A Research-based Design For Teaching Matter And Heat To Visually Impaired Students

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This study is part of a project financially supported by TUBITAK with contract number 114K725

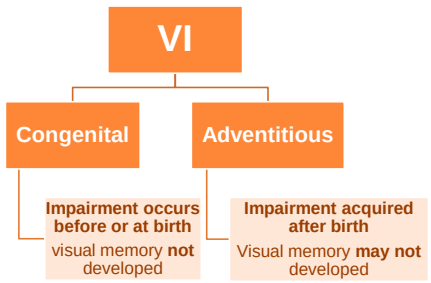
Impairments & Disability

- **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 disabililty 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



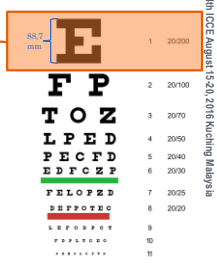
Terms used in VI

- **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 interest

Terms used in VI (cont.)

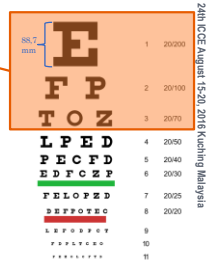
- **Legal blindness** is defined as
  - central visual acuity of 20/200 feet (or 6/60 in metric system) or less in better eye with best correction **or**
  - a central visual acuity of more than 20/200 if there is a visual field defect in which the peripheral field is contracted to such an extent that 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 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.

CHALLENGES OF VISUAL IMPAIRMENT IN THE CLASSROOM

- Fewer opportunities to acquire information visually (i.e. maps, art)
- Learning Difficulties
  - **may read very slowly –fall behind**
  - **difficult to meet the demands of general education classroom (note taking, etc)**
- Social difficulties
  - **can't catch non-verbal cues from others**
  - **inability to judge distance (i.e. stand too close when socializing)**

TEACHING SCIENCE TO VISUALLY IMPAIRED STUDENTS

- The students who are blind or visually impaired will typically need variety of assistance to explore and examine real materials or models together with some adaptations in the environment in order to let students having safe and full access to science.
- They must be exposed to a variety of experiences in science that can reasonably be explored.
- Science materials may include talking devices, tactile charts, reading materials, and equipment. But traditionally science teaching mostly depends on visual instruction.



PURPOSE OF THE RESEARCH

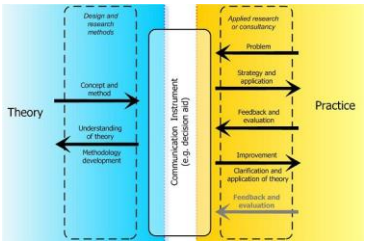
- Identify VI students' needs in learning science
- Development accesible instructional materials and activities for students with VI
- Develop design principles for instructional materials for VI students in science

RESEARCH QUESTIONS

1. What are the students' needs for the learning the concepts of 'Matter and the Heat' unit?
2. **How to develop instructional materials and activities that accesible by VI students?**
3. **What are the design principles for developing instructional materials for VI students in science with particular emphasis on 'Matter and heat' unit?**
4. What are the factors affecting the usefulness of the developed instructional design model?

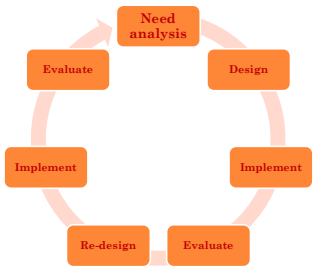
RESEARCH METHOD
DESIGN BASED RESEARCH

In this design based research (DBR) study, we developed an instructional design to narrow the gap between theory and practices. DBR focuses on developing theory and a methodology of designing, and DBR uses design research at a higher abstraction level



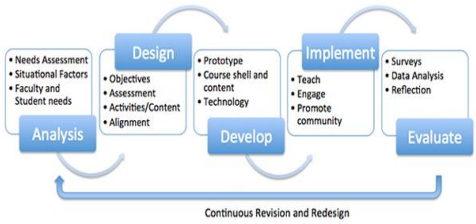
RESEARCH METHOD:
DESIGN BASED RESEARCH

The steps of the design-based research



ADDIE INSTRUCTIONAL DESIGN MODEL

The **ADDIE Model** is an approach used by instructional designers and content developers to create instructional course materials. The model has been adopted as the standard method by many instructional designers because of its flexibility



THE STUDY GROUPS

	Students no	Gender	Visual acuity
Needs Analysis Sample Group (2014-15)	NA1	Male	Low vision
	NA2	Male	Low vision
	NA3	Female	Low vision (advanced)
	NA4	Female	Low vision
	NA5	Male	Low vision
	NA6	Female	Low vision
Implementation Phase Sample Group (2015-16)	O1	Female	Blind
	O2	Female	Low vision (advanced)
	O3	Female	Low vision
	O4	Male	Low vision
	O5	Male	Low vision
	O6	Male	Low vision
	O7	Male	Low vision
	O8	Male	Low vision (advanced)

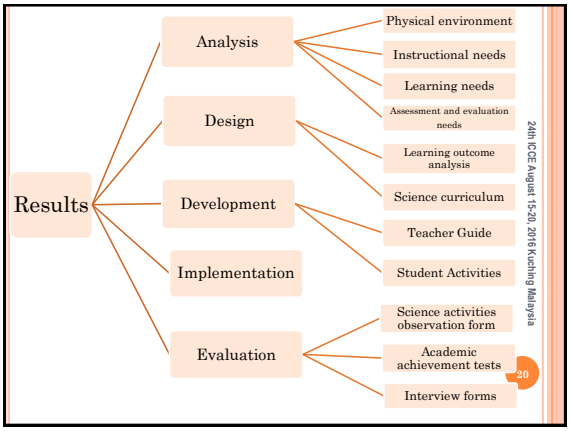
THE TEACHER

- Worked with a teacher:
  - **a male temporary replacement teacher, with no teaching experience, first time teaching.**
  - **Has no traning for teacing VI students**

DATA COLLECTION TOOLS

- Interviews and observations constitute the main data collection tools in this study.

1. Science lesson observation form (Needs analysis)
2. Science activities observation form (Evaluation)
3. Semi-structured teacher and students interview form (Needs Analysis + Evaluation)
4. Academic achievement tests (Evaluation)



ANALYSIS

Physical environment	• Classroom design and location of furnitures • Accessibility of materials in the classroom • Contrast at the colors of furniture, floors and walls for the students with low vision
Instructional needs	• Availabililty of enlarged texts according to the needs of student's impairment • Clear verbal communication during teaching process • The efficient use of time • The introduction of the materials
Learning needs	• Students' difficulties in distinguishing between the concepts of heat and temperature • The difficulties are experienced in the heat conduction ways • Fuel types are not acquired • Activities for the whole concept should be developed
Assesment and evaluation needs	• Exam paper should be Century Gothic, double-spaced, at least 18 points for students with low vision • Multiple choice test questions should be read by an assistant for blind students or printed in braille

NEEDS

- VI students have several conceptual misunderstandings/no understanding of basic concepts
- VI students are tend to learn through memorisation
- VI students need to develop practical skills, scientific process skills, critical thinking skills based on the practice, writing and reading skills are weak.
- VI students have negative views on science and mathematics. Be aware of this!
- Each VI student has different needs due to their visual aquity, personal needs, education background etc.
- VI students are easily distracted, lost connection.
- ….

DESIGN

Learning outcomes of 'Matter and Heat' unit were classified according to the Revised Bloom's Taxonomy and designed activities are analyzed according to Science Curriculum to the learning areas

Learning Outcome Analysis according to Revised Bloom's Taxonomy

Science Curriculum to the learning areas

The knowledge dimension

Cognitive process dimension

Skills
Affective
STSE

DEVELOPMENT

In the light of data obtained from the analysis and design stages of ADDIE model guides were developed

- Teacher's Guide
- Student Guide

IMPLEMENTATION

- Design model was applied for four weeks (4 hours in each weak) total of 16 hours.
- All lessons were recorded by video camera.
- Activity sheets were distributed to students before each lesson.
- Each class included practical activities accesible by VI students.
- Students were given extra time to investigate the materials at the beginning.
- They were allowed to carry activities as smal group (2-3 students) as well as individually.

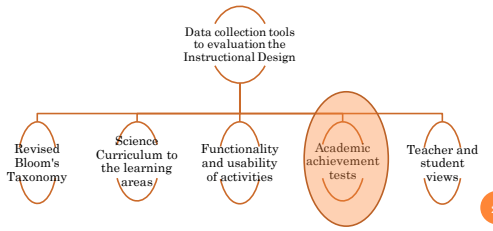
SAMPLE CLASS BEFORE & AFTER

Topic: Heat conductor and heat insulator
Observation Date: 03.25.2015

Observation Before The Intervention

EVALUATION

At this stage instructional design model was evaluated by the following data collection tools



DATA OF EVALUATION STAGE OF ADDIE MODEL

- All qualitative data is currently in the analysis phase. Only results of academic achievement tests are available.
- Quantitative data is based on achievement scores on the test taken.
- Gain score analysis was used to see the students gains. Because the gain score controls for individual differences in pretest scores by measuring the posttest score relative to the each person's pretest score.

GAIN SCORE ANALYSIS OF ACADEMIC ACHIEVEMENT TESTS

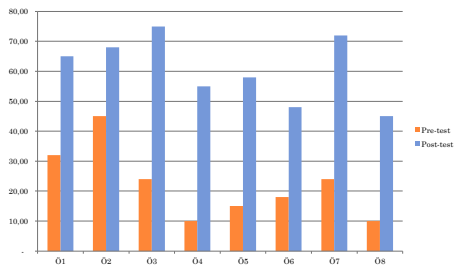
Calculate using pre/post test scores:

g = (%posttest – %pretest) / (100 – %pretest)

Student #	PRE score (%)	POST score (&)	Gain
Ö1	32	65	0,49
Ö2	45	68	0,42
Ö3	24	75	0,67
Ö4	10	55	0,50
Ö5	15	58	0,51
Ö6	18	48	0,37
Ö7	24	72	0,63
Ö8	10	45	0,39
		g:	**0.49**

"High-g" courses as those with > 0.7
"Medium-g" courses as those with 0.7 > () > 0.3;
"Low-g" courses as those with < 0.3.

COMPARISON OF PRE & POST-TEST



DISCUSSİON

- As a result, the design model has led to a change in the students' academic success rate of 49% (medium g).
- However, the observations showed evidence that VI students gained practical skills such as measuring, recording, reporting as well as analysis and critical thinking skills.
- VI students negative views on science started to become change. However, it seems they still see science as enjoyment or play rather than something part of their life!
- 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.
- As VI students are easily distracted by unnecessary details, materials has to be simple and focussed.
- As their reading and writing skills are so weak, it is better to give them handouts for the activities and materials.

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