

AN ACTIVITY DESIGN FOR STUDENTS WITH VISUAL IMPAIRMENT: WHAT IS ELECTRICAL FUSE?

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ABSTRACT

The use of teaching materials and tools in science lessons to support the students' conceptual understanding is important, especially when working with special education students. This study describes an activity designed to teach the principle of electrical fuse to the visually impaired grade 8 students within the scope of electricity in our life unit. The study group consisted of 8 students which had different levels of visual impairment. The structure of the electrical fuse activities was made using simulation models. The simulation model was designed as a model that could be perceived as tactile by the students with visual impairment. In addition, the fuse models are designed to be both large and tactile for students with different levels of visual impairment. As a result, the use of tools, materials, or activities that appeal to different sense organs of students with visual impairment had positive effects on students' learning.

Keywords: principle of electrical fuse, visually impairment, electricity.

GÖRME YETERSİZLİĞİ OLAN ÖĞRENCİLERE YÖNELİK BİR ETKİNLİK TASARIMI: SİGORTA NEDİR?

ÖZ

Fen bilimleri dersleri öğrencilerin algılamakta zorluk çekebilecekleri konu veya kavramları içerdiği için, içeriklere destek olacak öğretim materyal, araç-gereç ve etkinliklerinin kullanımı özellikle özel eğitim öğrencileri ile çalışırken çok önemlidir. Bu çalışma görme yetersizliği olan 8. Sınıf öğrencilerine Yaşamımızdaki Elektrik ünitesi kapsamında sigortanın çalışma prensibini kavratmak amacıyla tasarlanan bir etkinliği içermektedir. Çalışma grubu farklı düzeylerde görme yetersizliğine sahip olan 8 öğrenciden oluşmaktadır. Benzetim modeli kullanılarak yapılan etkinliğin öğrencilerin sigortanın yapısı ve çalışma prensibini algılayabilmeleri sağlanmaya çalışılmıştır. Etkinlikte kullanılan benzetim modeli görme yetersizliğinden etkilenen öğrencilerin dokunsal olarak algılayabilecekleri bir model olarak düzenlenmiştir. Ayrıca kullanılan sigorta modelleri de hem az gören öğrenciler için büyük olarak, hem de kör öğrenciler için dokunsal özelliklere sahip olacak şekilde tasarlanmıştır. Sonuç olarak görme yetersizliğine sahip öğrencilerin farklı duyu organlarına hitap eden araç-gereç, materyal veya etkinlik kullanımının öğrencilerin öğrenmeleri üzerinde olumlu etkileri olduğu belirlenmiştir.

Anahtar kelimeler: sigortanın çalışma prensibi, görme yetersizliği, elektrik.

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INTRODUCTION

It is important for students with visual impairments to have the skills and knowledge required by the science course, as it is desired for other students. However, the science course that provides students with the necessary knowledge for their academic life and everyday life, includes topics that students with visual disabilities have difficulty to grasp (Mayo, 2004).

The use of teaching materials, tools, and activities to support teaching a science topic is important, as science courses contain subjects or concepts that students may have difficulty in perceiving. It has been found more efficient and effective to use active learning methods involving tools and materials than using traditional methods in the science courses (Altıntaş, 1998). The teaching materials used during teaching can present students rich, colorful, visual, and auditory messages. Thus, the materials facilitate the interaction between learners and the content, contributing to the formation of more effective and concrete learning (Yaşar, 2001). In addition, the tools and materials used during the lesson activate the senses other than the sense of hearing. It is very important that these tools and materials, which are thought to be useful for students with normal vision, are also used during science teaching for the visually impaired. Especially the use of tools and materials that will appeal to tactile senses is of greater importance.

Students with visual impairment face many problems in their learning-teaching process due to their visual inadequacies. The fact that other senses other than the sense of sight are not actively used in the learning process is the basis of these problems. There have been many research studies conducted to contribute to solve the problems that students with vision impairment can face in learning science (Boyd-Kimball, 2012; Bülbül, 2013; Bülbül & Eryılmaz, 2010; Cooperman, 1980; Gupta & Singh, 1998; Karakoç, 2016; Mayo, 2004; Pereira, Aires-de-Sousa, Bonifacio, Mata, & Lobo, 2010; Poon & Ovadia, 2008; Ratliff, 1997; Rooks, 2009; Sözbilir, Gül, Okcu et al., 2015; Supalo, 2005). In addition to these studies, there are also many studies on the development of materials for students with

visual impairment in science lessons that facilitate teaching. Weems (1977) described the science laboratory program and the materials developed during the implementation of this program to facilitate the adaptation of blind students and students with partly visual impairment to the science class and to fully participate in science activities. Similarly, Kumar, Ramasamy, and Stefanich (2001) reported that different instructional strategies should be used for the participation of students with visual impairment in science classes. They concluded that future science teachers should have the ability to use the science classroom hands-on materials and adaptive technologies that facilitate the learning of students with vision impairment. In addition to these, some studies have mentioned about the teaching materials specifically developed for students with visual impairment (Buultjens, Aitken, Ravenscroft, & Carey, 1999; Bülbül, 2013; Bülbül, Garip, Cansu, & Demirtaş, 2012; Cole & Slavin, 2013; Goudiras, Papadopoulos, Koutsoklenis, Papageorgiou, & Stergiou, 2009; Mason, 1999; Masoodi, & Ban, 1980; McCallum & Ungar, 2003; Neely, 2007). These tools are the tools that are thought to contribute to the learning process of the students who are affected by lack of sight. The use of equipment and materials that take into account the level of vision impairment during the teaching process is of great importance to these students' learning.

These studies in the literature show that individuals affected by visual impairment can adapt to academic life with some modifications and regulations during teaching. It was found that the students were more active and their performance levels were positively affected in the teaching activities which were designed by considering the levels of visual impairment of the students.

In summary, it would be appropriate to carry out some instructional arrangements in the science education to be done for the individuals who are affected by the visual impairment. Our literature review showed that there has not been a study carried out on teaching the concept of electrical fuse, a concept that is frequently encountered in everyday life. In this study, a content standard was selected from the "Electricity in our Life" unit at the 8th grade and a teaching activity was

developed considering the level of visual impairment of the students in the classroom.

Some of the concepts contained in the "Electricity in our Life" unit, which is included in the science course and is in the learning strand of Physical Events at the 8th grade, are difficult to grasp for students. It is important that students understand the concepts in this unit since it includes terms and concepts used in everyday life. In order to understand the unit concepts, it is necessary to know the elements of simple electric circuit and their functions. Since electricity is one of the indispensable elements of everyday life, students must be able to identify the means they will use throughout their lifetime. One of the most important concepts is how the electric current is generated and in what situations it can be dangerous. For this reason, the safe use of electricity should be known by all students.

As a result of in-class observations and interviews conducted with visually impaired students in a science class, it has been determined that students do not have any information other than daily information on the safe use of electricity. This finding necessitated developing an activity and teaching this topic to the students considering their level of visual impairment.

Goal

When the related literature is examined, no material, tools, or activities have been found to teach the safe use of electricity in ways that students with visual impairments can understand. For this reason, a fuse design and a simulation model that describes the working principle of the fuse were developed in order to teach the safe use of electricity to the students with visual impairment. The purpose of this design is to support the comprehension of how the fuse tool in the circuit works in order to ensure the safety when there is overcurrent and which materials make up the fuse by the blind and under-sighted students. In addition, it is aimed that the students will be able to perceive the logic of the working principle of the fuse by analyzing the simulation model. The students did not know the meaning of electrical fuse concept which is frequently encountered in everyday life. The teaching of this concept, encountered both in the daily life and in the

academic life, is of great importance in terms of the safe use of the electricity and teaching the electricity in our life unit. This is the most important component that serves the purpose of this study.

The fuse that is used in homes, schools, workplaces, and wherever electric power is used is a tool that students frequently hear but do not know what function it has. An example of a fuse that is shown to students on safe use of electricity is a regular fuse found in schools. However, this tool is not understood by the visually impaired students because it is not designed according to the level of vision impairment. The tools and materials used for the conceptual learning of the unit concepts need to be selected or adapted according to the disability level of the students. The interviews with the students revealed that the materials used were not able to meet the students' needs and the used materials were not designed considering the individual student characteristics.

It has been determined that students had verbal knowledge about the working principle of the fuse, which is one of the concepts used in everyday life and is one of the concepts in "Electricity in our Life" unit, but the students did not grasp how the fuse cuts the power. Particularly, the blind students do not have any information about the fuse except for the fact that it cuts off the excess electricity. In addition, when the fuse is described in the lesson, a glass fuse model is shown which is too small even for the students with normal vision to have difficulty in seeing. Based on these observations, two fuse designs that are economical and have easily understandable features have been developed in order to enable the students to perceive the fuse and its functions.

The designed fuse models in this study are glass fuse and metal double fuse models in the school. These models are designed with tactile features according to blind students. These designs are also preferred because the glass and metal double fuses are the most commonly used fuses and they are among the samples found in school. In this way, enlarged models of fuse samples used in schools are developed. Very economical and easily found materials are used in the design.

Design Stages

For the glass fuse model, a plastic bottle is used which is transparent and has no texture on it. The design stages of the model made of plastic bottle are as follows:

1. Both sides of the bottle were cut and covered with a flat round cardboard.
2. 5 mm copper wire is used to make conductive wire inside the glass fuse and this wire is covered with black tape so that students with low vision can see better.
3. The cardboard at both ends of the bottle is pierced and the wire is placed in the center and fixed at both ends.
4. Then both sides of the bottle are covered with aluminum foil to look like the original of the glass fuse.
5. The model has been cut open at one edge and a structure has been created that will enable students to understand what is inside the fuse and also they can feel outside.

As a result, the model shown in Figure 1 is obtained.

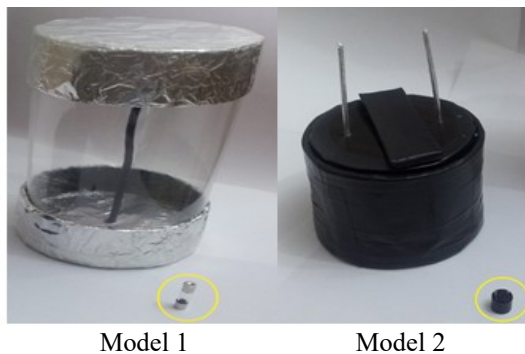


Figure 1. *Enriched Designed Teaching Materials Used in Teaching Fuse*

A plastic toy box is used in the construction of metal double fuse. The design steps of the metal double fuse are as follows:

1. The inside of the box is filled with sponge so as to form an elevation, and a round cardboard is cut on it.
2. It was then covered with a black glossy paper to give the original appearance.
3. Finally, the metal pairs were cut from 5 mm copper tin and covered with

aluminum foil and placed in the hole by drilling through the cover.

As a result, the second model shown in Figure 1 is obtained.

ACTIVITY IMPLEMENTATION

The participants of the study are the 8th grade students who were enrolled at the Visually Impaired Secondary School located in a city center in Central Anatolia during the 2014-2015 academic year. The characteristics of the participant students regarding their level of visual impairment are given in Table 1.

An activity was developed for a content standard related to the “Transformation of electric energy to heat (heat energy) and light (light energy)” considering the visual impairment levels of the students shown in Table 1. No electrical circuit was used in the event. The electrical circuit is described by the railway model and the working principle of the fuse is explored by the students on this model.

Table 1. *Application Phase Participant Students' Characteristics*

Student no	Vision level	Eye with inadequate vision
S ₁	Low vision	Both eyes
S ₂	Blind	-
S ₃	Low vision	Both eyes
S ₄	Low vision	One eye with low vision, other eye blind
S ₅	Low vision	Both eyes
S ₆	Advanced Myopic	Both eyes
S ₇	Low vision	Both eyes (Right eye has more vision impairment)
S ₈	Low vision	Both eyes

“What is Fuse?” activity is an activity that explains the use of the fuse in terms of safety. The content standard related to this activity is as follows: 2.5. Explains how a fuse works and the importance of the fuse in terms of safety. Tools and materials used in the activity are given in Table 2.

Table 2. *Tools and Materials Used in the What is Fuse? Activity*

- Fuse box
example
commonly
found in
houses
- Railway
model that
describes the
working
principle of a
fuse
- Fuse models
designed for
blind students

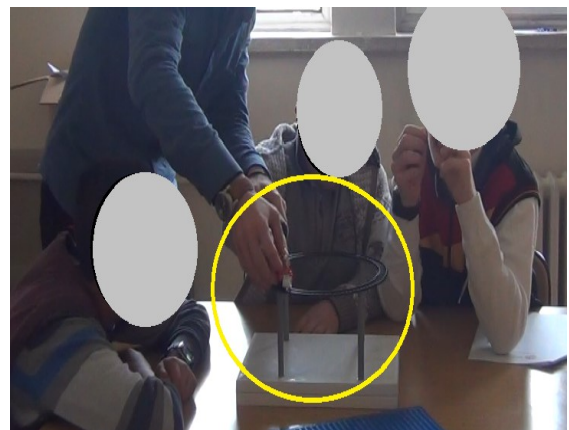


At the first phase of the activity, the teacher identified the students' prior knowledge by asking the students what a fuse was used for. At this phase, the students were shown an example of a fuse box commonly found in houses. Students' responses revealed that they had a general knowledge about fuse but they did not know how it worked and they lacked knowledge about its working principle. Then a railway model was used for students to understand the working principle behind a fuse.

In the railway model, the rails represent the connection cables in the electrical circuit and the wagons represent the electrical charges. When the number of wagons on the rails is increased, the rails are broken and the wagons cannot complete the rail. With this simulation, we aimed to demonstrate that the fuse is used for the prevention of overcurrent, by cutting the current when excess current flows to the circuit.

In the second phase, students were asked what the railway model could be used for. The students could not make any connection between the fuse and the railway model. Then the teacher explained to the students that the rails represent the connection cables in the electrical circuit and the wagons on the rails represent the electric current. Initially, when there were 3 wagons on the rails, no change was observed on the rails, when one wagon was added, it was observed that the rails were broken and the wagons could not complete the rail. This means that when an excess current flows into a circuit, the fuse starts working and cuts the current, causing the circuit to be incomplete.

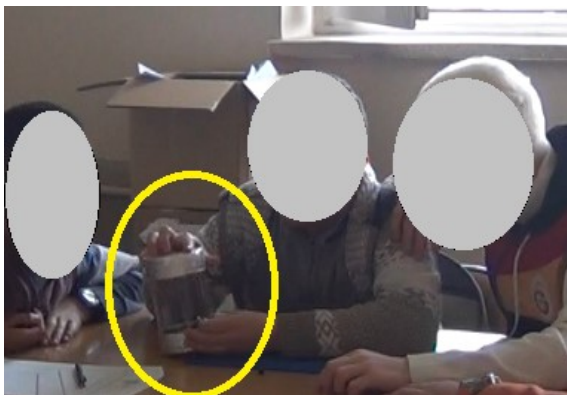
The activity was first completed by a blind student under the supervision of the teacher. The teacher grasped the hand of the blind student, letting him touch the model and recognize the model. The purpose here is to allow the blind student to touch and detect the change in the train path. At the same time, students who had vision impairment (low vision level) observed changes using their visual senses. It was then ensured that each student performed the activity. The working principle of the fuse is examined with this simulated model used. After the activity with the railway model, two different fuse models were introduced to the students, designed to help students understand what the insurance is and how it work (see Photographs 1, 2, 3, and 4).



Photograph 1. *A Students Examines the Model by Touching*



Photograph 2. *Implementing What is Fuse Activity*



Photograph 3. *A Blind Student is Examining the Glass Fuse Model*



Photograph 4. *Students Examine the Glass and Metal Double Fuse Models*

Glass fuse and metal double fuse models were designed to be quite large considering the level of vision impairment of the students. In the metal double fuse model, the metal pairs to which the electric circuit was connected were designed to be tangible. In the glass fuse model, a plastic bottle was used and an opening was left on one side of the plastic to fit

an adult human hand. This opening is intended to help students feel the conductive wire in the glass fuse.

After the activity, we conducted interviews with the students to find out what they learned regarding the content standard targeted in the lesson. Student responses to interview questions revealed that all students were able to explain how a fuse works and the importance of the fuse in terms of safety as expressed in the content standard. Examples of interview data used in determining the students' achievement in the "What is Fuse" activity are as follows.

Content standard 2.5: Explains how a fuse works and the importance of the fuse in terms of safety. Sample student responses regarding the importance of the fuse are as follows:

S₄: ... The fuse is there to cut off excess current immediately when there is a dangerous moment, but for example here we must not put too much pressure on the fuse and the circuit, we should know how to use the instruments that we possess against the danger of electric leakage.

S₆: ... um, now we need to use the fuse ... to help us use the electricity that comes to our homes safely. If too much electricity comes in, it will cut it down and insure the danger.

S₃: ... the thing, when excess current flows on the electrical circuit or it flows more than the electrical circuit can handle, the fuse works and cuts off the electricity, ensuring safety.

To sum up, in the activity, the students encountered a railway model, a toy. At the beginning, students did not connect the concept of fuse in the electricity unit with this toy model. However, the use of a toy model during the lesson attracted the attention of all the students and they wondered how the fuse was related to this model. In this way, the interest of the students to the lesson was also increased. They watched the movement of the wagons on the rails with interest and they were able to observe the breakage of the rails when the number of wagons increased. The teacher then explained to the students that the rails represent the electrical circuit and the wagons on the rails represent the electric current.

Representing the concept of fuse with the railway model was very interesting for the students, and they were able to explain what function a fuse has in an electric circuit. This and similar activities are promising applications that may promote permanent learning for all pupils with or without vision impairment. For this reason, interesting tasks and activities that can make learning more enjoyable and meaningful for the students should be used in the lessons. It has been observed during this activity that for both students and teachers, the use of more active teaching activities is very effective for reaching conceptual understanding. In addition, this activity can be used for students with visual impairment and normal vision, which is a positive side of the activity. In the lesson, the blind students used the tactile senses and the students who had low vision were able to use their sense of sight. For this reason, we think that this activity is useful since it addresses all students, whether or not they have visual impairment.

CONCLUSIONS and SUGGESTIONS

The implementation of the activity on the structure and working principle of the fuse did not result in any situation that could be dangerous for the students. The use of a simulation model to demonstrate the working principle of a fuse to the students may prevent the dangerous situations that may arise due to the increase of current in a real electric circuit. In this lesson, we experienced that students with visual impairment can participate actively in activities just as students with normal vision. It has also been found out that a lesson in which the individual characteristics of the students are taken into consideration provides positive effects on the learning of the students. Visual impairment levels of individuals vary considerably. This difference also affects the learning process of students. For this reason, teaching materials and activities should be developed considering the level of visual impairment of each student and adaptations should be made to suit the type and level of disability.

In the classroom observations made before this activity, it was observed that the students' individual differences were neglected. This situation decreases students' motivation and

interest toward the lessons. The materials and tools used in lessons are the tools and materials used for students with normal vision. However, there were no adaptations or changes regarding the visual impairment levels of students in these tools and materials. To increase students' learning opportunities, in this activity, we developed equipments and materials that can be easily used by the students with visual impairment.

The simulation model used in the activity was designed as a model that can be perceived as tactile by the students have vision impairment. In addition, the fuse models used were designed to be both large for students with low vision and tactile for blind students. The materials used were also economical. In addition to this, the simulation model used to demonstrate the working principle of a fuse is a railway model which can be easily accessible and its cost is very low, making this activity applicable in other classrooms. Again, the materials such as plastic bottle and cardboard box used in preparing the fuse models are very low cost materials.

With this study, positive effects of using materials, tools and activities in the lessons were observed and it was found that most of the problems encountered in the learning process of the students due to visual impairment could be reduced. In this regard, we conclude that the activities to be implemented or the tools and materials to be used in the classrooms that include visually impaired students, the lesson can be enhanced by making adaptations according to the needs of the students. This work is also important in terms of encouraging the Special Education teachers and Science teachers to develop or adapt materials or activities suitable for their students. In the design of educational materials, the color contrasts for students with low vision and the tactile properties for blind students are the most important factors to be considered. We believe that this study will represent an example of the work to support and enhance the learning process of the students with visual impairment.

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