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# Teaching the Concept of Sound Waves using a Closed Organ Pipe for Students with Deaf and Hard of Hearing

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**ABSTRACT**

The goal of this research was to describe how to teach the concept of sound waves to Deaf and Hard of Hearing (DHH) students. The method used was the experimental method (pre-and post-test design) on 5 DHH students aged 12 to 16 years. The presentation of the sound wave concept material used both the speech method and the experimental method. The speech method included visual images, while the experimental method employed a closed organ pipe filled with water. A sound level meter was used to measure the intensity of the sound produced. The result of the study found that the material about the concept of sound waves could be taught to DHH students. The students could understand that sounds produce waves that propagate through the media (the experiment used water as the media) to reach the human ear. The teacher's communication style, the student's ability to read the teacher's lips, the student's sound perception, and the media used contributed to the success of conveying the concept of sound to DHH students.

***Keywords:***
Deaf; hard of hearing; sound waves

## 1. Introduction

Hearing impairment or the inability to hear affects Deaf and Hard Hearing (DHH) student language skills [1]. DHH students have deficiencies, particularly in the formation of grammar, that prevent language development [2]. Learning and providing education for students with hearing impairment focuses on abilities that can be developed students, one of which is by improving sound perception abilities [3]. Providing knowledge to students regarding natural laws and concepts that apply in nature through problem-based learning methods and daily contextual events by applying knowledge and skills simultaneously to solve a problem [4]. The principle of learning through experimentation can provide opportunities for students to move actively during teaching and learning sessions. Students can learn from the results of experiments by observing and analysing [5]. Teaching in

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science education is often associated with STEM [6]. Many reports regarding strategies to teach DHH students [7-22].

It is necessary to start training as early as possible so that DHH students can gain sound awareness [23]. Sound awareness exercises improve the functioning of residual hearing and vibrating senses. Students are taught the fundamental concepts of sound, including sound waves, at the start of the activity.

Several reports on sound recognition for DHH students have been conducted, including the teaching of sound intensity [24], sound reflection [23], and sound detection [25]. There has been no research on teaching the concept of sound waves to DHH students based on the results of these studies.

The goal of this research was to teach the concept of sound waves to DHH students. This research used speech and experiment methods. The experiment used a closed organ pipe filled with water. DHH students utilized a sound level meter to detect whether or not a sound was being created. This was taught to DHH students as the foundation for developing their understanding of sound. The experimental method (pre-and post-test design) was employed on 5 DHH students who had a severe level of hearing loss of hearing capacity.

## 2. Methodology

The subjects of this study were five DHH students at special schools in Yogyakarta. They were 12 to 16 years old. The research method used was the experimental method without a control group. The stages were pretest-treatment-post-test. The research subjects were students with a very severe loss of hearing ability level. The material for the concept of sound waves was delivered through speech and experimental methods.

This research went through 3 stages, namely:

i. Pretest
ii. Treatment
iii. Post-test.

In the pretest, students were given five questions about the concept of sound waves. In treatment, students were given material about sound waves through the speech method and were equipped with pictures. Next, the students experimented using a closed organ pipe filled with water. An organ pipe filled with water was struck to produce a sound. A sound level meter was used to measure the intensity of the sound produced. In the post-test, students were given five questions about the concept of sound waves. Student ability data were assessed on a scale of 0 (do not understand), 1 (understand a little), and 2 (understand).

When the material about sound waves was delivered to DHH students, the researcher observed the students' surrounding factors, including lip-reading, sound perception ability, and sound identification ability. All of this data used a scale of 0 (does not have the ability), 1 (has a little ability), and 2 (has the ability).

## 3. Results and Discussion

### *3.1 Student Demographic Data*

The subjects of this research were five students aged 12 to 16 who had severe hearing loss. Student A, a 14-year-old boy, had a moderate level of speaking competence but low comprehension.

Student B, a 14-year-old girl, spoke well and understood moderately. Student C, a 14-year-old girl, had good speaking skills but had problems with understanding. Student D, a 12-year-old girl, had excellent speaking and comprehension skills. Student E, a 16-year-old girl, had good speaking skills but struggled to understand.

Student speaking ability data were required to determine how well they could communicate knowledge and questions orally during conversations and experiments. Data on understanding ability were required to determine the student's ability to comprehend learning materials when it was delivered and when the experiment was performed.

### *3.2 Experiment Result*

The sound is produced when two objects collide strongly, swiftly, and equally. The air moves/vibrates due to the collision of the two objects. Sound waves propagate in all directions as a result of the vibration. Sound is a longitudinal wave that propagates across a medium in physics (liquid, solid, and gas). Air molecules vibrate in all directions, creating sound waves. The human ear receives sound waves. Figure 1 shows the sound waves of high-frequency and low-frequency sounds.

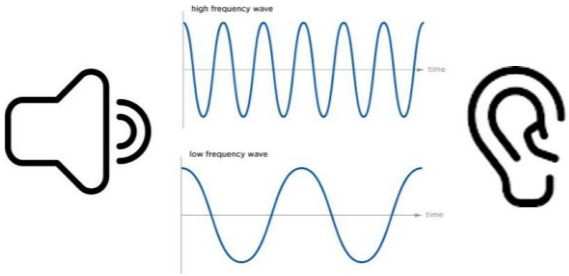


**Fig. 1.** Sound waves

### *3.3 Teaching Process*

The steps in teaching sound waves are as follows:

i. The teacher used the lecture method to teach students about sound waves and provided them with pictures of the process of sound wave occurrence and how sound reaches the human ear.
ii. Students were allowed to discuss the teacher's explanation of sound waves.
iii. Students and teachers prepared closed organ pipes, water, and sound level meters, as shown in Figure 2.
iv. Students were explained how each piece of equipment that had been prepared worked.
v. Students were given an explanation of the experimental process using the prepared equipment.
vi. Students conducted an experiment in which they beat a closed organ pipe filled with water and listened to the sound. The sound level meter was used to measure the intensity of sound and to help students detect the sound produced. When the sound level meter moved, it meant that there was a sound.
vii. Students were allowed to discuss the results of previous experiments.
viii. Observing the student's lip reading, sound perception, and sound identification abilities during the experiment.

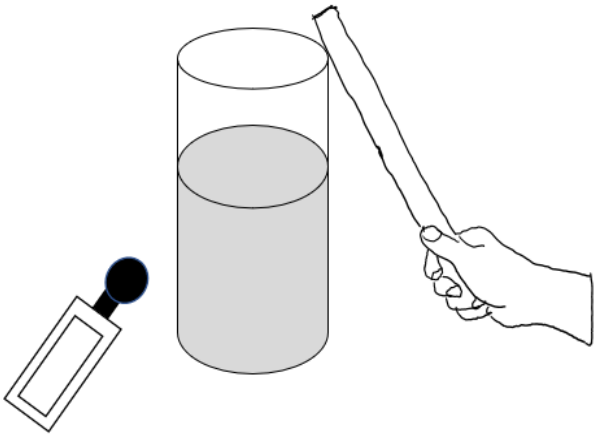

**Fig. 2.** The experimental process using a closed organ pipe filled with water

### *3.4 Teaching Sound Waves to Subjects*

Table 1 shows the student's understanding of sound waves before and after the activity. The pretest and post-test scores indicated that the student understanding improved after the teacher presented the material.

**Table 1**
Comparison of Subject

| Statements | Students | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A | | B | | C | | D | | E | |
| | x | y | x | y | x | y | x | y | x | y |
| 1. Why do human speech organs produce sound waves? | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 1 |
| 2. Are the sound waves produced by humans different? | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 |
| 3. What happens when an organ pipe filled with water is hit? | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 4. Why does an organ pipe filled with water make a sound when struck? | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 5. How does sound reach the human ear? | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |

* Note: x is pretest, y is post-test

From five questions, the same students scored 0 on the pretest, showing that they could not answer the question correctly. During the post-test, all students print at least 1, which means that they have some understanding of the topic. In most categories, more students scored 2 in the post-test than in the pretest. This shows that effective instructions in helping students learn about this science topic.

Overall, most students increased their understanding of sound waves between pretest and post-test. The following performance of each student. Student A answered all questions correctly during the pretest and post-test. Student B answers question 1 wrong in the pretest and correctly in the post-test. Student B answers questions 2, 3, 4, and 5 correctly in both tests. Student C answers to question 1 wrong for pretest and post-test. Student C answered questions 2 and 5 correctly in both tests. Student C increased their understanding of questions 3 and 4 between pretest and post-test. Student D answered question 1 wrong in the pretest and correct in the post-test. Student D increased their understanding of question 3 between the pretest and post-test. Students who answer question 1 are wrong for the pretest and correct in the post-test. Student E answered questions 3 and 4 wrong on the two tests. Student E answered question 5 correctly in the post-test. Student E showed the least increase in the post-test.

### *3.5 Student Surrounding Factors*

Table 2 describes the student's surrounding factors, including the ability to read lips, sound perception, and sound identification. Observations were made during the process of providing material on the concept of sound waves.

Most respondents managed to understand the principle of sound waves after experimental learning activities (see Table 1). Students A and E understand little about why human speech organs produce sound waves, while students B, C, and D understand them well. For questions about the differences in sound waves produced by humans, what happens when an organ pipe filled with water is hit, why does an organ pipe filled with water make a sound when struck, and how does sound reach the human ear, it is possible to imagine that all students understand it after being given a lesson about the concept of sound waves using a closed organ pipe.

Successful teaching is supported by students' ability to read lips when the teacher explains the material. The ability to perceive sound and identify sounds is also a contributing factor to student success. The data showed all students had good lip reading and sound perception skills. For sound identification, students A and E have little ability to identify sounds, while students B, D, and D have good sound identification skills (see Table 2).

**Table 2**
Student Surrounding Factors

| Things to Observe | | Subject | | | | |
|---|---|---|---|---|---|---|
| | | A | B | C | D | E |
| 1. | Lips reading | 2 | 2 | 2 | 2 | 2 |
| 2. | Sound perception | 2 | 2 | 2 | 2 | 2 |
| 3. | Sound identification | 1 | 2 | 2 | 2 | 1 |

Some interesting things emerged when teachers taught sound waves to DHH students. Students when enthusiastically listening to the teacher's explanation of sound waves and the process of sound waves. Teachers use image media to explain the process of sound waves and how the sound process reaches the human ear.

Furthermore, DHH students were asked to discuss the material they had obtained, namely about sound waves. Student A asks "Why do not we see sound waves?", the same question is also asked by student D "Where are the waves?". The teacher explained that sound waves cannot be seen, but we can listen to sound through the ear, and feel sound through vibration, we can also use a sound level meter to mark if there is a sound. When the sound level meter moves, the sign has a sound, if the sound level meter is silent, it means there is no sound.

After the material is presented and discussed, teachers and students prepare materials for simple experiments, namely closed organ pipes, water, and sound level meters. The teacher explained how each piece of equipment and the materials prepared worked. The teacher explains how each piece of equipment has been prepared and the position of each piece of equipment (Figure 2).

Next, students conduct experiments with teacher assistance. First, students hit a closed organ pipe filled with water. Second, students detect the sound produced by a closed organ pipe filled with water being hit. Students listen with residual hearing and vibrational feelings they have. To measure the intensity of the sound produced and to assist DHH students in detecting the presence or absence of sound, a sound level meter is used. After the experiment is over, students are allowed to ask questions and have discussions. During the learning process, teachers observe DHH students' ability to read lips, detect sounds, and identify sounds.

## 4. Conclusion

The findings demonstrated that DHH students could be taught about sound waves. This was proven by the student's understanding that sound produces waves that move through the media to reach the human ear. Choosing the right method or strategy for learning about sound concepts is important so that the sound concept material, especially sound waves, can be mastered by students with hearing impairments. The sound wave learning method can be demonstrated so that learning methods for deaf children can be adapted to a visual approach to increase students' understanding of material about sound waves. The teacher's teaching methods, learning media, and student abilities in lip reading, sound perception, and sound identification contribute to the successful delivery of the concept of waves to DHH students. Teaching the Concept of Sound Waves Using a Closed Organ Pipe for Students with Deaf and Hard of Hearing can be carried out. Teachers are required to understand this method and master the steps for implementing the method for students with hearing impairments, so that learning objectives can be achieved and students experience improvement in sound wave material.

In this regard, researchers recommend conducting extensive tests to see the effectiveness of teaching the Concept of Sound Waves Using a Closed Organ Pipe for Students with Deaf and Hard of Hearing.

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