How to Make Science Accessible to Students with Visual Impairments (VI)?

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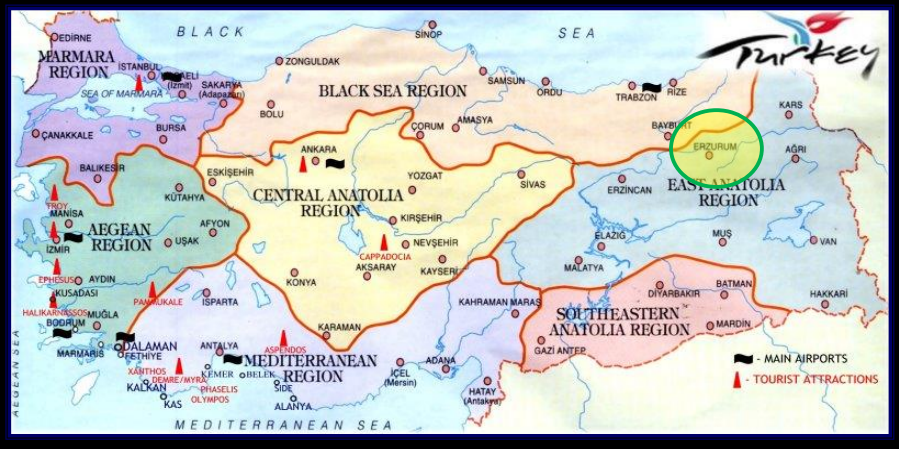
Turkey - Geographical Regions



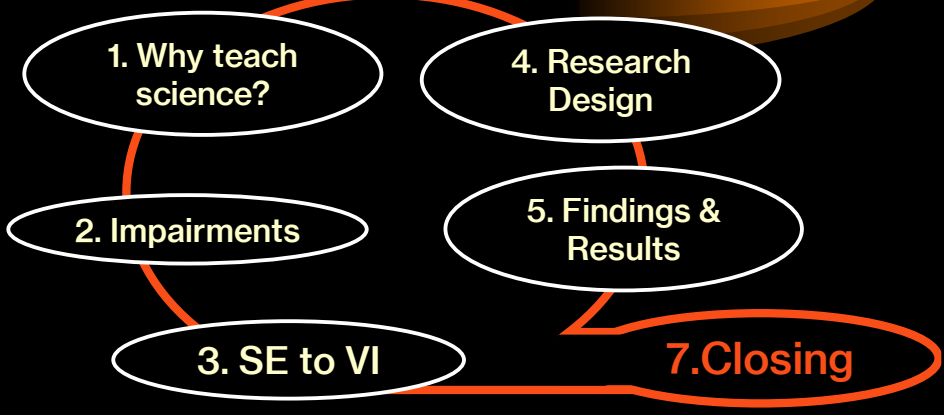
Turkey-Physical

Scenes from Erzurum






Outline of the Presentation



Why do we teach science?

- Reasons for science education are based on four arguments:
  - **Economic** (training more scientist and engineers to meet the needs of industry and science related fields)
  - **Democratic** (raising an informed citizens and knowledgeable consumers in the future)
  - **Skills** (science instills certain transferable skills that are important to students' understanding of science)
  - **Cultural** (the history and philosophy of science should play an integral role in science curriculum)

Ref: http://www.science-as-inquiry.org/why-do-we-teach-science.html

How to develop Skills?

Practical works help to develop **skills.**

What is **practical work?**

Practical works include

- teacher demonstrations,
- activities that students do themselves either through structured, guided or open inquiry,
- observing, collecting data, analyzing and interpreting their own data or given data and
- reporting them in various formats

Why use practical works in science teaching?

- It can motivate students towards the study of science,

However;

- Although it generates short-term engagement, they are relatively ineffective in generating motivation to study science at post compulsion or longer-term personal interest (Abrahams, 2009; Hodson, 2005)

If so ?

Why use practical works in science teaching?

- Beyond affective arguments (such as motivation, attitudes, interests towards science)

Practical works help to:

- skills development,
- conceptual understanding of basic science concepts,
- development of procedural knowledge for scientific method and nature of science (Millar, 2010)

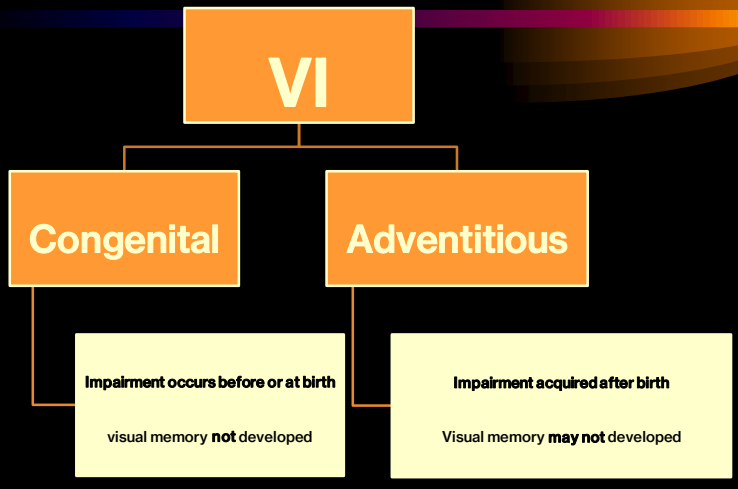
Impairments & Disability

- **Impairments** are problems in body function or alterations in body structures such as blindness (WHO, 2011)
- **Disability** is defined as the loss or limitation of opportunities to take part in society on an equal level with others due to social and environmental barriers (Northern Officer Group Report, 2002)
- WHO states that disability is not an attribute of the person, but inaccessible environments create disability by creating barriers to participation and inclusion.

Visual Impairment (VI)

- **Visual impairment (VI)**, also known as vision impairment or vision loss, is a decreased ability to see to a degree that causes problems not fixable by usual means, such as glasses (WHO, 2011).

Causes of VI



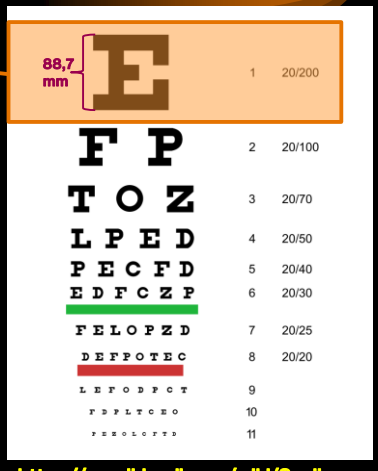
Terms used in VI

- **Blind** refers to individuals with **no vision** or **only light perception.**

The word 'blind' is only a physical description of a person's vision and should not be used for the person's abilities, intelligence, personalities, or

Terms used in VI (cont.)

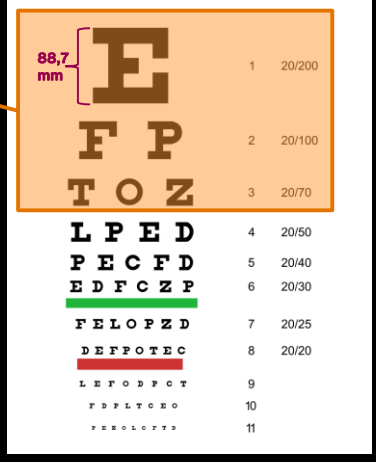
- **Legal blindness** is defined as
  - central visual acuity of 20/200 feet (or 6/60 in metric system) or less in better eye with best correction **or**
  - a central visual acuity of more than 20/200 if there is a visual field defect in which the peripheral field is contracted to such an extent that widest diameter of visual field subtends an angular distance of no greater than 20 degrees.
- Inability to read the top letter from 20 feet is considered legally blind.



https://en.wikipedia.org/wiki/Snellen_chart

Terms used in VI (cont.)

- **Low vision** is generally defined as
  - a central visual acuity of 20/70 to 20/200 in the better eye with correction **or**
  - a visual field of 20 to 40 degrees or less in better eye with correction.



Terms used in VI (cont.)

Definitions changes place to place due to the state benefits that provided to the visually impaired people.

Since the term **blind** has a negative connotation to some people, some prefer to use **visually impaired (VI).**

VI vs Sighted Students

- Students with VI are required to complete the same curriculum and examinations as sighted students.
- However, resources and instructional methods are based on the vision is partly or not accessible at all by visually impaired students.
- What is the solution?

What is the solution?

Solution is making science accessible via

modification, adaptation or **intervention**

in the educational resources and methods according to the needs of individuals with VI

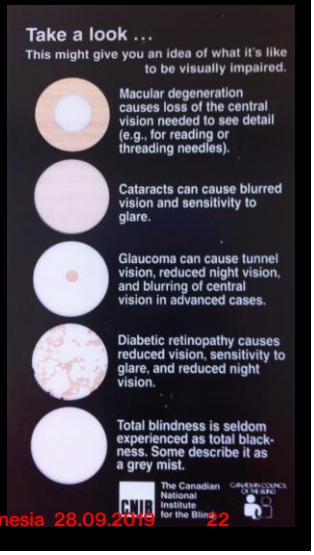
Adaptation but how?

- Because students with VI
  - differ in intellectual ability,
  - development rate,
  - social competence,
  - ....

Adaptation but how? (Cont.)

- Students with VI differ in their
  - impairments (low vision, blind etc),
  - the extent of their visual acuity,
  - ability in using the whatever vision they have.

Even if they have the same identical acuities and fields of vision this does not mean that they use the vision they have in the same way and capacity



Adaptation but how? (Cont.)

- Moreover, as they are different persons, they differ in terms of
  - personalities,
  - motivation,
  - cognitive abilities,
  - the degree to which they have learned to use their vision vary and affect their visual performance.

Adaptation but how? (Cont.)

- Some students take full advantage of their existing vision, other may not do the same.
- Therefore, **modification**, **adaptations** or **interventions** have to be done in a way that **all take full advantage of educational experiences** (Huebner, 2000)

Another Source of Difficulty !

- Teachers' knowledge, skills and the experiences
- School facilities and materials available

Designing an instructional setting for students with impairments is like solving a problem with multiple variables!

For an Effective Instructional Design

- Teacher should understand
  - students' needs,
  - be aware of their own capabilities, knowledge and skills,
  - the facilities available in the school.
  - understand the nature of visually impaired students as a whole (teaching is mostly done as groups).

Teaching Science to VI

- VI are under represented in STEM workforce due to discouragement to learn STEM fields.
- Misconceptions in
  - VI students themselves,
  - Parents
  - Teachers
  - Employers
  - Society ....

Research in teaching science to VI students is scarce

- Current research is focussed on
  - Instructional design and adaptation of available methods
  - Instructional material development
  - ICT integration
  - Studies on affective dimensions

Benefits of science education for students with impairments

- Expanding experiential background for students who have had limited experiences
- Covering skills and knowledge important for adult functioning
- Using concrete, hands-on learning activities
- Developing, through science activities, problem solving and reasoning skills (Mastropieri & Scruggs, 1992).

Benefits of science education for students with VI

- Science education will help to develop:
  - compensatory skills for observing, manipulating, and classifying phenomena and related matters (Supalo, 2012)
  - motivation towards STEM
  - encouragement VI students to take part in STEM workforce
  - Basic science knowledge development needed for everyday life

Purpose

- This study is aimed to provide a broad aspect to the questions
  - what are the needs of VI students in learning concepts and skills relevant to science?
  - can students with VI be efficiently taught basic science concepts, critical thinking and scientific process skills?
  - If so, which methods or adaptations of methods and materials have been seen to be the most effective in delivering science education?

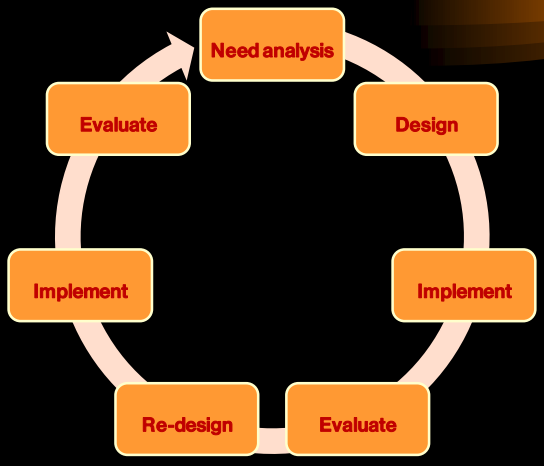
Research questions

- What are the needs of visually impaired students' in carrying out practical works?
- How these needs could be met in designing instructional materials and activities for practical works?

Research Design

- The whole project is designed as a design-based research (DBR).
  - DBR "blends empirical educational research with the theory-driven design of learning environments, is an important methodology for understanding how, when, and why educational innovations work in practice" (Design-Based Research Collective, 2003).

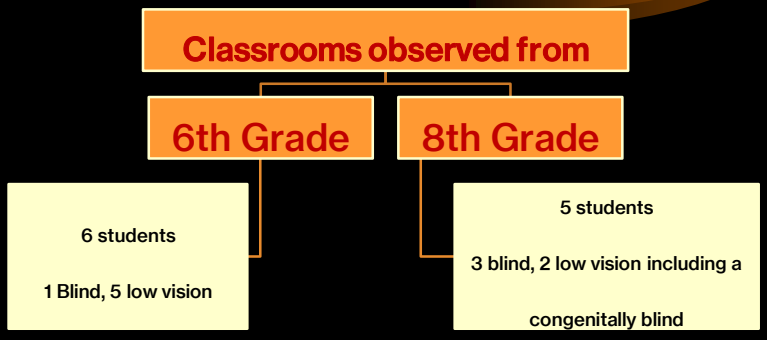
DBR Stages



Need Analysis

- This was done by **observations** made in classrooms during science teaching, **interviews** carried out with students and their science teacher, as well as **curriculum analysis**.
- Unstructured observations were conducted in classrooms from a special middle school for visually impaired students in Erzurum city center during 2014-15.

The Participants



The Participants

- Worked with two different teachers
  - Need analysis stage: a female teacher with more than 10 years of experience in science teaching but only less than 3 years of experience working with VI students.
  - Implication stage: a male teacher, temporary replacement teacher, with no teaching experience.
  - None of the teachers has any kind of traning for teacing VI students

Topics

- Observations made from three different topics in science:
  - reproduction, growth and development in plants and animals from life sciences
  - matter and heat from matter and change
  - conduction of electricity from physical phenomenon
  - Energy in living system in chemistry

Findings

- Teaching based on
  - Lecturing with not much adaptation of materials or instructional setting
  - Some adaptation made based on experience not knowledge!
- The main reason is teacher's lack of knowledge in teaching science to VI students, and lack of facilities.

Findings (cont)

- Teacher does demonstrations but blind students are excluded.
- Print materials were not enough and not available in Braille.
- Students stay passive. No practical works at all.
- Science was found as boring by the students!

Findings (cont)

- The basic needs are materials and hands-on-activities designed carefully to meet the needs of low vision & blind students separately.

Individual Needs

- Students individual needs were identified by functional vision evaluation instrument called GIGDA (Gazi İşlevsel Görme Değerlendirme Aracı-Gazi Functional Vision Evaluation Instrument) developed by professionals in Gazi University in Ankara.

Individual Needs - GIGDA

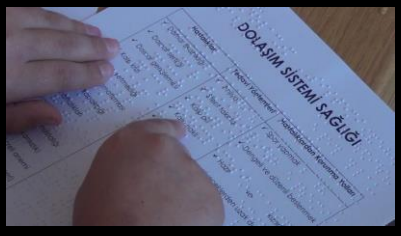
- Functional vision evaluation included:
  - eye condition,
  - focusing objects from different angles, following an objects,
  - seeing objects in close distance (seeing 1cm objects less than 60 cm distance),
  - identification of the colors,
  - acuity in contrast,
  - reading,
  - writing
  - seeing from a distance (seeing 10x10 object from 1 m distance).

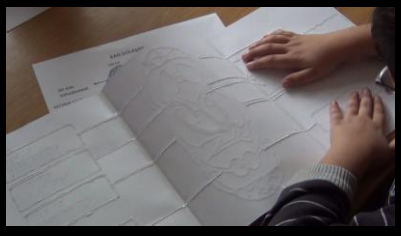
GIGDA Application

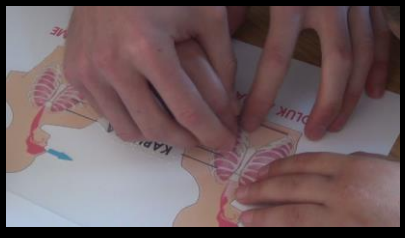
Design needs for text came out of GIGDA

- The minimum size for text has to be at least 20 point (1 point = 1/72 inch)
- Best font is the Century Gothic.
- Braille materials should be printed with normal text (for this braille and color in embosser is used)
- Pictures should be tactile

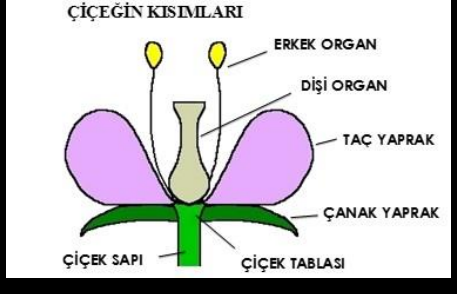
Sample tactile print documents





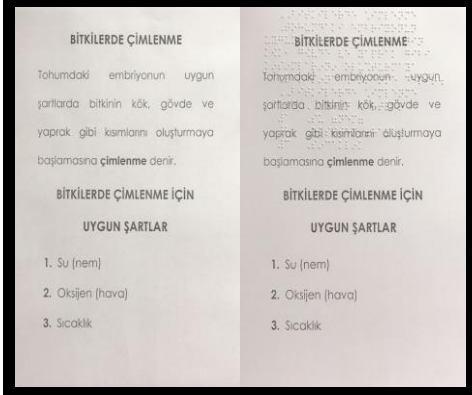


Sample print documents (cont)



Two types of the same working paper. The one on the *left* is printed by braille and color in embosser for *blind* students, while the one on the *right* is printed a color printer for *low vision* students. Both materials printed in enlarged fonts.

Sample print documents (cont)

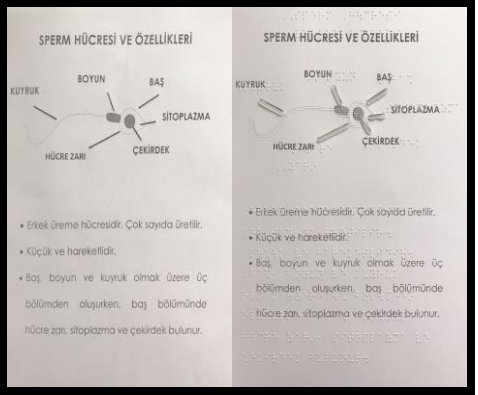


BİTKİLERDE ÇİMLENME

Tohumdaki embriyonun uygun şartlarda bitkinin kök, gövde ve yaprak gibi kısımlarını oluşturmaya başlamasına **çimlenme** denir.

BİTKİLERDE ÇİMLENME İÇİN UYGUN ŞARTLAR

1. Su (nem)
2. Oksijen (hava)
3. Sıcaklık



SPERM HÜCRESİ VE ÖZELLİKLERİ

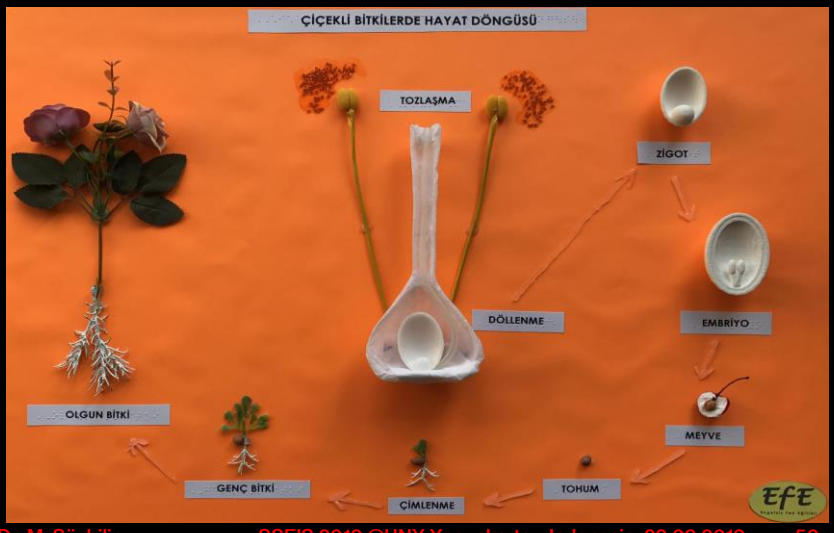
- Erkek üreme hücresidir. Çok sayıda üretilir.
- Küçük ve hareketlidir.
- Baş, boyun ve kuyruk olmak üzere üç bölümden oluşurken, baş bölümünde hücre zarı, sitoplazma ve çekirdek bulunur.

Two types of the same working paper. The one on the *left* is printed by braille and color in embosser for *blind* students, while the one on the *right* is printed for *low vision* students. Both materials printed in enlarged fonts.

Sample tactile documents (cont)

Two tactile materials made with everyday objects and 3D printer for female and male reproductive system of a flower.

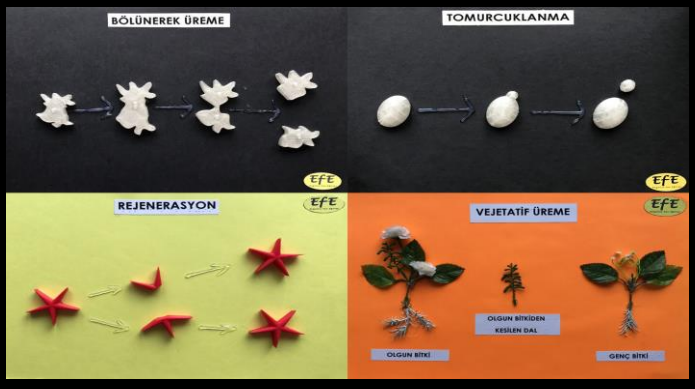
Sample tactile documents (cont)



Sample tactile documents (cont)

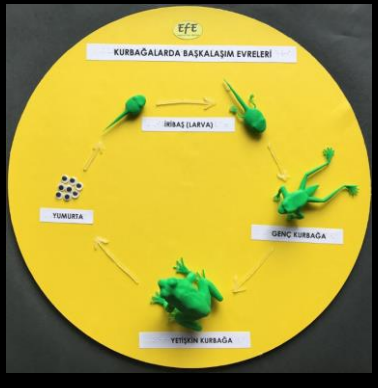
Tactile materials made with everyday objects and 3D printer for female and male reproductive system for human.

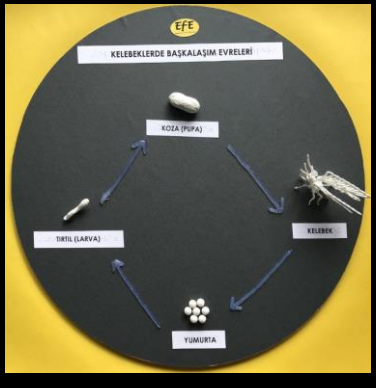
Sample tactile documents (cont)



Tactile materials made with everyday objects and 3D printer for vegetative reproduction.

Sample tactile documents (cont)



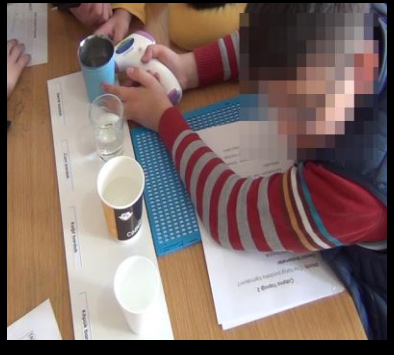


Tactile materials made with 3D printer

Sample tactile documents (cont)

Activity for heat transfer

Sample tactile documents (cont)

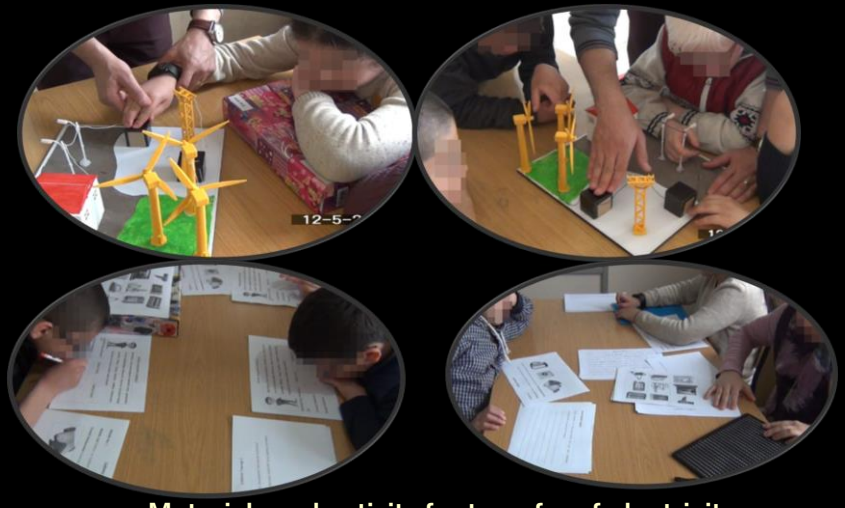


Activity for heat transfer

Sample tactile documents (cont)

Activity for heat transfer

Sample tactile documents (cont)

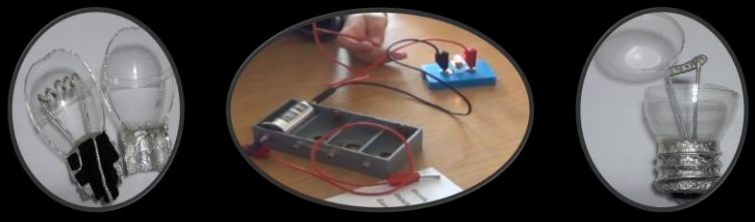


Materials and activity for transfer of electricity

Sample tactile documents (cont)

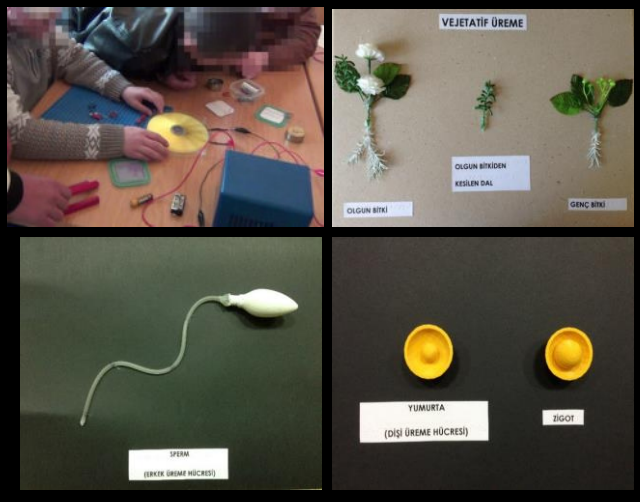
Materials and activity for resistence

Sample tactile documents (cont)



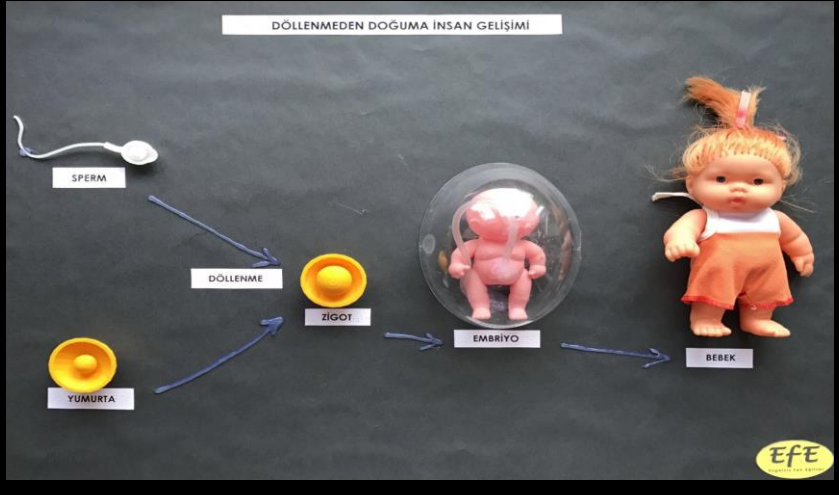
Materials and activity for resistence and bulb

Sample Tactile Materials



Different types of the adaptation of everyday materials or 3D printed materials. All the materials include features for *low vision* and *blind* students

Sample Tactile Materials



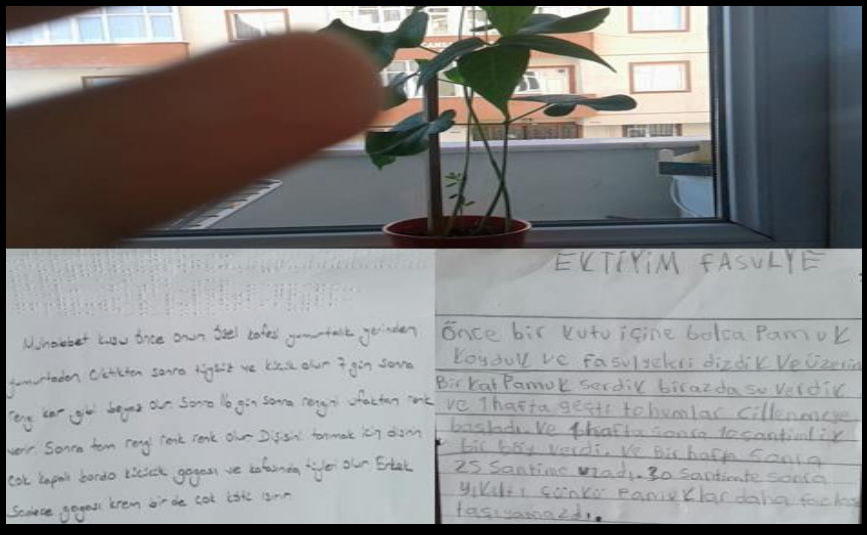
Different types of the adaptation of everyday materials or 3D printed materials. All the materials include features for *low vision* and *blind* students

Designing tactile materials for practical works

- Adapt current materials for sighted students
- Develop with everyday materials.
  - Everyday materials are cheap and easily available but not durable always.
- Use emerging 3D printing technology.
  - Expensive, not available for everybody but versatile & durable

Classroom activities

Classroom activities



Results (Positive aspects)

- ❖Motivation & interest towards science is increased
- ❖Positive attitudes developed
- ❖Students develop practical works skills
- ❖Learning & understanding is improvement.

Results (Drawbacks)

- Time management is difficult due to too much time devoted to the understanding the materials and activities,
- Lack of scientific process skills to carry out the activities
- Analysing the results
- Writing reports
- Overcoming the understanding that practical works are for understanding the science not just for play!

Closing

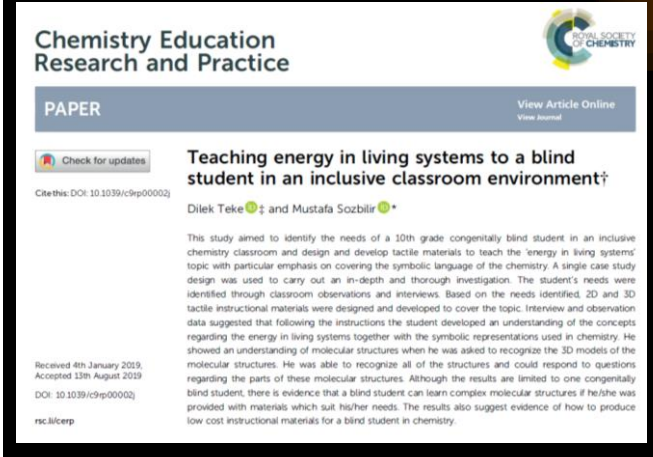
- Each VI student has different needs. VI students needs should be identified individually

- Close collaboration of working together students, teachers, parents and experts are required.

Closing (cont)

- Practical works are not just for play, but for understanding the science
- As VI students are easily distracted by unnecessary details, materials has to be simple and focussed.

Some publications in English



Chemistry Education Research and Practice

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Cite this: DOI: 10.1039/c9rp00002j

Teaching energy in living systems to a blind student in an inclusive classroom environment†

Dilek Teke ‡ and Mustafa Sozbilir *

This study aimed to identify the needs of a 10th grade congenitally blind student in an inclusive chemistry classroom and design and develop tactile materials to teach the 'energy in living systems' topic with particular emphasis on covering the symbolic language of the chemistry. A single case study design was used to carry out an in-depth and thorough investigation. The student's needs were identified through classroom observations and interviews. Based on the needs identified, 2D and 3D tactile instructional materials were designed and developed to cover the topic. Interview and observation data suggested that following the instructions the student developed an understanding of the concepts regarding the energy in living systems together with the symbolic representations used in chemistry. He showed an understanding of molecular structures when he was asked to recognize the 3D models of the molecular structures. He was able to recognize all of the structures and could respond to questions regarding the parts of these molecular structures. Although the results are limited to one congenitally blind student, there is evidence that a blind student can learn complex molecular structures if he/she was provided with materials which suit his/her needs. The results also suggest evidence of how to produce low cost instructional materials for a blind student in chemistry.

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rsc.li/cerp

Journal Paper:

Teke, D., & Sozbilir, M. (accepted). Teaching energy in living systems to a blind student in an inclusive classroom environment. *Chemistry Education Research and Practice*, *x*(x), xxx-xxx. doi.10.1039/C9RP00002J

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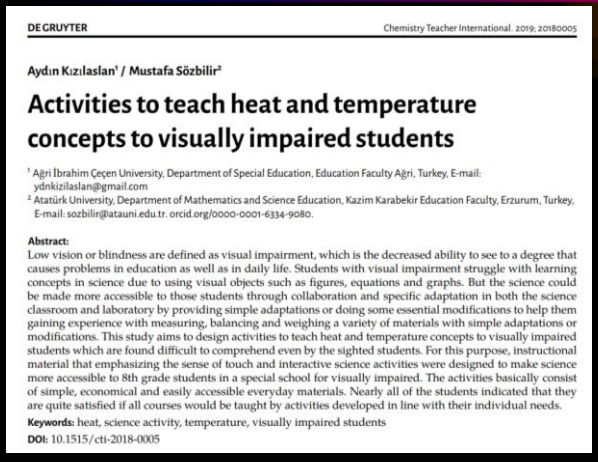

DE GRUYTER Chemistry Teacher International. 2019; 20180005

Aydın Kızılaslan[1] / Mustafa Sözbilir[2]

Activities to teach heat and temperature concepts to visually impaired students

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Abstract:
Low vision or blindness are defined as visual impairment, which is the decreased ability to see to a degree that causes problems in education as well as in daily life. Students with visual impairment struggle with learning concepts in science due to using visual objects such as figures, equations and graphs. But the science could be made more accessible to those students through collaboration and specific adaptation in both the science classroom and laboratory by providing simple adaptations or doing some essential modifications to help them gaining experience with measuring, balancing and weighing a variety of materials with simple adaptations or modifications. This study aims to design activities to teach heat and temperature concepts to visually impaired students which are found difficult to comprehend even by the sighted students. For this purpose, instructional material that emphasizing the sense of touch and interactive science activities were designed to make science more accessible to 8th grade students in a special school for visually impaired. The activities basically consist of simple, economical and easily accessible everyday materials. Nearly all of the students indicated that they are quite satisfied if all courses would be taught by activities developed in line with their individual needs.

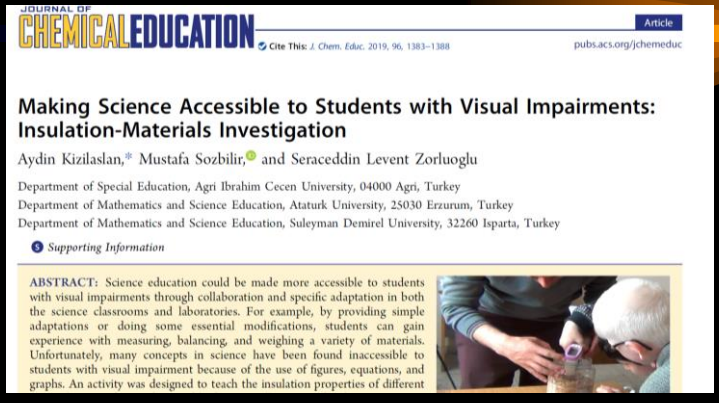
Keywords: heat, science activity, temperature, visually impaired students

DOI: 10.1515/cti-2018-0005

Journal Paper:

Kızılaslan, A., & Sözbilir, M. (accepted). Activities to teach heat and temperature concepts to visually impaired students. *Chemistry Teacher International*, *x*(x), xxx-xxx. doi.10.1515/cti-2018-0005.

Some publications in English



JOURNAL OF CHEMICAL EDUCATION Article

Cite This: *J. Chem. Educ.* 2019, 96, 1383−1388 pubs.acs.org/jchemeduc

Making Science Accessible to Students with Visual Impairments: Insulation-Materials Investigation

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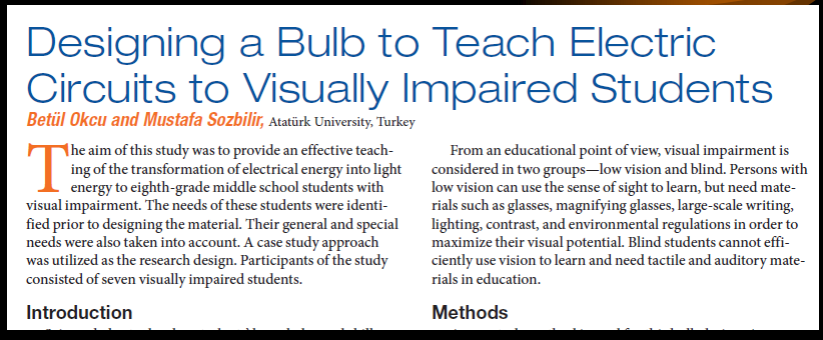
Supporting Information

ABSTRACT: Science education could be made more accessible to students with visual impairments through collaboration and specific adaptation in both the science classrooms and laboratories. For example, by providing simple adaptations or doing some essential modifications, students can gain experience with measuring, balancing, and weighing a variety of materials. Unfortunately, many concepts in science have been found inaccessible to students with visual impairment because of the use of figures, equations, and graphs. An activity was designed to teach the insulation properties of different

Journal Paper:

Kizilaslan, A., Sozbilir, M., & Zorluoglu, S.L. (2019). Making science accessible to students with visual impairments: insulation-materials investigation. *Journal of Chemical Education*, *96* (7), 1383-1388. doi:10.1021/acs.jchemed.8b00772.

Some publications in English



Designing a Bulb to Teach Electric Circuits to Visually Impaired Students

Betül Okcu and Mustafa Sozbilir, Atatürk University, Turkey

The aim of this study was to provide an effective teaching of the transformation of electrical energy into light energy to eighth-grade middle school students with visual impairment. The needs of these students were identified prior to designing the material. Their general and special needs were also taken into account. A case study approach was utilized as the research design. Participants of the study consisted of seven visually impaired students.

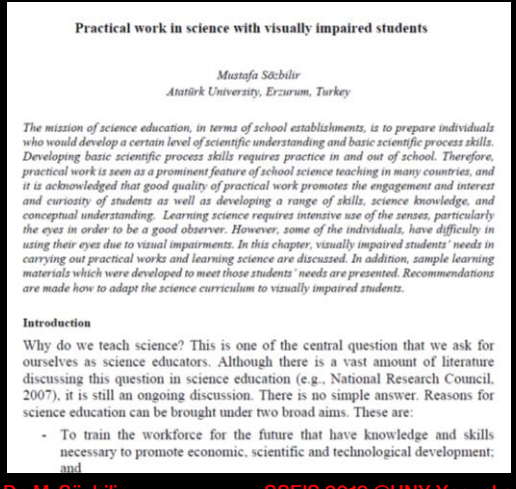
From an educational point of view, visual impairment is considered in two groups—low vision and blind. Persons with low vision can use the sense of sight to learn, but need materials such as glasses, magnifying glasses, large-scale writing, lighting, contrast, and environmental regulations in order to maximize their visual potential. Blind students cannot efficiently use vision to learn and need tactile and auditory materials in education.

Introduction **Methods**

Journal Paper:

Okcu, B., & Sozbilir, M. (2019). Designing a bulb to teach electric circuits to visually impaired students. *The Physics Teacher*, *57* (2), 99-101. doi.10.1119/1.5088470

Some publications in English



Practical work in science with visually impaired students

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The mission of science education, in terms of school establishments, is to prepare individuals who would develop a certain level of scientific understanding and basic scientific process skills. Developing basic scientific process skills requires practice in and out of school. Therefore, practical work is seen as a prominent feature of school science teaching in many countries, and it is acknowledged that good quality of practical work promotes the engagement and interest and curiosity of students as well as developing a range of skills, science knowledge, and conceptual understanding. Learning science requires intensive use of the senses, particularly the eyes in order to be a good observer. However, some of the individuals, have difficulty in using their eyes due to visual impairments. In this chapter, visually impaired students' needs in carrying out practical works and learning science are discussed. In addition, sample learning materials which were developed to meet those students' needs are presented. Recommendations are made how to adapt the science curriculum to visually impaired students.

Introduction

Why do we teach science? This is one of the central question that we ask for ourselves as science educators. Although there is a vast amount of literature discussing this question in science education (e.g., National Research Council, 2007), it is still an ongoing discussion. There is no simple answer. Reasons for science education can be brought under two broad aims. These are:

- To train the workforce for the future that have knowledge and skills necessary to promote economic, scientific and technological development; and

Book Chapter:

Sözbilir, M. (2016). Practical work in science with visually impaired students. In I. Eilks, S. Markic, & B. Ralle (Eds.), *Science education research and practical work* (pp. 169-179), Aachen: Shaker Verlag.

Acces to other publications

- More papers to come in the future ...
- For full list of the publications and the materials you may visit http://efe.atauni.edu.tr/standartsite/projeurunleri.aspx
- Unfortunately majority are in Turkish ☹

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