Research Article

Journal of Innovative Research in Teacher Education, 5(3), 186-201,
ISSN: 2757-6116
http://www.jirte.org
DOI: 10.29329/jirte.2024.669.1
Received: 29/04/2024
Revised: 04/10/2024
Accepted: 23/10/2024

Developing science experiments for hearing-impaired children and examining their opinions*

Sema Yiğit[1], Sema Bulut[2], and Gülbin Özkan[3]

Abstract

This study aims to introduce science lessons and science experiments to 4-8-year-old hearing-impaired students and investigate their views on science experiments and science lessons. In this research, a case study, which is one of the qualitative research methods was used. The research sample consists of 18 hearing-impaired students aged 4-8 studying at an Education Centre for Individuals with Special Needs in Istanbul. The research data was collected qualitatively. Data were collected from all participants voluntarily. A student survey form consisting of open-ended questions prepared by the researcher was used as a data collection tool. This qualitative data collection tool was prepared to examine hearing-impaired students' views on science experiments and science. The data obtained from this study were analyzed by using content analysis. The findings are presented in tables. Considering the results obtained from the research, it was found that hearing-impaired students liked science lessons and experiments and had fun while doing the science experiments. Pre-experiments were conducted, and it was found that the students had not done science experiments before and did not know much about science experiments. Students stated that their desire to do experiments increased because of the experiments, and they were surprised and happy. In contrast, the experiments were being carried out, and the experiments made them curious. In light of the results, it is suggested that science experiments should be given due importance and carried out actively in lessons by including schools with disabled students. This study suggests that conducting science experiments with hearing-impaired students could fill essential research gaps in both increasing accessibility to scientific education and supporting the participation of these students in various fields.

Keywords: Science experiments, Hearing-impaired, Students' opinions, Special education

Cite: Yiğit, S., Bulut, S., & Özkan, G. (2024). Developing science experiments for hearing-impaired children and examining their opinions. *Journal of Innovative Research in Teacher Education, 5*(3), 186-201. https://doi.org/10.29329/jirte.2024.669.3

* Ethics approval was received from Yildiz Technical University Ethics Committee (Date: 25/05/2022-Number: 2022.05)
[1] Yildiz Technical University, Faculty of Education, Department of Mathematics and Science Education, Turkey. sema.yigit@std.yildiz.edu.tr

[2] Yildiz Technical University, Faculty of Education, Department of Mathematics and Science Education, Turkey. bulutsema660@gmail.com

[3] Corresponding author, Yildiz Technical University, Faculty of Education, Department of Mathematics and Science Education, Turkey. gozkan@yildiz.edu.tr

INTRODUCTION

In this century, science and technology are developing and progressing rapidly. Every single day, there is new information and new technological developments. While everything is developing and changing quickly, people cannot be expected to stay where they are. There is a need for individuals who develop and transform themselves. It is necessary to educate children as individuals who can do research, think analytically, and are prone to science and technology, even from a young age. In this century, people must be science-literate to adapt to the century and understand the current science and technology (Belhan, 2012). Özdemir (2010) defines the concept of science literacy as 'Serving the understanding, adoption and conscious use of scientific and technological developments; 'competence' includes cognitive, affective and psychomotor skills that can protect individuals' quality of life and natural life.'. Science literacy helps individuals be productive and take responsibility. It allows us to comprehend the increasing entrepreneurial activities. It creates individuals who think about the natural world in a particular order, produce solutions in critical situations, and have an independent mindset. This situation shows that the importance given to science education should be increased (Çepni et al., 2003).

Science education has essential features such as enabling individuals to discover the outside world and helping science concepts become more meaningful and permanent, as all subjects within it derive their origin from real-life situations and nature. For this reason, teaching topics that enable them to structure information based on experience will help students understand better (Kırpık & Engin, 2009). The methods used when transferring science information to students are essential. It states that many people cannot learn science due to traditional teaching methods, including oral expression and reading written texts (Aktürel, 2004).

A scientifically literate individual can analyze and recognize the outside world very well. They produce different products, are interested in research, and have a sense of curiosity. These individuals can solve problems, think critically, and make decisions (Kaya & Bacanak, 2013). While it is difficult for healthy individuals to be scientifically literate persons who can use technology correctly and do research, disadvantaged individuals in society cannot keep up with this century. Individuals live a life utterly dependent on their senses. They create their experiences by using these feelings obtained through their senses (Bransford et al., 1999). The information they acquire through their feelings forms the individuals' environments and creates various functions (understanding, imagining, thinking). In order to have these functions, intelligence, and senses must be used effectively. There are disadvantaged individuals in society when it comes to using these senses (Gardner, 1983). One type of disability that is disadvantageous in society is hearing-impaired disability. Hearing impairment is when the hearing test performed on individuals slightly or significantly differs from the accepted threshold value. There are different classifications around the world according to hearing loss levels. For example, according to the British Association of Audiologists, there are four types of hearing loss (mild hearing loss, moderate hearing loss, severe hearing loss, and profound hearing loss (Aktürel, 2004). Due to the problem caused by the hearing senses, problems may occur in functions such as understanding and thinking. Hearing disability is the most significant factor that prevents an individual's development, adaptation to society, and communication with society (Demirhan, 2008). However, despite the challenges in communication and social interaction, cognitive and learning abilities remain unaffected by hearing loss.

It has been stated that there is no difference in learning skills between hearing-impaired children and their hearing peers. However, hearing-impaired children will have reading comprehension problems due to language developmental delay (Kılıç, 2007). The education given to hearing-impaired students should help them develop both academically and socially in line with their needs and help them develop oral language and communication skills for an environment in which they can participate and adapt to their society on equal terms (Aktürel, 2004).

Hearing-impaired children acquire information from their peers at work in a similar way. However, it is essential for hearing-impaired people to actively engage in activities in their education due to the necessity of concrete experiences among their needs (Girgin, 2023). According to Lang and Steely (2003), the best practices in science education that enable the participation of hearing-impaired students are active learning, experiential learning, interactive learning, etc. Experiments in science classes enable students to develop their cognitive skills and increase their motivation by activating the learning environments (Demirhan, 2008).

It has been revealed that all kinds of experiments (e.g., individual and group experiments, teacher experiments) increase the success of individuals (Bekar, 1996). According to Kaptan (1998), experiment and observation are the most essential features of the science class. In addition to this idea, it can be said that science lesson experiments will positively impact students' learning, make them more active, and thus help attract their attention. Based on these views, it is thought that a program can be prepared within the plan to ensure that teaching science experiments to hearing-impaired students who are disadvantaged in experiments will contribute to the success of individuals. Therefore, this study aims to introduce science classes and experiments to hearing-impaired students and examine their opinions about science experiments and science classes.

In recent years, multiple studies have investigated the benefits and challenges of conducting science experiments with hearing-impaired students, highlighting the importance of inclusive teaching methods. For example, research suggests that employing hands-on, visual-based instructional strategies can significantly enhance learning outcomes for hearing-impaired students by aligning with their primary modes of communication and sensory processing (Akay, 2021). These methods often include visual aids, detailed written instructions, and tactile models, which enable students to engage actively with the material and better grasp complex scientific concepts (Ediyanto et al., 2017).

Studying science experiments conducted by hearing-impaired students is vital for several reasons, as it not only broadens our understanding of how these students engage with scientific concepts but also informs the development of more inclusive and effective teaching methods. Science education heavily relies on verbal instructions and auditory cues, which can pose significant challenges for hearing-impaired learners (Parhoon et al., 2014). Research has shown that hearing-impaired students benefit from alternative methods, such as visual aids, tactile materials, and sign language support, which align better with their sensory strengths (Ediyanto et al., 2017). Moreover, such research emphasizes the value of diversity in science education, as it promotes a more inclusive approach that can reduce educational disparities and improve overall engagement in science fields. This can help foster a more diverse generation of future scientists who bring varied perspectives and abilities to the field (Ponomarenko et al., 2019). In this context, the problem of this study is 'What are the students' opinions about the usefulness of science experiments prepared for hearing-impaired individuals?'.

METHOD

Research Design

This study used a case study, a qualitative research method. A case study is a type of qualitative research used to find answers to scientific questions in which one or more interconnected systems are examined in depth (Büyüköztürk et al., 2020). In a case study, factors related to a situation are investigated with a holistic approach (Yıldırım & Şimşek, 2021).

Sample of Study

The research sample consists of 18 hearing-impaired students aged 4-8 studying at an Education Centre for Individuals with Special Needs in Istanbul. The sample was selected using a purposeful sampling method. Purposeful sampling is a type of sampling that is not random when conducting in-depth research (Büyüköztürk et al., 2020). Volunteer participants were determined before starting the research. Approval from the participants' families and permission from the ethics committee was obtained. In addition, official permission was received from the Istanbul Education Centre for Individuals with Special Needs to carry out the study.

Since the students had hearing loss, the researchers read the questions. The researchers and the participants communicated through sign language. Two of the researchers have a sign language certificate. The participants' hearing loss varies between 20 and 70 percent.

Data Collection Instruments and the Procedures

Table 1 gives the purpose of the activities carried out.

Table 1. Purpose of the activities

Name of the activity	Purpose of the activity
Dry ice experiment	Understanding sublimation is one of the phase changes.
Bubbling color experiment	Introduction of acid-base concepts; observation of the reaction and gas evolution in the mixture of acid and base.
Metal detector	Learning the concepts of metal, conductor, and insulator. Learning whether the surrounding substances are conductors or insulators by testing them with a metal detector.
3-6 years old density experiment	Learning the concept of density.
Germ experiment	Understanding the importance of hand washing to protect against germs.
Colored Tower Experiment	Learning about a capillary phenomenon.
Non-Bursting Balloon Experiment	Explaining the expansion of heated air.
Rain Experiment	Understanding how rain occurs using the logic of the water cycle.
Rainbow Experiment	Learning about rainbows and capillarity.
Magnet Picture	Learning about magnets and what substances the magnets can attract.

In order to carry out the activities, five days of activities were held at the Training Center for Individuals with Special Needs. Practice was made for 4 hours every day. While carrying out the activities, the student's disabilities and age groups were considered, and experiments were carried out in a safer, slower, and more understandable way. In order to attract their attention, appropriate activities were carried out with the participating students under the guidance of the researchers. Some images from experiments conducted with hearing-impaired students are given in Figure 1.

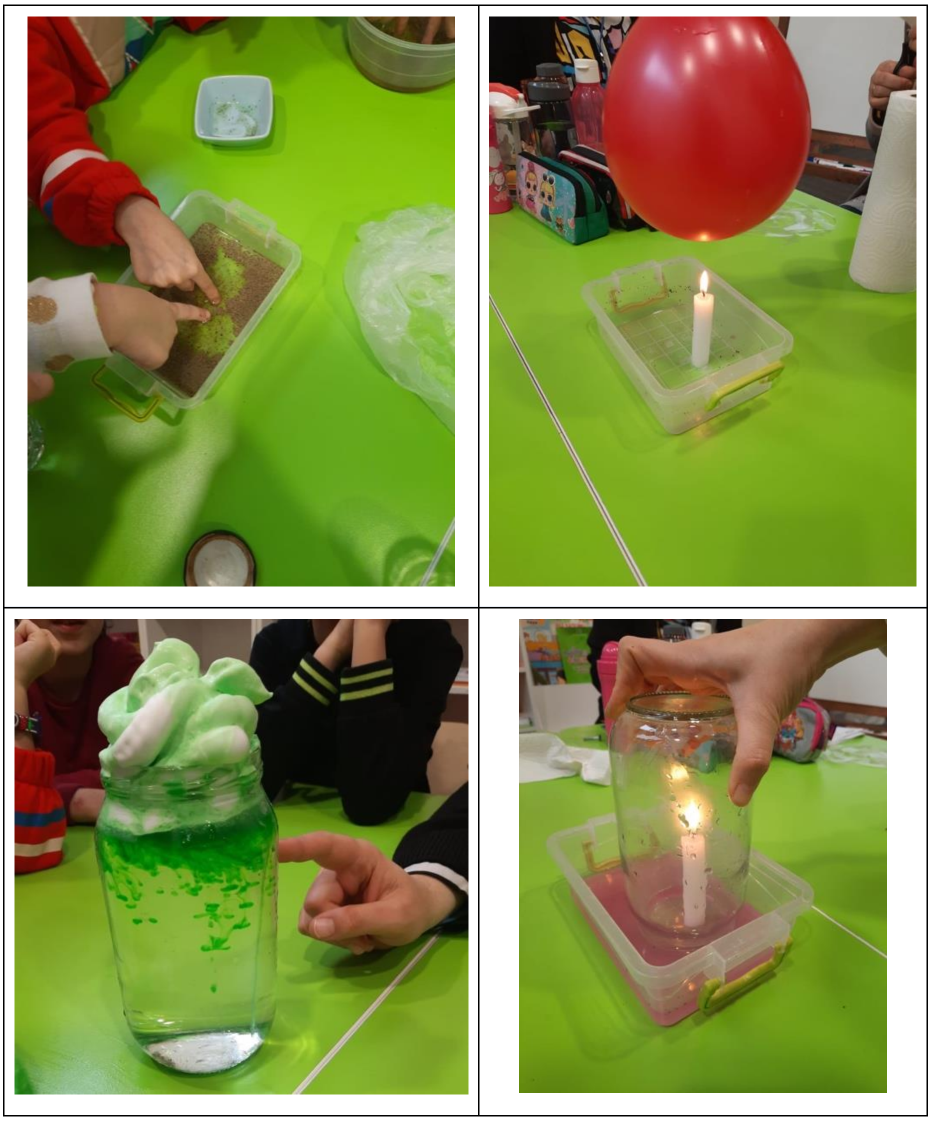

Figure 1. Images from Activities

A student survey form consisting of open-ended questions was used as a data collection tool. Researchers developed this data collection tool to examine hearing-impaired students 'views on science experiments and science class. After the data collection was presented to expert opinion, it was given its final form. The questionnaire form was prepared as open-ended to examine the participants 'thoughts and opinions in depth. Voluntarism and confidentiality principles were used as a basis throughout the process. Each participant answered the questionnaire form for an average of 20-25 minutes. Although the research aimed to determine the opinions of hearing-impaired students about the experiments, three questions were asked of the participants before the implementation to determine whether they had experimented before. The questions included in the data collection tool are as follows:

Questions asked before implementation:
1. What is the meaning of the experiment? Please explain.
2. Have you ever experimented before?
3. Do you think you can do the experiments?

Questions asked after implementation:
1. Did you like to experiment? Why?
2. How did experimenting make you feel?
3. Did you understand the experiments?

4. Did the experiments arouse your curiosity?
5. Are there any problems you encountered in the experiment? If so, what were they?
6. Did experimenting help you learn anything?
7. Would you like to do science experiments like this more often? Why?
8. How would you like the experiments to be done?
9. What did you learn as a result of science experiments? What did they bring to you?
10. What did you like and dislike about the experiments?

Data Analysis

The data obtained from the data collection tool were analyzed using the content analysis method. The data was first converted into codes and, in the next step, into categories and themes. Two researchers analyzed the data separately, and it was found to be 95%. This value gives the rater reliability. The findings are presented in tables.

FINDINGS

The findings obtained from the data collection tool are presented in this section. Content analysis was performed on the data collected with the open-ended questionnaire. The findings obtained from the content analysis are presented in tables, and examples of student responses are given for each category. First, before students encounter experimental activities, they must ask, 'What is an experiment?' and their answers to the question were examined. Table 2 students' 'What is an experiment?' Answers to the question show their situation.

Table 2. Students' definition of 'experiment'

Definitions	Frequency	Percent (%)
Know	8	44.4%
Do not know	9	50.0%
Make class	1	5.6%
Invent	1	5.6%
Making something	1	5.6%
Mixing chemicals	1	5.6%
Making mud-concrete	1	5.6%
Mixing slime	1	5.6%
Doing research	1	5.6%

According to Table 2, it was concluded that half of the students did not know the definition of the experiment. For example, student number 6 said and expressed herself/himself, "I do not know what the experiment is." Table 2 summarizes whether the students had experimented before or not before the implementation. Students' definitions mainly included concepts related to experiments they had encountered before. Figure 2 shows whether the students have ever done a science experiment before.

Figure 2. Number of Students Who Experimented Before the Implementation

As seen in Figure 2, 53% of the students stated that they had done a science experiment before, 42% stated that they had never done one, and 5% stated that they did not remember whether they had done one before.

When asked, "Have you ever experimented before?" The students stated the names of the experiments they had done before this implementation. The students' experiments are given in Table 3.

Table 3. Experiments carried out by students

Experiments Carried Out	Frequency	Percent (%)
Making slime	2	11.1%
Pickle experiment	2	11.1%
Black pepper experiment	1	5.6%
Balloon experiment	1	5.6%
Corn experiment	1	5.6%
Yoghurt experiment	1	5.6%
Making mud	1	5.6%
Watercolor	1	5.6%
Dissolution experiment	1	5.6%

It was conducted that most of the students who applied the implementation had done simple experiments before. Student number 12 expressed on this subject as follows: “I did. I did the black pepper experiment and the balloon experiment. I also did the corn experiment. I did experiment with pickles and yogurt.”

Before starting the activities, the students were asked the last question, "Do you think you can do the experiments?" Table 4 summarizes the students’ thinking so that they can do the experiments.

Table 4. Students think that they can do the experiments

Students think that they can do the experiments	Frequency	Percent (%)
Trust to do	15	83.3%
Do not trust to do	3	16.7%

Only three students thought they could not experiment before doing the experiments. As seen in Table 4, most students think they can experiment. Student number 8 expressed herself/himself on this subject: “I believe I can experiment.”

After the experiments were implemented, the students were asked whether they liked doing experiments. While 17 participants (94.4%) stated that they liked doing experiments, 1 participant (5.6%) stated that he/she did not like it. Table 5 shows the students' reasons for liking experimenting.

Table 5. Students' reasons for liking doing experiments

Students' reasons for liking doing experiments	Frequency	Percent (%)
Find it fun	6	33.3%
Make you own	2	11.1%
Like it	1	5.6%
Find it good	5	27.8%
Be educational	1	5.6%
Like 'the experiment.'	3	16.7%
Be happy	1	5.6%

As seen in Table 5, almost all students liked doing experiments. Student 12 expressed himself/herself in this regard: 'I liked it because experiments are so much fun.'

After the implementation, the students were asked what emotions they felt while experimenting. Table 6 shows the emotions and feelings students felt while experimenting.

Table 6. Emotions felt during the experiment

Emotions felt during the experiment	Frequency	Percent (%)
Being happy	9	50.0%
Be amazed	6	33.3%
Be excited	2	11.1%
Enjoy	1	5.6%
Have fun	2	11.1%
Rejoice	3	16.7%

As seen in Table 6, the students felt positive and good emotions during the experiment. In this regard, student number 4 said, 'I had fun, I was surprised, I was happy.'

After the experiments, the students were asked whether they understood the experiments. While 15 students (83.3%) said they understood the experiment, three (16.7%) said they partially understood it. No student said they understood completely. Tablo 7 shows the parts that students understood better in the experiments.

As Table 7 shows, most of the students understood the experiments. Student 7 said, 'Yes, I understand. I learned how to mix vinegar and baking soda.'

Table 7. Students' understanding of the experiments

Understanding of the experiments	Frequency	Percent (%)

Understanding sublimation with dry ice	3	16.7%
Understanding how to protect yourself from germs with the black pepper experiment	4	22.2%
Understanding the vinegar-baking soda mixture	3	16.7%
Understanding painting with magnets	1	5.6%
Understanding capillary	2	11.1%
Understanding experiment	1	5.6%
Understanding the balloon experiment that does not burst	1	5.6%

Another question asked after the activities was, "Did the experiments arouse your curiosity?" After the implementation, 17 students (94.4%) stated that the experiments aroused curiosity, while 1 (5.6%) said they did not. The responses to the most intriguing point are presented in Table 8.

Table 8. Curiosity of experiments

Curiosity of experiments	**Frequency**	**Percent (%)**
Playdough aroused curiosity	1	5.6%
The dry ice experiment aroused curiosity	1	5.6%
The vinegar and baking soda mixture aroused my curiosity	1	5.6%

Table 8 shows that almost all students were curious about the experiments. Student 8 stated, 'I wondered what would happen if you mixed vinegar and baking soda.'

After the experiments, the students were asked what problems they encountered. Table 9 shows the problem situations that students encountered in the experiments.

Table 9. Problem encountered in the experiment

Problem encountered in the experiment	**Frequency**	**Percent (%)**
No problem	16	88.9%
Ice hurts the hand	1	5.6%
Foam formation	1	5.6%

Table 9 shows that most of the students did not encounter any problems during the experiments. In this regard, student number 4 said, 'Nothing happened.'

Students were also asked about how experiments helped them learn. Table 10 summarizes how experiments help learning.

Table 10. How Experiments Help to Learn

How experiments help to learn	**Frequency**	**Percent (%)**
It helped to learn	7	38.9%
Learning electrical conduction	3	16.7%
Learning insulation	1	5.6%

Learning magnet	6	33.3%
Learning to mix colors	1	5.6%
Learning density	1	5.6%
Learning the effect of salt on density	2	11.1%
Learning to sublimate	2	11.1%
Learning about rainfall from clouds	2	11.1%
Learning the bubble color experiment	1	5.6%
Learning to rainbow	1	5.6%
Learning to experiment	1	5.6%

As seen in Table 10, experiments are a positive factor in students' learning. In this regard, student number 10 said, ' Yes, sublimation. In the electrical experiment, I learned about conductivity because it was metal. I learned isolation.'

After implementing the experiments, the students were asked how often they preferred to carry out such experimental activities. Table 11 summarizes the students' opinions about the frequency with which they would like science experiments to be conducted after the science experiments were conducted.

Table 11. Request for Science Experiments

Reasons for wanting to repeat science experiments	Frequency	Percent (%)
Wanting because liked	5	27.8%
Wanting because it is fun	3	16.7%
Wanting because they are excellent experiments	1	5.6%
Wanting because it is instructive	1	5.6%
Wanting because it is effective learning	1	5.6%
Wanting because it interests	1	5.6%

As seen in Table 11, students want science experiments to be done frequently. All of the students wanted these experiments to be repeated. Student 17 said, 'Yes, I would like it because it is enjoyable and educational. I am learning something.'

After the implementation, students were asked how they preferred to conduct the experiments from now on. Table 12 shows students' opinions on how they would like the experiments to be conducted.

Table 12. Students' opinions on how they want experiments to be done

Codes	Frequency	Percent (%)
Want to do it individually	13	72.2%
I do not want to do it. Individually, because they are bored	1	5.6%
Want to do it together	2	11.1%

Monitoring from smart board	1	5.6%
I want everyone to do it	1	5.6%

As seen in Table 12, most students want to do the experiments individually. For example, student number 9 said, 'I was happier when I did it myself.'. However, student number 8 thinks: 'I would like to do something difficult with both of us. That is why I needed your help.'.

Students were asked what they learned from science experiments and what they gave them. Table 13 summarizes what students learned as a result of science experiments brought to them.

Table 13. Students learning and achievement status as a result of science experiments

Students' learning and achievement statuses are a result of science experiments.	Frequency	Percent (%)
Learning experiment	1	5.6%
Learning conductivity-insulation	3	16.7%
Learning that metals conduct electricity	4	22.2%
Learn how it rains	7	38.9%
Learning cloud	1	5.6%
Learning how to form foam in a vinegar-baking soda mixture	2	11.1%
Learning the effect of salt on density	1	5.6%
Learning that soap cleans germs	3	16.7%
Learning the magnetic picture experiment	1	5.6%
Learning to sublimate	2	11.1%
Happiness and winning the teachers' hearts	1	5.6%
Learning capillarity	1	5.6%

As seen in Table 13, some of the students learned about rain. For example, student number 5 expressed: 'I learned how to make rain come from clouds. When you put salt in the water, the egg came up. When you do not put anything into the water, the egg will not go up.'.

Students were asked about their likes and dislikes in science experiments. Table 14 shows what students liked and disliked about science experiments.

Table 14. Situations that students liked and disliked in the experiment

Liking status	Reason	Frequency	Percent (%)
None	None	1	5.6%
Like	Experiment	3	16.7%
	Like everything	2	11.1%
	Rainbow experiment	5	27.8%
	Rain experiment	3	16.7%
	Egg experiment	3	16.7%

	Germ experiment	4	22.2%
	Non-explosive balloon experiment	1	5.6%
	Magnet painting experiment	4	22.2%
	Bubbling color experiment	2	11.1%
	Transmission of electricity	1	5.6%
	Color tower experiment	2	11.1%
Do not like	Holding dry ice	3	16.7%
	Magnet painting experiment	1	5.6%

As seen in Table 14, students generally liked the experiments. Five students said they liked the rainbow experiment; four liked the microbe and the magnetic picture experiment. For example, student number 8 said, 'Yes, I liked it. We mixed baking soda and vinegar; I loved it. I loved the rainbow; it was so beautiful. I liked the experiment with magnets; it was funny because the magnet sticks to metals, so I liked it.'.

Most of the students did not like the experiments. For example, student number 10 expressed, 'I liked them all; there was nothing I did not like.'

DISCUSSION AND CONCLUSION

According to the results obtained from the research, it was seen that hearing-impaired students aged 4-8 liked science lessons and science experiments and had fun while doing the experiments. It has been observed that individuals' interests and motivation in the course are positively affected by science experiments. Before the experiments were conducted, it was observed that the students had not done any experiments before and did not know much about science experiments. They thought some daily activities, such as studying and researching, could be experiments. Students stated that their desire to do experiments increased due to the experiments and that they were surprised and happy. In contrast, the experiments were carried out, and the experiments made them curious. Students also mentioned that science experiments should be conducted more frequently. Most of the students said that they understood the experiments and that the experiments were practical in learning something. Again, most students stated they wanted to conduct the experiments individually.

When the research findings were examined in the literature, it was seen that they were parallel to the findings of many studies. When these studies were examined, Sözer (1998) stated that other methods should be used occasionally in plain language to generate positive data due to learning. In light of the experiments applied in this research, it can be concluded that participants' perspectives on science have changed positively by allowing them to use more than one sense organ and helping them gain experience. Experiments were conducted with hearing-impaired individuals, and their interest and motivation in science classes were expected to increase due to these experiments. This result was observed to be achieved.

According to Hakan (1991), students will understand the experiments more quickly when applied more simply and understandably appropriate to their level. The study's findings also support this view. Both researchers' demonstration and explanation of experiments to hearing-impaired individuals and students' experiences in experiments positively increase their interest in science. Some students stated that they also did science experiments at home.

Okan (1993) stated that the quality of teaching is higher because students, especially those who carry out the experiments on their own, practice the experiments by experiencing them, both with their eyes and all their senses. The results of this study also support this view. According to the findings, most students wanted to do the experiments individually.

Mertens (1991) stated that the studies he applied to hearing-impaired students in the 4-week summer education programs, in the classroom, in the laboratory, and on-site, to investigate their interests and attitudes towards science changed individuals' interests and attitudes towards science. The findings obtained as a result of the research also support this view. It has been observed that the experiments attracted the students' attention; they were entertained and surprised. It was concluded that the experiments made it easier for individuals to learn science subjects. It was concluded that students learned more because they conducted individual experiments by touching and seeing.

According to recent research, using experiments in science classes can significantly increase students' interest in the subject. Ma's (2023) study showed that introducing the participatory teaching method positively impacted students' learning motivation. Similarly, another study from 2021 explored the effects of inquiry-based learning in science schools. This research concluded that when students can explore scientific questions through experiments, their motivation and engagement in science improve significantly. This approach allowed students to connect more personally with the material, making them more likely to pursue further learning in the sciences (Fortus & Touitou, 2021). Both studies highlight the critical role that practical, experimental learning plays in cultivating a lasting interest in science among students, underscoring the importance of experimental teaching methods in modern science education.

Based on the research findings, it can be suggested that science experiments should be carried out in every age group and at every school level, including disadvantaged students in society, and lesson plans should be prepared this way. Because in the study, it was seen that participants were very interested and showed they learned, even if they were young. According to Kaya (2011), the laboratory method, which is widely used and increases permanent learning in science education, is a teaching method that both develops mental activities in students and makes it possible to work individually or in groups. In this context, it is thought that the frequent use of laboratory methods and science experiments in the curriculum of disadvantaged individuals will be beneficial in increasing permanent learning in students and developing positive perceptions and attitudes. While working with disabled individuals, their active participation should be ensured (by taking the necessary safety precautions) so that students will not be just spectators. The study's findings are limited to 18 hearing-impaired students aged 4-8. In future studies, the opinions of more students in broader age ranges can be examined. Studies can be conducted examining the opinions of individuals with different types of disabilities regarding science experiments. In addition, the following suggestions can be given as a result of experiences gained from experiments with hearing-impaired people: It can be thought that the participation of hearing-impaired students in the course may increase by including experiments that will provide them with experience in the content of science class.

It can be thought that hearing-impaired students' interest and motivation toward science lessons may increase if they carry out experiments appropriate to their level of understanding and experience these experiments themselves.

In order to determine the feelings and thoughts of hearing-impaired students toward science, the effects on their interests and levels can be examined using different methods and techniques. These methods and applications can be graphs, charts, or diagrams. Using visual materials can be effective in helping hearing impaired students understand scientific concepts. These materials provide a better understanding of conceptual information. Videos and animations can also be used. Educational videos with subtitles or sign language explanations can be used for hearing impaired students.

Statement of Researchers

Researchers' contribution rate statement: The first author is the project manager (40%), the second author is the researcher (35%), and the third author is the advisor (25%). Contributions are distributed according to the order of names.
Conflict statement: There is no conflict of interest.
Support and thanks: This study was supported by the TÜBİTAK 2209-A Project.

REFERENCES

Akay, E. (2021). The use of audio-visual materials in the education of students with hearing Loss. *International Education Studies, 14*(7), 1–11. https://doi.org/10.5539/ies.v14n7p1

Aktürel, İ. E. (2004). *İşitme engelli öğrencilerin fen öğretimine verdikleri yanıt ve öğrenci özellikleri bakımından incelenmesi. [Investigation of hearing-impaired students' responses to science education and student characteristics]* (Unpublished master thesis). Eskişehir Anadolu University, Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ Access Date: 23.08.2024.

Bekar, S. (1996). *Laboratuvar destekli Fen bilgisi öğretiminin öğrenci başarısına etkisi. [The effect of laboratory supported]* Gazi University, Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ Access Date: 23.08.2024.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (1999). How people learn: Brain, mind, experience, and school. Washington: National Academy Press.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş. & Demirel, F. (2020). *Eğitimde bilimsel araştırma yöntemleri [Scientific research methods in education].* Ankara: Pegem Akademi.

Çepni, S., Bacanak, A. & Küçük, M. (2003). Fen eğitiminin amaçlarında değinilen değerler: Fen–teknoloji–toplum [Values mentioned in the aims of science education: Science – technology – society], *Değerler Eğitimi Dergisi [Values Education Journal], 1*(4), 7-29. https://dergipark.org.tr/en/download/article-file/302588

Demirhan, T. (2008). *Bilişim teknolojilerinin işitme engellilerin eğitimine etkisinin incelenmesi. [Examining the effects of information technologies on the education of hearing-impaired individuals]* Trakya University, Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ Access Date: 23.08.2024.

Ediyanto, E., Atika, I., Hayashida, M., & Kawai, N. (2017, August). A literature study of science process skill toward deaf and hard of hearing students. In *1st Annual International Conference on Mathematics, Science, and Education (ICoMSE 2017)* (pp. 190-195). Atlantis Press.

Fortus, D., & Touitou, I. (2021). Changes to students' motivation to learn science. *Disciplinary and Interdisciplinary Science Education Research, 3*(1), 1-14. https://doi.org/10.1186/s43031-020-00029-0

Gardner, H. E. (2011). *Frames of mind: The theory of multiple intelligences*. NY: Basic Books.

Girgin, Ü. (2005). İşitme engelli çocuklar için erken dönem okuma yazma eğitimi. *İşitme, konuşma ve görme sorunu olan çocukların eğitimi. [*Early literacy education for hearing impaired children. *Education of children with hearing, speech and vision problems.]* Umran Tüfekçioğlu (Ed.), Eskişehir: Anadolu University Publishing.

Hakan, A. (1991). *Eğitim program ve eğitim yöntemleri. [Educational programs and educational methods],* Eskişehir: Anadolu University Publishing.

Kaptan, F. (1998). *Fen Bilgisi öğretimi. [Science teaching],* Ankara: Anı Publishing

Kaya, H. (2011). İlköğretim II. kademe öğrencilerinin fen ve teknoloji dersine ve fen deneylerine karşı tutumları [Attitudes of primary school second grade students towards science and technology courses and science experiments]. *TUBAV Journal of Science, 2,* 120-130. https://dergipark.org.tr/en/download/article-file/200937

Kaya, M. & Bacanak, A. (2013). Fen ve Teknoloji öğretmen adaylarının düşünceleri: Fen okuryazarı birey yetiştirmede öğretmenin yeri. [Thoughts of science and technology teacher candidates: The role of the teacher in raising scientifically literate individuals]. *Dicle University Ziya Gökalp Faculty of Education Journal, 21,* 209-228. https://www.ajindex.com/dosyalar/makale/acarindex-1423939709.pdf

Kılıç, B. (2007). *İşitme engelli öğrencilerin fen bilimleri deneysel etkinliklerindeki bilimsel süreç becerilerinin değerlendirilmesi,* [Evaluation of hearing impaired students' scientific process skills in science experimental activities], Anadolu University, Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ Access Date: 23.08.2024.

Kırpık, M. & Engin, A. (2009). Fen Bilimlerinin öğretiminde laboratuvarın yeri önemi ve biyoloji öğretimi ile ilgili temel sorunlar, [The importance of the laboratory in teaching science and the basic problems related to biology teaching], *Kafkas University Institute of Science Journal, 2*(2), 61-72. https://dergipark.org.tr/en/pub/kujs/issue/30856/338561

Lang, H. G., & Steely, D. (2003). Web-based science instruction for deaf students: What research says to the teacher. *Instructional Science*, *31*, 277-298. https://doi.org/10.1023/A:1024681909409

Ma, Y. C. (2023). Using participatory teaching in hands-on courses: Exploring the influence of teaching cases on learning motivation. *Education Sciences*, *13*(6), 547. https://doi.org/10.3390/educsci13060547

Mertens, M. D. (1993). Instructional factors related to hearing impaired adolescents' interest in science, *Science Education, 75*(4), 429–442. https://doi.org/10.1002/sce.3730750405

Okan, K. (1993). *Fen Bilgisi öğretimi. [Science teaching],* Ankara: Okan Publishing.

Özdemir, O. (2010). Fen ve teknoloji öğretmen adaylarının fen okuryazarlığının durumu. [The status of science literacy of science and technology teacher candidates], Journal of *Turkish Science Education,* *7*(3), 42-56. https://acikerisim.mu.edu.tr/xmlui/bitstream/handle/20.500.12809/5765/%c3%b6zdemir.pdf?sequence=1&isAllowed=y

Patton, M. Q. (2018). *Nitel araştırma ve değerlendirme yöntemleri*. [Qualitative research and evaluation methods], (M. Bütün ve S. Demir, Çev. Ed.). Ankara: Pegem Akademi.

Parhoon, K., Hassanzadeh, S., Parhoon, H., & Movallali, G. (2014). Educational needs assessment of students with hearing impairment in inclusive school. *International Journal of Academic Research in Progressive Education and Development*, *3*(2), 31-40. https://doi.org/10.6007/ijarped/v3-i2/910

Ponomarenko, E. P., Krasavina, Y. V., Zhuykova, O. V., & Serebryakova, Y. V. (2019). Specific features of intellectual and cognitive processes in hearing impaired students of technical university. *Special Psychology,* 673-679. https://doi.org/10.32343/2409-5052-2019-13-4-664-675

Belhan, Ö. (2012). *Bilim-fen ve teknoloji Kulübü'nün öğrencilerin fen ve teknoloji okuryazarlığı ve fene yönelik tutumlarına etkisi, [The effect of science-science and technology club on students' science and technology literacy and attitudes towards science],* Available from ProQuest Dissertations & Theses Global. (2700374031). Retrieved from https://www.proquest.com/dissertations-theses/bilim-fen-ve-teknoloji-kulübü-nün-öğrencilerin/docview/2700374031/se-2 Access Date: 23.08.2024.

Sözer, E. (1998). Sosyal bilgiler öğretiminde kullanılan araç gereçler, *Sosyal bilgiler öğretimi.* [Tools and equipment used in teaching social studies*, teaching social studies],* Gürhan Can (Ed.), Eskişehir: Anadolu University Publishing.

Yıldırım, A., & Şimşek, H. (2021). *Sosyal bilimlerde nitel araştırma yöntemleri.* [Qualitative research methods in social sciences*],* Ankara: Seçkin Publishing.

Author Biographies

Sema YİĞİT, studies in the Department of Mathematics and Science Education at Yildiz Technical University. While continuing her university education, she completed a TÜBİTAK project as a manager. Her research interests are science education and science activities.

Sema BULUT, studies in the Department of Mathematics and Science Education at Yildiz Technical University. While continuing her university education, she completed a TÜBİTAK project as a researcher. Her research interests are science education and science activities.

Assoc. Prof. Gülbin ÖZKAN, works as an Assoc. Prof. in the Department of Mathematics and Science Education at Yildiz Technical University. She completed her master's in Physics Education at Dokuz Eylul University and her doctoral education in Science Education at Yildiz Technical University. Her research interests are science education, STEM education, and science activities.