)</td>
<td>S12, S19 2 Students (25%)</td>
<td>S01, S07, S21 3 Students (38%)</td>
</tr>
<tr>
<td>2</td>
<td>S08, S11, S12, S19, S21, S23</td>
<td>S23 1 Student (17%)</td>
<td>S19, S21 2 Students (33%)</td>
<td>S08, S12 2 Students (33%)</td>
</tr>
<tr>
<td>3</td>
<td>S07, S12, S17, S19, S21</td>
<td>-</td>
<td>S07, S12, S21 3 Students (60%)</td>
<td>S17 1 Student (20%)</td>
</tr>
<tr>
<td>4</td>
<td>S01, S07, S08, S11, S19</td>
<td>S08 1 Student (20%)</td>
<td>S07, S11, S19 3 Students (60%)</td>
<td>S01 1 Student (20%)</td>
</tr>
<tr>
<td>5</td>
<td>S01, S07</td>
<td>S07</td>
<td>-</td>
<td>S01</td>
</tr>
<tr>
<td>No</td>
<td>Pre-test</td>
<td>Good Change (GC)</td>
<td>Bad Change (BC)</td>
<td>No Change (NC)</td>
</tr>
<tr>
<td>----</td>
<td>----------</td>
<td>------------------</td>
<td>----------------</td>
<td>---------------</td>
</tr>
<tr>
<td>S08, S12, S18, S20</td>
<td>2 Students</td>
<td>1 Student (50%)</td>
<td>1 Student (50%)</td>
<td></td>
</tr>
<tr>
<td>S01, S07, S09, S11, S14, S18, S20</td>
<td>4 Students</td>
<td>S01, S09, S11, S18</td>
<td>1 Student (14%)</td>
<td>S14</td>
</tr>
<tr>
<td>S02, S03, S05, S07, S08, S09, S11, S13, S14, S16, S20, S23, S25</td>
<td>13 Students</td>
<td>S09, S13, S20, S23</td>
<td>4 Students (31%)</td>
<td>S03, S05, S08, S16</td>
</tr>
<tr>
<td>S08, S09, S10, S18, S19</td>
<td>5 Students</td>
<td>S09</td>
<td>1 Student (20%)</td>
<td>S18, S19</td>
</tr>
<tr>
<td>S07, S12, S17</td>
<td>3 Students</td>
<td>-</td>
<td>S07</td>
<td>1 Student (33%)</td>
</tr>
<tr>
<td>S07, S08, S16, S18, S19</td>
<td>5 Students</td>
<td>-</td>
<td>S07, S16, S18</td>
<td>3 Students (60%)</td>
</tr>
<tr>
<td>S12, S14</td>
<td>2 Students</td>
<td>-</td>
<td>S12</td>
<td>1 Student (50%)</td>
</tr>
<tr>
<td>S12, S16, S18, S21</td>
<td>4 Students</td>
<td>-</td>
<td>S12, S21</td>
<td>2 Students (50%)</td>
</tr>
<tr>
<td>S07, S08, S09, S12, S18</td>
<td>5 Students</td>
<td>-</td>
<td>S09, S12</td>
<td>2 Students (40%)</td>
</tr>
<tr>
<td>S07, S18</td>
<td>2 Students</td>
<td>-</td>
<td>S07, S18</td>
<td>2 Students (100%)</td>
</tr>
<tr>
<td>S08, S12, S23</td>
<td>3 Students</td>
<td>-</td>
<td>S12</td>
<td>1 Student (33%)</td>
</tr>
<tr>
<td>S01, S08, S11, S17, S18</td>
<td>5 Students</td>
<td>S11</td>
<td>1 Student (33%)</td>
<td>S01, S17, S18</td>
</tr>
<tr>
<td>S01, S07, S11, S14</td>
<td>1 Student</td>
<td>S11</td>
<td>S01, S07, S14, S17</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 3 shows the changes in students who had misconceptions during the pre-test and the direction of changes in their conceptions at the post-test, whether they moved towards understanding (U), partial understanding (PU), no understanding (NU), misconceptions (M) or encodable (E). Changes in misconceptions for the good change (GC) category occurred in the U and PU conception categories. For U category, the highest change occurred in question 7 (57%) and the lowest occurred in questions 3, 10, 11, 12, 13, 14, 15, 16, 19 and 20 (0%). Meanwhile, the highest PU category occurred in question 15 (100%) and the lowest occurred in questions 5 and 6 (0%). Both these changes were expected because students who had misconceptions during the pre-test, their understanding changed for the better. The misconceptions for the bad change (BC) category occurred in the NU and EC categories. The highest change for the NU category was in question 20 (67%), while the lowest occurred in questions 15 and 18 (0%). For the EC category, the highest change occurred in question 7 (14%), and the rest was the lowest, which was 0%. This change was not expected because instead of making students’ conceptions better, they turned into bad ones. The last is the category of no change (NC), which is the M category, meaning that students’ conceptions did not change, either during the pre-test or post-test. Meanwhile, the highest change for the M category occurred in questions 10 and 16 (33%) and the lowest occurred in questions 4, 5, 7, 11, 12, 15, 17, 19 and 20 (0%). This change was actually not expected because no change occurred after the learning process. Furthermore, these changes are reviewed based on the category of changes in the misconceptions shown in Figure 8.
Figure 8. Changes based on the category of misconceptions’ change

Figure 8 shows the changes that occurred during the post-test based on the category of misconceptions’ change. It can be seen that the most changes occurred in the good change (GC) category (with 56%), followed by bad change (BC) (with 32%) and finally no change (NC) (with 12%). However, these results indicate that there is a change for the better after the implementation of SWiCS. Another analysis was then carried out with the Rasch analysis.

Rasch analysis was also carried out to identify changes overall for all conceptions, either during pre-test or post-test. The output used is variable (Wright) maps which serve to map thoroughly. This output also identifies the potential distribution of students (person) and questions (item). The distribution can be seen in Figure 9.

Figure 9. Distribution of conceptions: (a) pre-test and (b) post-test

In Figure 9(a), the left side is the distribution of students marked with the symbol S and followed by the serial number of students 1–25. The right side is the distribution of items or question numbers marked with the symbol N and followed by a serial number of questions 1–20. From this distribution, students have the potential for misconceptions. At the time of the pre-test, all students had the
potential to have a misconception on N8, N1 and N18 because the picture shows that the item number is outside the S boundary (standard deviation item). In addition, S8, S7, S12 and S18 students have the potential for misconceptions on all questions because in the picture these students are outside the S boundary (standard deviation person). At the time of post-test, three students S23, S9 and S7 did not have the potential to have misconceptions for all questions. However, S22 had the potential to have misconceptions in all questions. From this comparison, the potential for misconceptions for all questions decreases from pre-test to post-test, as can be seen from the shift in the median (M) indicated by the red box. In the pre-test, the position of M is close to logit −1, while in the post-test the position of M is close to logit +1. If viewed from the students who have the most alternative conceptions during the pre-test (S8, S7, S12 and S18), then at the post-test the position of all students is higher than the pre-test. There is one student (S22) who can be seen in the picture having a decreased position. The researcher concludes that there is a change in the conception of the bad change (BC). This happened because of the limitations of researchers to supervise the implementation of learning, thus many variables were difficult to control (i.e., students’ thinking, involvement in collaborative group work, and student motivation). As a result, some changes in students’ misconceptions are not included in the category of good change (GC).

4. Discussion

Based on the results of the study, the smallest misconceptions during the pre-test occurred in questions 5, 12 and 15. In sequence, the misconceptions contained frequencies and amplitudes, including 1) students considered that the closer they were to the sound source, the frequency that the observer heard the greater; 2) students assume that if the mass of strings is enlarged, the frequency produced by the strings will be greater; and 3) students assume that the frequency produced by the air column will be smaller if the length of the air column is shortened. This misconception in the basic concept of frequency occurs because of confusion among students about frequency and amplitude. This phenomenon also occurs in a previous research (Pejuan et al., 2012), which suggests that there is confusion between pitch or frequency and volume or intensity. Other studies have also revealed that there are misconceptions about the frequency and amplitude of sound waves. Wiyantara et al. (2021) showed that students have misconceptions when explaining the frequency of guitar strings. This misconception occurs as much as 70%. In fact, it is a basic concept in studying waves. In this study, the least misconceptions occur in the basic concept of frequency (Darman et al., 2019), but this cannot be ignored because it can affect the conception of other concepts. This is in accordance with the statement (Aminudin et al., 2019) which states that understanding the basic concepts is very important in physics. Thus, when the misconception has been detected, the teacher or tutor must immediately deal with it, before the misconception becomes the student’s understanding (Ekawati et al., 2021; Samsudin et al., 2021; Suhandi et al., 2017). This action is to anticipate students’ conceptions because basically, students come to class with conceptions that come from several sources, such as from experience, TV, the Internet, books or legends in the students’ homes, and these conceptions are not necessarily true or in accordance with scientific conceptions.

Meanwhile, the most misconceptions during the pre-test occurred in question 8 regarding the Doppler effect. Students assume that the closer they are to the sound source, the greater the frequency heard by the observer. In fact, the frequency of the sound source heard by the observer will be greater if the sound source and observer are closer to each other. Indeed, the concept of the Doppler effect is an advanced concept of frequency. This is in accordance with the statement (Pössel, 2020) that in the relativistic explanation of the explosion, the Doppler effect is used as a more advanced preconception. Saparini et al. (2021) state that a misconception that often arises when
studying sound waves is the concept of the Doppler effect. Thus, it is not surprising that students have
the highest misconceptions about the concept of the Doppler effect. In this study, the handling of
misconceptions on the concept of frequency and the Doppler effect was carried out using a SWiCS
simulation. The simulation for the Doppler effect is presented in terms of the frequency as it passes
through the sound source. The use of simulation has indeed been proven in several cases in dealing
with misconceptions (Fratiwi et al., 2018; Kaniawati et al., 2021; Wibowo et al., 2017). Moreover,
simulations of abstract concepts in physics are very helpful in understanding them. Thus, with the help
of simulations, students’ misconceptions can be lowered or even changed into a better understanding.

Changes in conception for the better are expected after the treatment is carried out. Based on the
results of this study, the use of SWiCS made a change in the conception which was dominated by good
changes. This is in accordance with previous research (Samsudin et al., 2020) that uses simulation as a
medium for changing students’ conceptions. In addition, the use of SWiCS can also suppress changes
in the no change category. This means that the misconceptions that occur after treatment are
reduced, and their distribution is changed towards a better conception. Thus, the use of SWiCS has a
positive impact on changes in students’ conceptions. Moreover, the learning conditions after the
pandemic have taught practitioners in the field about distance learning, where all preparations in
terms of rules, facilities and schemes must be prepared properly because it will become a new habit in
learning. The use of SWiCS can help the implementation because its use can be used anywhere,
anytime and under any condition, whether conventional or distance learning.

5. Conclusion

The results show that the average decrease in students’ misconceptions that occurred for all
questions was 88% (steep category). Meanwhile, changes in misconceptions during the post-test
mostly occurred in the good change (GC) category (56%) and the lowest category in no change (NC)
(12%). This is also reinforced by Rasch’s analysis which explains that there is a decrease in the
potential for misconceptions from pre-test to post-test after treatment is given. Thus, the use of SWiCS
in the POE strategy can reduce misconceptions about the concept of sound waves well and
change the conception for the better.

6. Recommendations

Computer simulation media has been widely used in several cases in physics learning. However,
only a few studies have developed media based on misconceptions, like SWiCS, which was developed
and implemented to reduce and change students’ misconceptions for the better. Thus, we
recommend the use of SWiCS to reduce misconceptions about the sound wave concept.

References


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