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Teaching Experiences of Science Teachers Working in Schools for the Visually Impaired

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Abstract

This study aims to determine the teaching experiences of science teachers working in schools for the visually impaired. In this context, the instructional arrangements made by the teachers for students with visual impairment in science lessons and the issues they had difficulties with were determined, and suggestions were offered for the effective and efficient implementation of science lessons. A phenomenological design was used in the study, and a sample consisting of 12 science teachers was formed. The interview form was used as the data collection tool, and content analysis was applied to analyse the data obtained. At the end of the research, five themes emerged: lesson plan, material, content presentation, teaching environment, and evaluation. It was determined those science teachers working in schools for the visually impaired made various instructional arrangements for students with visual impairment. In addition, it was determined that teachers had different problems within the framework of these five themes. Thus, some solutions were put forward to overcome these problems and conduct more effective and efficient science lessons. The results obtained were discussed within the scope of the relevant literature, and recommendations were given.

Keywords: Science Teacher, Students with Visual Impairment, Teaching, Instructional Arrangements

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INTRODUCTION

The main objectives of education include preparing individuals for life and enabling them to react to events in their daily lives. The contribution of science lessons is significant in achieving these goals because students can systematically examine nature and natural phenomena in science lessons (Costu, Unal & Ayas, 2007). To predict unobserved events, they can recognize their surroundings and develop appropriate reactions. To adapt to the world, they live in, they need to observe the environment, establish cause-effect relationships between events, and acquire the skills to reach results. In this context, for students to be beneficial to themselves, their families and society, they can be taught to examine their environment with scientific methods and develop correct thinking and make decisions in events/situations through science lessons (Kaptan, 1998). In other words, students can scientifically research the world they live in thanks to science classes (Carin, Bass & Contant, 2005; Tolman & Hardy, 1999). At the same time, they can be prepared for the future with their decision-making and problem-solving skills and improve their knowledge, understanding, skills, attitudes, and values with the science class (Topsakal, 2005). Science classes aim to raise individuals who can produce knowledge, use it in daily life, think critically, solve problems, be entrepreneurs, have strong communication skills, and contribute to society and culture (Ministry of National Education, 2018). Today, individuals are faced with many complex problems. Therefore, to overcome these problems, they need to acquire some skills and have 21st-century skills that provide a universal literacy framework (Akgunduz et al., 2015). Students must develop these skills, especially acquiring competencies in the science program (Bahar, Yener, Yilmaz, Emen & Gurer, 2018). In addition, the science course is at the top of the lessons in which these skills are taught, and it plays a key role (Yilmaz et al., 2008).

In today's world, where knowledge and technology are developing very rapidly, there is a need for individuals who have problem-solving and decision-making skills based on science and technology in every field. Therefore, science education is essential for each student. In this respect, it is necessary to provide all students with the knowledge, attitude, or skills required by the age, whether they have any disabilities or not. In short, science education is necessary for all students, and no discrimination should be made on gender, culture, disability, etc. (Topsakal, 2005). In this context, science lesson has an important place in the education of students with visual impairment and all students. Students with visual impairment may have limitations in learning processes and cognitive development due to reasons arising from their lack of vision (Sozbilir et al., 2017). Therefore, they may experience more difficulties than their peers who study, especially in courses requiring field knowledge (Kandaz, 2004). In particular, they may have more problem in science lessons where visual information is used extensively (Karakoc, 2016). In addition, the science curriculum contains a large number of abstract topics, concepts, or knowledge. This situation may cause students with visual impairment to have difficulties in science classes (Lang, 1983; Zorluoglu & Kizilaslan, 2019). Students with visual impairment need more concretization to access abstract contents in science classes (Gursel, 2011; Tuncer, 2005). In other words, the presentation of content and the use of materials to be prepared by considering the readiness of students with visual impairment are crucial for them to gain more experience.

Researchers argue that students with visual impairment need a rich environment to gain diverse and continuous experiences and opportunities to learn by doing and living (Koenig & Holbrook, 2000; Lowenfeld, 1974). It is estimated that sighted students learn about 85% of their academic, social, and functional skill areas through the sense of sight (MasCuspie, 1992). Therefore, unique methods and techniques are needed in the education of students with visual impairment (Koenig & Holbrook, 2000; Lowenfeld, 1974). For example, students with visual impairment need to use their remaining senses other than sight to systematically explore the contents of science classes. In addition, students with visual impairment need to learn, primarily through tactile and auditory means (Lowenfeld, 1974). In other words, they need tactile and auditory materials and visual materials to participate effectively in educational activities (Yalcin & Kamali Arslantas, 2020). Accordingly, it can be said that it is essential for science teachers to make some adaptations in the materials or course contents to enable students with visual impairment to access the curriculum (Zorluoglu, Sozbilir &

Kizilaslan, 2016). Science teachers should choose appropriate teaching activities and use proper materials or make some adaptations in materials (Cavkaytar & Diken, 2012; Sozbilir, Gul, Okcu, Kizilaslan, Zorluoglu & Atilla, 2015). Adapting the materials or content delivery used for students with visual impairment means that these students have a great chance to achieve academic success (Rooks, 2009). From this perspective, we can say those science teachers who carry out teaching activities for students with visual impairment are of critical importance.

In Turkey, the same curriculum is applied to students with visual impairment and their sighted peers (Cakmak, Yilmaz & Isitan, 2017; Sozbilir et al., 2017). This situation is also valid for the science program. Science lessons are carried out by the in-field teachers who graduated from the relevant field. Even though it is a school for the visually impaired, in-field teachers give science lessons. Therefore, science teachers who work with students with visual impairment have essential duties because making instructional arrangements for students with visual impairment is directly under the teacher's responsibility to conduct the lesson (Yalcin, 2020). For example, these responsibilities include the adaptation of the content, appropriate teaching materials, the use of different teaching methods and techniques, or assessment and evaluation. However, we should also point out that although science teachers have many responsibilities, they are equally likely to have difficulties. Science teachers receive a general education during their college education, and therefore they lack the idea of adapting the content for students with visual impairment (Fraser & Maguvhe, 2008). When the curriculum of the universities that train science teachers in Turkey is examined, there is a lesson called "special education and inclusion" (Council of Higher Education, 2018). The lesson's content in question generally includes special education subjects and students with visual impairment to a limited extend. Accordingly, it can be said that science teachers have limited knowledge about students with visual impairment. This situation will cause science teachers assigned to schools for the visually impaired to feel ineligible and have difficulties in teaching activities. Islek (2017) states that the in-field teachers working in the school for the visually impaired are assigned without any special training; they consider themselves inadequate in the education of students with visual impairment and that there are fundamental problems in academic lessons. According to Yazici (2017), science teachers are hesitant about science lessons with students with visual impairment and generally prefer verbal expression. Based on this, we can state that science teachers working with students with visual impairment should be supported to teach effectively. Kumar, Ramasamy & Stefanich (2001) says that teacher training is an effective way for more accessible science education. They also suggest that teachers should be taught how to teach science to students with visual impairment through in-service training activities.

In the literature, there are studies about the experiences of educators working with students with visual impairment. When these studies are examined, Erwin, Perkins, Ayala, Fine & Rubin (2001) investigated teachers' experiences regarding how students with visual impairment were supported in natural learning environments with a structured curriculum and adapted materials. Researchers stated that science teaching should be presented to students with visual impairment with a multi-sensory approach to obtain positive benefits about tactile and auditory interactions. In a similar study, Fraser & Maguvhe (2008) examined the experiences of science teachers working with students with visual impairment. According to the research results, it was determined that using teaching plans designed or adapted for students with visual impairment increased the success of these students in science class. Using the mixed method, Islek (2017) examined the views of 13 educators and 12 students with visual impairment and compared their experiences in the context of the academic program and expanded core curriculum applications. It was revealed that teachers had difficulties in lessons or subjects with visual content. In another study, Kumar et al. (2001) analyzed science teachers' policy implications for teaching, alternative assessment, educational technology, and adaptations for students with visual impairment. According to the research results, it was suggested to use natural objects so that students with visual impairment can feel by touching, allowing them to explore some subjects in natural environments and provide hands-on learning experiences. In the research conducted by Wild & Allen (2009), a political analysis of science-based best practices for students with visual impairment was conducted. Researchers demonstrated that using a curriculum designed or adapted for students with visual impairment increases the success of these students in science and that science teacher should be well supported. Zorluoglu et al. (2016) examined the views of academicians on the creation of scientific literacy in students with visual impairment. According to the research results, it was emphasized that activating the senses other than sight was effective in teaching concepts to students with visual impairment and increased success. The present study is essential in determining the difficulties faced by science teachers working in schools for the visually impaired and finding solutions based on their experiences. In addition, it is considered necessary in terms of revealing the instructional arrangements to be made in the teaching of science lessons to students with visual impairment. The results obtained from this study can provide important information about revealing the necessity of revising the content of the special education and inclusion course in the science teaching undergraduate program. On the other hand, the research findings may help science teachers who are or may work with students with visual impairment to develop their opinions. In addition, it is thought that it will support the limited number of studies conducted in the literature on science teachers working with students with visual impairment and contribute to the knowledge. This framework aimed to determine the teaching experiences of science teachers working in schools for the visually impaired. For this purpose, it was aimed to find solutions for the instructional arrangements made by teachers for students with visual impairment in science classes, the subjects they have difficulties with, and the effective and efficient conduct of science lessons.

METHOD

Research Design

Phenomenology, one of the qualitative research methods, was employed in the study. The phenomenological model is aimed to reveal the perception, experience and meanings that individuals attribute to an event based on real experiences (Yildirim & Simsek, 2014). In this study, the phenomenological research model was chosen as it was aimed to examine the teaching experiences of science teachers working in schools for the visually impaired in depth.

Participants

Participants of the study consisted of science teachers working in schools for the visually impaired. According to the Ministry of National Education (2020) official statistics, there were 18 schools for the visually impaired in Turkey in the 2019-2020 academic year. In this context, it was aimed to reach the entire scope of the study in the research, so no sample selection was made. Five of the science teachers working in these schools stated that they did not want to participate in the study, and one was not included in the sample due to his health condition. For these reasons, 12 science teachers were included in the study sample, three of whom are male, and nine are female. The ages of the participants vary between 30 and 60, with an average of 42.5. While two participants have a Master’s degree, the remaining 10 participants have Bachelor’s degree. The average teaching experience of the participants is 17.7 years (Min: 9, Max: 29) and the average duration of teaching at the school for the visually impaired is 9.9 years (Min: 3, Max: 22). Detailed information about the participants is presented in Table 1.

Table 1. Characteristics of the Participants

Code	Gender	Age	Education Status	Total Teaching Experience (year)	Teaching Time at the School for the Visually Impaired (year)	Interview Date	Interview Duration (minute)
T_1	Female	40	Bachelor	19	8	26.02.2021	19
T_2	Female	32	Bachelor	9	5	27.02.2021	15
T_3	Female	52	Bachelor	26	10	28.02.2021	15
T4	Female	34	Master's	13	9	29.02.2021	24
T_5	Female	33	Master's	9	6	01.03.2021	15
T_6	Male	42	Bachelor	17	3	06.03.2021	22
T_7	Male	48	Bachelor	22	18	01.03.2021	25
T_8	Female	56	Bachelor	23	15	05.03.2021	18
T_9	Female	60	Bachelor	29	15	07.03.2021	26

T_{10}	Male	40	Bachelor	15	4	08.03.2021	15
T_{11}	Female	44	Bachelor	22	22	09.03.2021	19
T_{12}	Female	30	Bachelor	9	4	12.03.2021	15

Data Collection Tool

The interview form consisting of two parts was developed and used as a data collection tool in the study. The first part aims to gather information about the participants and includes gender, age, education status, total teaching experience, and teaching time in a school for the visually impaired. In the second part, there are open-ended questions to determine the teaching experiences of science teachers. The questions were designed so that teachers' instructional arrangements for students with visual impairment in science classes, the subjects they had difficulties and suggestions for the effective and efficient conduct of science lessons were obtained. In the development of the interview form, the literature was first reviewed by the researchers and draft interview questions were prepared (Batmaz, 2017; Cay & Yikmis, 2020; Korkmaz Ersan & Sonmez-Kartal, 2020; Kot, Sonmez, Yikmis & Ciftci Tekinarslan, 2015; Metin & Altunay, 2020; Vural & Yikmis, 2016; Yonter, 2009; Zorluoglu et al., 2016). Draft questions were organized to serve the research purpose. Then, expert opinion was taken to evaluate the questions regarding their suitability for purpose, clarity, and comprehensibility. Expert opinions were also received through a form. Along with this form, interview questions were sent to seven field experts with a doctoral degree via e-mail, and they were asked to evaluate the interview form. Four of them are field experts in science teaching to the visually impaired, two in general science teaching, and one in qualitative research. Experts conveyed their evaluations to the researchers via e-mail. Arrangements were made in the interview form, taking into account the opinions and suggestions received. In addition, some questions suggested to be changed were corrected, and expert opinion was sought again. In the last stage, a pilot interview was conducted with a science teacher who was not among the study participants but had experience working with students with visual impairment. After this meeting, a change was made in one item to make it more straightforward.

Data Collection

The researchers completed the data collection process of the research in the 2020-2021 academic year. We conducted interviews with science teachers between the dates of 26.02.2021–12.03.2021. Since the participating teachers were in different cities, time and cost concerns, and the COVID-19 pandemic, which is particularly intense in our country, the research data were collected online via Zoom. Firstly, the teachers were reached by phone and information was obtained about whether they could participate in the study or not. An appointment was made for online interviews with the teachers who agreed to participate in the study. On the day and hour of the interview, the relevant teachers were invited to the interview by sending a Zoom link. Both researchers conducted interviews with participants. Before starting the interview, teachers were informed about the purpose and scope of the research and permission was asked to record the interviews. Teachers were assured that their personal and school information would be kept confidential, that codes would be used instead of real names in the study, and a participant consent form was used for this. The researchers interviewed each teacher one-on-one, and each interview took an average of 19 minutes (Min: 15, Max: 26). The researchers recorded all interviews. At the end of the meeting, the interviews were concluded by thanking the teachers for their participation.

Data Analysis

The researchers used the content analysis technique in the analysis of the data. Content analysis is defined as an effective method in classifying and comparing texts to make theoretical inferences (Cohen, Manion & Morrison, 2007). In this context, the opinions of science teachers who took part in the study were analysed in detail. Some themes and sub-themes were reached as a result of the analysis. These themes are presented under the headings of instructional arrangements made by science teachers for students with visual impairment, issues they have difficulties with, and solution suggestions for the effective and efficient conduct of science lessons. The authors coded the interviews, and the themes reached were agreed upon. Different views were resolved through discussion. The themes obtained were supported by quoting some of the teachers' responses. In addition, the results obtained were shared with the teachers and participant confirmation was received.

FINDINGS

The findings of the interviews with science teachers, as obtained from the content analysis, are presented under five themes: a) Lesson plan, b) Material, c) Content presentation, d) Teaching environment, and e) Evaluation. The instructional arrangements made by science teachers regarding these themes, the issues they have difficulties with, and the number of teachers' who gave opinions were also included.

Theme 1: Lesson Plan

The opinions of science teachers working in schools for the visually impaired about the lesson plan are presented in Table 2. Units of analysis consisted of six components.

Table 2. Opinions about the Lesson Plan

Instructional Arrangements	Challenging Issues	Solutions for Effectiveness
Creating your own plan. (3) Making plans for the needs. (2)	Plans are inefficient. (1)	The program for the visually impaired should be changed. (6) Lesson hours should be increased. (2) Group meetings should be held separately. (1)

When science teachers' opinions about the instructional arrangements they make in the lesson plan for students with visual impairment are examined, it was determined that teachers created their programs or made plans according to the needs (n=2). T_9 said, *"I apply the plans I have created myself."* and T_8 said, *"We need to make a separate plan for our students."*

Only one teacher (T_{11}) stated that the plans were inefficient regarding the subjects they had difficulty, and said, *"The planning in the lessons is inefficient."*

Science teachers focused more on changing the curriculum for the students with visual impairment for the effectiveness of lesson plans. The following statements can exemplify opinions on this subject: *"In order to be more successful, there must be some changes in the curriculum. We shouldn't be forced to complete the units. Different things can be done. It can be more efficient if different subjects are put."* (T_8); *"The gains must be optional. Some revisions can be made in the acquisitions. It can be screening, sorting, or converting to a different size. The program should be reevaluated for students with visual impairment."* (T_1); *"My suggestions are that the annual plans should be different for us. Not every subject should be told to children."* (T_3).

Opinions were expressed that the course hours should be increased as an effective solution. On this issue, T_7 said, *"For the students with visual impairment, at least two more hours should be given for the laboratory or lesson. It should be 6 hours, not 4 hours."*; T_{12} said, *"The lesson hours can be increased for the students with visual impairment to be able to do activities because it takes at least 10 minutes for us even to enter the lab. It is troublesome in terms of time to go there together, examine the items there and explain how we can use them."* T_9 stated that the meetings should be held separately and said, *"We organize the group meeting. But it should not be with the school near us. We should do it with the other school for the visually impaired. What normal schools do does not match ours."*

Theme 2: Material

The opinions of science teachers working in schools for the visually impaired on the use of materials are summarized in Table 3. Units of analysis consisted of 13 components.

Table 3. Opinions on the Use of the Material

Instructional Arrangements	Challenging Issues	Solutions for Effectiveness
Preparing teacher-made material. (11) Using tactile material. (7) Using ready-made material. (3) Preparing materials with students. (2) Choosing the right material for the plan. (2)	Inadequate material. (9) Not getting enough support from the state. (3) Material preparation takes a lot of time. (3) The material is not durable. (2)	Sufficient material should be provided. (11) Materials for the student with visual impairment should be used. (3) Materials must have a standard. (3) Technology should be used. (3)

When the opinions of science teachers about the instructional arrangements they make about materials for students with visual impairment were examined, it was seen that almost all of the teachers stated that they prepared materials (n=11). More than half of them used tactile material (n=7). One of the teachers who stated that he prepared teacher-made materials, T_{12} said, *"I mostly prepare the materials myself."*; T_8 said, *"I am trying to make materials."*; and T_4 said, *"I am making my materials myself."*. The opinions of teachers who use tactile materials can be exemplified as follows: *"I attach importance to tactility in materials."* (T_2); *"There is a cardboard, a material called Eva, I made things out of felting to activate them to touch. For example, I made a periodic table. I wrote in braille."* (T_4); *"I prepare the materials by creating textures with silicones and Eva papers."* (T_{12}).

In addition, some teachers stated that they used ready-made materials, included students in the material preparation process, and selected materials suitable for the plan. Commenting that he used ready-made materials, T_3 said, *"Materials come from various places. We distribute them."*; T_4, who prepared materials with the students, said, *"I get help from my students, I make it with them."*, and T_2 said, *"I arrange the materials according to the plan."*

Material inadequacy was emphasized as the most challenging situation by science teachers. The following statements can exemplify this situation: *"The material prepared as braille in our school is minimal."* (T_1); "*Our materials are very limited, almost non-existent. We have many problems with equipment. We have almost nothing at school."* (T_2); *"Our material is incomplete."* (T_6); *"There is not much material in our school."* (T_7). Expressing that they could not get enough support in addition to the lack of material, T_2 used the following statement: *"Unfortunately, our government does not give much support."* Another factor that teachers have difficulties with regarding material is the time allocated to prepare the material. T_5's statement, *"It takes time to prepare the materials related to the lesson."* is an example of the difficulty experienced. However, another challenge is that the prepared materials are not durable. This difficulty was expressed by two teachers as follows: *"The child does not know, when touched hard, the material breaks immediately. I can't use it on a second child. Sometimes it gets harmed quickly. I can't use it later."* (T_2); *"We can only use what we have made. There is no more material that we can use for the second time."* (T_7).

Almost all of the teachers (n=11) emphasized that adequate material support should be provided. In this regard, T_1 said, *"You cannot use a single instrument in a classroom. The material should be used more or less for each student or a specific person and individually."*; T_5 said, *"It would be great if material support was provided to us to make the lesson more effective. Our job would also get easier. It might be better if ready-made tools and equipment for the students with visual impairment are brought to us."* and T_8 said, *"The number of our materials should be increased."* Five of the teachers stated that in order to conduct effective and productive lessons, materials suitable for the students with visual impairment should be used. T_1's statement can exemplify this situation: *"For students with visual impairment, certain materials must be available, designed, and produced suitably for certain gains."* In addition, some teachers stated that the materials used should have a standard. For example, T_1 made the following statement on this subject: *"There must be a standard. For example, while explaining the subject of pressure, there should be a standard for the material that it must be designed to use while explaining the fluid pressure to that student."* Finally, teachers' opinions on making use of technological materials were obtained.

Theme 3: Content Presentation

The opinions of science teachers working in schools for the visually impaired on content presentation are given in Table 4. Units of analysis consisted of 21 components.

Table 4. Opinions on Content Presentation

Instructional Arrangements	Challenging Issues	Solutions for Effectiveness
• Utilizing the sense of touch. (12) • Describing the content. (10) • Doing the activity even if they do not see it. (8) • Learning by doing/experiencing. (8) • Using animation/models. (8) • Dealing with each student individually. (5) • Using different teaching methods. (5) • Using the senses other than sight. (2)	• Having difficulty in some topics. (9) • Abstractness of the course content. (8) • Inability to benefit from visual content. (6) • Inability to do all activities. (5) • Inability to complete the curriculum. (3)	• Different teaching methods and techniques should be used. (4) • Teachers at school for the visually impaired should be trained. (4) • Teachers should improve themselves. (4) • Topics should not be skipped. (2) • Should be adjusted to the level of student. (2) • A special teacher should be selected for the school for the visually impaired. (2) • Content should be concretized. (1) • Teacher should make student love the lesson. (1)

When Table 2 is examined, it is seen that various instructional arrangements have been made for students with visual impairment regarding the content presentation. All of the science teachers participating in the study (n=12) stated that they used the sense of touch while transferring the course contents. About this issue, T_2 said, *"We teach the students with visual impairment by making them touch all the time. If the child does not touch, he definitely cannot understand."*; T_3 said, *"We use one-to-one teaching method by touching."*, and T_4 said, *"I explain the subject by making the student touch it. I make the students touch everything. There is nothing in our lab without fingerprints."* In addition to touching, the majority of teachers (n=10) describe the content. Quotations from teachers' statements regarding the description are as follows: *"We carry out experiments based on seeing by describing them. For example, the temperature in the thermometer beaker is increasing; it is now 60 degrees. I'm describing by saying -the temperature is rising, it is in eighty.-"* (T_1); *"We make verbal descriptions for the students with visual impairment. It is necessary to vocalize a voltmeter. If there is an event, we need to describe it. In a way that the student will understand. For example, if it is an issue with electricity, electricity issues the devices speak, that is, it measures volts, but by having it tell 5 ml or 3 volts."* (T_7); *"I'm describing the experiments to them. I describe it as this is done like this."* (T_{12}). Two teachers stated that senses other than sight were used. Opinions on this subject are, *"We conduct experiments in a way that appeals to other sensory organs other than vision. Planning is done in a way that it appeals to other senses."* (T_1); *"The main point is how we can explain the subject of science in relation to the four senses when one sense is missing. While teaching the concepts in science to the students with visual impairment, we try to appeal to the four senses. This is the most fundamental point I see. If we appeal to all the senses, we will make learning easier. For example, we cannot realize learning when the student does not touch, does not smell, and cannot examine different shapes with his hand."* (T_{10}).

Some of the teachers stated that they used different teaching methods and techniques while presenting the course content. T_4 said, *"I try to teach everything by making drama and gamification. I make up too many stories. As if I was living in my daily life. They are also laughing and having fun. I try to set the subject in their minds with the stories"*; T_8 said, *"We try to solve it by playing games and dancing"* However, most teachers emphasized that they practice learning by doing/experiencing (n=8) and using animation/models (n=8). Expressing that he used knowledge by doing/experiencing, T_2 said, *"We mostly practice doing and living. We have the lesson with continuous activities."*; T_{10} noted, "*For example, you will explain the concept of force. How can we explain this by doing and living? For example, we need to give the concept of direction so that we can take our student and explain the properties of the force. We have to give the effect, the reaction by touching, pulling and pushing. We have to show it by doing and living. It's like pushing and lifting a row."* One of the teachers who used animation/modelling applications in the content presentation, T_1, said, *"Animation or working on a model is done in a way that supports that acquisition."*; T_7 said, *"Since science is a lesson about* *nature, you need to model it. This situation attracts both the attention and interest of the student."*; T_{10} said, *"We explain the concepts through modelling."*; T_{12} said, *"I always explain the systems through body models. While I am describing the states of matter, I press them close. Solid particles are like this, I say, and I decompose a little more in liquid. In gas, they are both mobile and separate; I mean, I try to involve students."*

Most of the teachers (n=8) stated while presenting the course contents. They do the activities even if students do not see them. For example, T_1 said, *"The student does not see, but I still experiment in the classroom."* Regarding the adaptations, T_4 said, *"I especially introduce the microscope in science applications. I introduce the lamella. But I try to get people with low vision to find images. Even if he sees little, he cannot see; he says, 'I saw it, there is something there, teacher'. I also say 'yes, right. There is. It looks like a square, like a rectangle, right?' I do these kinds of applications to motivate students with low vision."* and T_8 said, *"For example, we mix water and olive oil. Oil stays on top. I see this. The child does not see. What is happening? The child keeps this in mind. Or we mix water with salt. It evaporates. There's salt left in the bottom of the bowl, I say. It feels like I'm stirring, lighting the stove. He feels the salt remaining at the bottom by touching it with his finger. He says there is salt left. We are trying to make such adaptations."* In addition to these, five of the teachers stated that they took care of each student individually while carrying out the activities. Example expressions on this subject are as follows: *"I start with the student in the first row, go one by one, I do the study one by one until I get to the last student."* (T_1); *"Since the number of students is small, you always have the chance to work individually."* (T_4); *"Since I have few students, we are in one-to-one communication. I call the children one by one in each process."* (T_5).

Science teachers emphasized that they had difficulties, especially in some topics. While these topics are shown in Figure 1, the opinions of the teachers are as follows: *"Topics related to light and reflection. It is complicated to adapt these topics to them. For example, colours, a third colour that emerges from the combination of two colours, is very memorable."* (T_1); *"I have a hard time in simple machines, heat and temperature issue. Students have a hard time understanding the size of the planets. They have difficulty understanding the distance of the moon to the world. They can't understand spatial things."* (T_2); *"We are having a hard time with light. I have trouble explaining the subject of colour."* (T_3); *"The most problematic issue is the light. Absorption of light, the formation of colours, the laws of reflection, shadow formation are the issues that I have difficulty with. We're talking about simple machines, but we're having trouble."* (T_8).

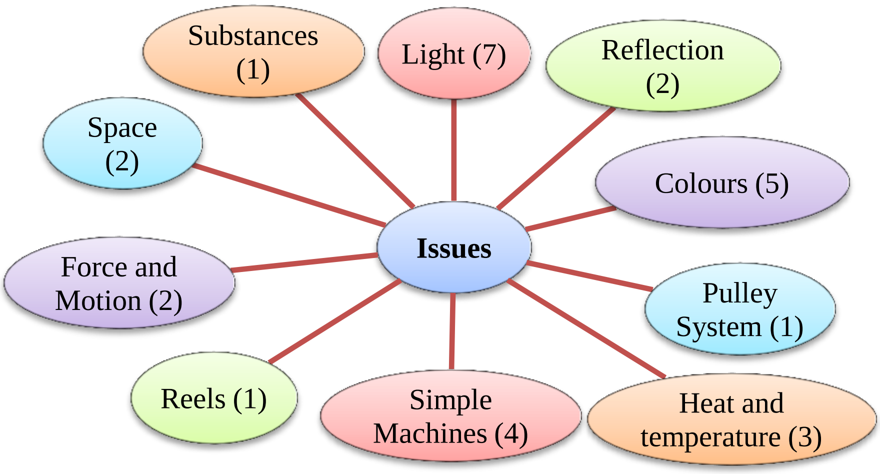

Figure 1. Issues that Teachers Have Difficulty

The teachers stated that they had difficulties due to the abstract nature of the course content. In this regard, T_1 said, *"Some of the achievements remain very abstract, and it is a little difficult to teach. It is not even a little, it is quite a problem."* and T_7 said, *"It is difficult to explain abstract things to students with visual impairment."* However, while teachers emphasized that visual content could not be used, T_7 said, *"It is difficult to explain the subject. We are teaching a simple subject, but what is easy for sighted ones is difficult for the students with visual impairment. There is some difficulty in science because there are no things to see for the students with visual impairment."* Because of these situations, it is seen that teachers do not carry out all the activities in the content and cannot complete the curriculum. T_3's statement, *"Of course, we cannot do some experiments. Our students with visual impairment cannot do some experiments."* This can be given as an example of this situation. Teachers' failure to complete the curriculum is associated with short course hours. Opinions on this subject are as follows: *"Time is insufficient for students with visual impairment. In addition, it is not good to have to do the same activity with each of them while the process continues in terms of using Time efficiently. It takes a lot from the lesson."* (T_1); *"General theoretical knowledge in science. When there is no material while explaining the non-theoretical, we have difficulties in practice. The normal curriculum cannot be conducted in 4 hours. It is not possible to complete the topics."* (T_7); *"Four lessons are not exactly enough."* (T_{12}).

The solutions offered by teachers to conduct effective and efficient lessons for students with visual impairment vary. For example, it is recommended to use different teaching methods and techniques to present the content. T_4 said, *"It is necessary to use the drama method."* Stating that the subjects should not be skipped for students with visual impairment, T_1 said, *"All should be done without skipping. One cannot say that it is unnecessary because they do not see."*; T_{11} said, "*It is useful to do all activities for students with visual impairment."* In addition, opinions were obtained regarding the need to adjust the lesson to the students' level and concretize the content. Statements on this subject can be exemplified as follows: *"Students with visual impairment can be distracted very quickly. It is important to be able to determine their needs well. It is necessary to benefit from the experiences of their daily lives. We should adjust to the level of the student."* (T_4); *"The activities we will do should be adjusted to the level of the student."* (T_{10}); *"I think the experiments done should be made morwere donencrete."* (T_{11}).

Another component that teachers offer as a solution is related to the teachers who teach the lessons. Accordingly, it was found that the teachers working in the school for the visually impaired should be trained, specially selected, and they should improve themselves. For example, T_2 said, *"Science teachers must be supported or trained."*; T_9 said, *"Students with visual impairment should receive an education. The teacher needs to be trained. It should take at least one year of training. The teacher who will come here should pass the course."*; and T_{11} said, *"Science teachers need to be supported with workshops and support training."* T_9 suggested selecting teachers who will work in schools for the visually impaired by saying, *"The teacher who will work here should be a chosen one."* Finally, it was seen that there were suggestions for teachers to improve themselves. On this subject, T_4 said, "*The primary condition for the development of our students is that teachers should improve themselves."*

Theme 4: Teaching Environment

The opinions of science teachers working in schools for the visually impaired on the teaching environment are shown in Table 5. Units of analysis consisted of five components.

Table 5. Opinions on the Teaching Environment

Instructional Arrangements	Challenging Issues	Solutions for Effectiveness
• Use of different environment. (3) • Organizing the environment according to the course content. (3) • Using U-Shape pattern. (1)	• Small classrooms. (1)	• Lessons should be conducted in the lab. (1)

When the opinions of science teachers about the instructional arrangements made in the teaching environment for students with visual impairment are examined, it is seen that the teachers use different settings (n=3), arrange the environment according to the course content (n=3), and use the U-Shape (n=1). T_4 said, *"I prefer to use the garden. I used the school's conference room in freezing weather.";* T_{12} said, *"We did experiments related to pressure in the open air."* According to the course content, one of the teachers who arrange the environment according to the course content, T_1 said, *"I prepare a learning environment according to the needs."*; T_2 said, "*I set the classroom environment according to the lesson. For example, I say, 'consider the classroom like the sun. I bring a walnut and say think of it as the world."* Only one teacher expressed the view that the classroom was small and said, *"We had a hard time because our classes are tiny."* (T_4). As a solution proposal for the teaching environment, a teacher gave his opinion and stated that the lessons should be taught in the laboratory. His view is as follows: *"Science laboratories must be mandatory in schools. It would be much better if the lessons could be taught in laboratories more."* (T_{11}).

Theme 5: Evaluation

The opinions of science teachers working in schools for the visually impaired regarding the evaluation process are presented in Table 6. Units of analysis consisted of 15 components.

Table 6. Opinions on the Evaluation Process

Instructional Arrangements	Challenging Issues	Solutions for Effectiveness
• Teacher reads the questions. (9) • Students write the answers. (7) • Use of technology. (5) • Not asking visual questions. (4) • Preparation easy questions. (4) • Braille exam preparation. (4) • Getting help from a teacher who knows braille. (3) • Having another studunt read the answers. (2)	• Student performances are not the same. (7) • Exams take a long time. (5) • Parent factor. (5) • Problem of preparing questions and reading answers. (4) • Difficulty with questions with visual content. (3)	• Arrangements should be made according to exams. (8) • Alternative assessment should be used. (2)

The instructional arrangements made by science teachers during the evaluation process vary. For example, in the evaluations, it is seen that the questions are read by the teacher (n=9) or braille exams are prepared (n=4). As an example of the views that the teacher read the questions, the following comments were made: *"I am reading the questions."* (T_1); *"I read the papers, I read the question and the options."* (T_2); *"I'm reading the questions. I read it three or four times until the students answer within a certain time."* (T_4); *"I'm reading the questions to the children."* (T_5). The opinions of teachers who prepare braille exams are as follows: *"We have a printer with braille alphabet. There, questions can be printed out."* (T_3); *"Exams are in braille. We prepare on Word and take a printout from the printing machine in our school and deliver it to our students."* (T_8).

While preparing the evaluation questions, teachers try not to ask visual questions (n=4) and prepare easy questions (n=4) for visually impaired students. In this regard, T_8 said, *"Our questions are not visual.";* T_{10} noted, on the other hand, *"They are exempt from the shape questions in evaluation."* T_3 said, *"I usually ask about the writings from the book."* Again, different applications were encountered on the subject of receiving students' answers and reading these answers. More than half of the teachers receive the answers by asking students to write them. Their views can be exemplified as follows: *"Students take their braille tablets and pens and write."* (T_4); *"They have devices. They put on their headphones. They solve the questions. Or their typewriters are in front of them. They use their braille typewriters."* (T_1). In reading the answers, the practices of having another student read the answers and getting help from a teacher who knows braille were observed (n=2). Regarding having another student read, T_3 said, *"I ask a student with visual impairment to read the question. I write down the answers. I score the student accordingly."* Opinion of T_8, who stated that he received help from a teacher who knew braille, is as follows: *"I ask the visually impaired teachers in our school. In our spare time they read to me and I score."*

The most challenging issue for teachers in the evaluation process is that student performances are not the same. Seven teachers emphasized this situation, and their opinions are as follows: *"In our school, there are children who do not know braille and cannot learn because of their mental processes. Some do not have perfect intelligence. Some students say they cannot read the article they have written themselves."* (T_2); *"Each student's capacity is different. If there are six students in the* *class, there are three levels. Their perceptions are different. For two students, everything can be solved by speaking normally, but nothing works for two of them."* (T_8). Another problem is that the exams take a long time. On this subject, T_5 said, *"There are usually two lessons allocated for exams."* T_7 said, *"Sometimes it takes 20-25 minutes for a question. Since the science lesson is 4 hours, it is a serious process when you think that we should complete the topics to be taught."* The issue of preparing questions and reading the answers is also seen as a problem by science teachers. For example, T_3 said, *"They have difficulties in such questions with graphs because they cannot read them."*; T_1 said, *"When you prepare even a short question in braille, it can take a couple of pages, especially for new generation questions."*; and T_4 said, "*We also have problems in reading the answers."*

Science teachers put forward two suggestions to make the assessment process more effective and efficient. These are the use of alternative assessment and making arrangements for exams. T_7 offered an alternative evaluation: *"Exams are not correct measurement methods, mostly alternative evaluations are required. However, we have exams out of necessity. I think it would be more useful to do things such as maybe making observations and evaluating without the student noticing."* Other views can be cited as an example for the arrangements for exams: *"The Ministry needs to make serious regulations in exams. There are huge grievances."* (T_1); *"Highly visual questions should be removed from the curriculum."* (T_2); *"Questions with shapes should not be asked."* (T_5); "*Exam questions must be separate. We should also ask for visuals. Central exams are a problem."* (T_6).

DISCUSSION

This study aimed to determine the teaching experiences of science teachers working in schools for the visually impaired. For this purpose, 12 science teachers were interviewed. As a result of the interviews, the instructional arrangements made by the teachers for the students with visual impairment in science lessons, the issues they had difficulties and their suggestions for the effective and efficient conduct of science lessons were revealed. These were discussed within the scope of the lesson plan, material, content presentation, teaching environment and evaluation categories.

Students with visual impairment in Turkey follow the same program as the students in a science lesson like other curriculum programs (Cakmak et al., 2017). Therefore, it can be said that there is no difference between the education programs applied to the students with visual impairment and their sighted peers by the principles of equality and normalization in education (Sozbilir et al., 2017). However, this situation can ignore the learning needs of students with visual impairment. As a result of the opinions obtained within the scope of this research, it was determined that the lesson plans of science teachers were insufficient and that they prepared their plans or made plans according to the needs. In addition, teachers stated that they could not complete the science curriculum and related this to the limited number of hours and the individual attention paid. Accordingly, it can say that the science curriculum applied to students with visual impairment results in some limitations. In addition, it is thought that this situation may affect the efficiency of science lessons. Science teachers who participated in the study emphasized the need to change the students with visual impairment program and increase the lesson time. Regarding changing the curriculum, the teachers drew attention to not covering every unit in the curriculum, the need to simplify or reorganize the outcomes, and argued that more successful and effective lessons would be conducted in this way. It was stated that using teaching plans designed or adapted for students with visual impairment increases the achievement of these students in science lesson (Wild & Allen, 2009) and facilitates their learning (Fraser & Maguvhe, 2008).

Students with visual impairment cannot learn as efficiently as other students in lessons that require content knowledge, especially in science lessons with intensive visual information (Kandaz, 2004; Karakoc, 2016). Science lessons include a large number of abstract topics, concepts, and communication. This situation may cause students with visual impairment to have difficulties in science classes (Lang, 1983; Zorluoglu & Kizilaslan, 2019). At the same time, science teachers working with students with visual impairment are likely to have difficulties. It was determined that the teachers who participated in the study had difficulties in some subjects such as light and colour together with the abstract course contents. Therefore, it should not be considered surprising that science teachers working with students with visual impairment have difficulties while teaching abstract topics or concepts. Students with visual impairment may have limitations in learning and cognitive development due to several reasons arising from their lack of vision (Sozbilir et al., 2017). While this situation may restrict the students' observation skills, it can also deprive them of the opportunity to examine visually, mainly because they cannot see what they are dealing with (Fraser & Maguvhe, 2008). In addition, it can limit the use of visual content by science teachers working with students with visual impairment. Findings supporting this statement were found in the research. For example, in this study, it was determined that teachers could not benefit from visual content and could not do all activities in this direction. Coinciding with these findings, in Islek's (2017) study, it has been revealed that teachers have difficulties in lessons or subjects with visual content. Accordingly, it can conclude those science teachers have problems presenting visual content to students with visual impairment. Sozbilir et al. (2017) emphasize that they should make various adaptations in teaching method, environment, and material usage to overcome the difficulties encountered. Considering that there is no separate science program for students with visual impairment in Turkey, some instructional arrangements should be made for these students in science lessons. For example, studies of concretizing knowledge, associating the acquired knowledge with daily life, creating learning environments by doing and experiencing and making sense in mind can be done (Aslan & Savas, 2020). This study determined that science teachers working in the schools for the visually impaired included various instructional arrangements. Some of these arrangements involve utilizing the sense of touch, using other senses other than seeing, using animation/modelling/using living learning activities, and describing the course contents. For students with visual impairment, giving information orally is not enough, but education should be supported with appropriate materials and activities such as trips and observations. Supporting this view, for example, Kumar et al. (2001) suggests using natural objects so that the student can feel by touch, allowing them to explore some subjects in natural environments and provide hands-on learning experiences. Erwin et al. (2001) explain that science teaching to students with visual impairment should be presented with a multi-sensory approach to achieve positive benefits such as tactile and auditory interactions. Zorluoglu (2019) states that activating the senses other than sight is effective in teaching concepts to students with visual impairment and increases success. In this context, it can say that the suggested practices in the literature are similar to the findings obtained from the present research.

Science lessons in Turkey are conducted by teachers who are graduates of the field. Therefore, making the instructional arrangements for students with visual impairment directly influences the teacher's responsibility to operate the lesson (Yalcin, 2020). In this regard, science teachers working at the school for the visually impaired have essential duties. However, science teachers working in these schools receive a general education in universities. Thus they are deprived of the idea of adapting content for students with visual impairment (Fraser & Maguvhe, 2008). Therefore, although they may be hesitant about their science lessons with students with visual impairment, they may prefer to teach the lessons verbally (Yazici, 2017). In the research conducted by Islek (2017), it was determined that the in-field teachers working in schools for the visually impaired were assigned without any special training, they found themselves inadequate in the education of students with visual impairment, and there were significant problems in academic lessons. In this respect, it is stated that teacher education is an effective way to make science education more accessible for students with visual impairment. In addition, teachers should be equipped with science teaching methods for students with visual impairment through special workshops, and teachers should make every effort for practical science lessons (Kumar et al., 2001). Similarly, in this study, suggestions were made by science teachers to train teachers and improve themselves. In addition, recommendations were made by teachers to concretize the content and use different teaching methods. Similarly, findings regarding the concretization of the content for students with visual impairment were reported in Fraser & Maguvhe's (2008) research. In another study, it was stated that different teaching strategies could increase the success of students with visual impairment in learning science (Zorluoglu & Kizilaslan, 2019).

The use of materials in the teaching process is significant for students' success in science lessons (Karamustafaoglu, 2006). This importance increases even more for students with visual impairment because students with visual impairment need much material use or adaptation (Sahin, 2019). However, in this study, most of the science teachers pointed out that their materials were insufficient. In the literature, results supporting this finding were found. For example, Islek (2017) reached a similar conclusion, and it was determined that teachers had difficulties due to a lack of material. Kandaz (2004) also stated that the lack of material was a problem. Another study shows that materials prepared for students with visual impairment are incomplete (Unlu, Pehlivan & Tarhan, 2010). It has been stated by the Toenders, de Putter-Smits, Sanders & den Brok (2017) that there is not enough material available. In this direction, it can be said that the findings of the research in the literature are parallel to the findings obtained from the research. As a result, it can be commented that science teachers working at schools for the visually impaired have difficulties with materials.

In this study, all science teachers stated that they use teacher-made materials to eliminate material deficiencies. However, in this process, it was declared a problem that the preparation of the material took a lot of time and the materials used were not durable. Teachers stated that they included students in the material preparation process and used ready-made materials at times. In addition, it was determined that they preferred tactile materials for students with visual impairment. Studies in the literature show that tactile materials and graphs can help students with visual impairment (Supalo, Humphrey, Mallouk, David Wohlers & Carlsen, 2016; Zebehazy & Wilton, 2014). In this regard, Kumar et al. (2001) state that it is crucial to provide tactile material (e.g. diagrams, graphics) to students with visual impairment and use braille labels. However, students with visual impairment also need visual and auditory materials and tactile materials to participate effectively in educational activities (Yalcin & Kamali Arslantas, 2020). In this context, it can say that it is vital for science teachers to adapt their course materials to enable students with visual impairment to access the curriculum (Zorluoglu et al., 2016). Sozbilir et al. (2017) emphasise that it is essential to provide visually impaired students with easy to perceive and convey information directly. Suggestions were made to give and use appropriate materials for students with visual impairment and have a standard for them. In this respect, it can state that the materials to be used must meet the needs of students with visual impairment. In addition, sufficient material should be provided, especially for science lessons. Rule, Stefanich, Boody & Peiffer (2011) recommend using teaching materials designed and adapted for students with visual impairment. In this way, it can ensure that science lessons are more effective and efficient, and also, students with visual impairment can fully participate in these lessons. Another issue suggested by teachers is that technology should be used. Kumar et al. (2001) recommend that course materials be delivered in braille and flexibly translated into electronic media. They also state that, wherever possible, science teachers should use assistive technologies to improve students' access with visual impairment to science education.

Friend & Bursuck (1999) emphasizes the need for adaptations for students with visual impairment while making an assessment. This study shows that science teachers include instructional arrangements such as reading the questions themselves, preparing a braille exam, having students write the answers, having another student read, or getting help from a teacher who knows braille. However, the teachers also stated that the exams took a long time, and they had problems preparing questions and reading the answers. In addition to these problems, students' performances are not the same, and visual content is a problem. Despite these difficulties, the teachers stated that they made arrangements not to ask visible questions and ask straightforward questions. It is among the suggestions of teachers that arrangements should be made for exams and should use alternative assessments to make evaluations in science lesson more effective and efficient. According to Kumar et al. (2001), science teachers should consider alternative assessment methods for students with visual impairment. In other words, it can say that alternative assessment reforms are needed to ensure equality for students with visual impairment (Stefanich & Egelston-Dodd, 1994). Considering the difficulties teachers encounter in their assessment processes, the use of alternative assessment methods may be advantageous. In other words, adopting alternative methods will be beneficial in terms of supporting the concept development and making a precise evaluation (Sozbilir et al., 2017). In addition, when the effects of disability on learning are clearly felt, alternative assessment methods should be considered (Kizilaslan, 2020). In this respect, it can state that it is essential to use alternative methods to evaluate students with visual impairment. We can use different evaluation strategies for this. Some of these strategies include giving extra time, preparing braille or enlarged exam paper, getting staff assistance for reading questions and using technology. In addition, arrangements such as using verbal evaluation, product evaluation, peer support, giving additional time in exams, taking exams on their braille tablets or computers using voice-over programs and computer software, preparing exams with large print for students with low vision who can benefit from vision power, magnifying glass with assistive technology tools, or benefitting from screen enlargement programs can also be made.

In this study, the teaching experiences of science teachers working in a school for the visually impaired were examined. Similarly, research can be conducted with teachers who teach Turkish, social studies, mathematics, or other school lessons. In addition, these studies can be carried out with teachers working in inclusive environments, except for the school for the visually impaired. The experiences of teachers in different educational settings can be compared. The results obtained from the current research are limited to the findings obtained from the interviews conducted qualitatively. For this reason, it is recommended to make lesson or classroom observations and the teachers' opinions. In this way, more holistic data can be obtained.

We want to give some suggestions to science teachers who work with students with visual impairment. For example, while teaching concepts, knowledge or skills in science class, adapting the teaching plans is vital for students with visual impairment to understand the content. Within this framework, you can make adaptations, especially in the materials, presentation of the content, or content itself. In addition, you can create learning by doing environments with various methods such as concretizing information, using the sense of touch, visualizing, using models or materials, associating the acquired knowledge with daily life, and demonstration technique. In addition to these, you can concretize science lessons and reinforce learning with experience-based activities such as trips and observations. Rather than lectures based on verbal expression, using techniques such as experiment, observation, and demonstration frequently, students with visual impairment can develop cause-effect relationships, logic and reasoning, research and questioning skills. Material use is an essential tool in concretizing the outcomes, and activities are critical tools to enable students with visual impairment to be active. It should keep in mind that using materials and activities frequently will allow students with visual impairment to learn effectively. If suitable materials for students with visual impairment cannot be found in this context, existing materials can be adapted, descriptions or technology can be used. In addition, collaborative teaching arrangements can be used to participate in students with visual impairment in classes by benefiting from peer support.

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