

# An Instructional Design Model for Teaching Science Concepts to Visually Impaired Students

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## Definitions of visual impairment

**Visual Impairment**, also known as **vision impairment** or **vision loss**, is a decreased ability to see for a degree that causes problems can't be corrected fully with glasses, contact lenses, medication or eye surgery.

- **Functionally blind**: the student will use tactual media (which includes braille) as a primary tool for learning to be able to communicate in both reading and writing at the same level of proficiency as other students of comparable ability
- **Low vision**: can read with magnification or environmental modification
- **Totally blind**: must use tactual media (which includes braille) and auditory learning; no meaningful input through vision

## 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.



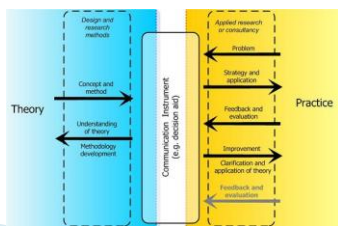
## Research questions

In this study, we developed an instructional design to teach the concepts of 'Matter and Heat' unit to visually impaired students. The answers of following questions were sought in the study:

- ▶ What is students' conceptual learning difficulties related to the concepts of 'Matter and Heat' unit?
- ▶ What criteria should be considered while developing materials to teach 'Matter and Heat' unit to visually impaired students?
- ▶ What is the effect of the instructional design model developed on students' conceptual learning of concepts of 'Matter and Heat' unit?

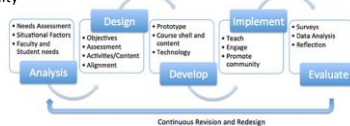
## Research Method: Design Based Research

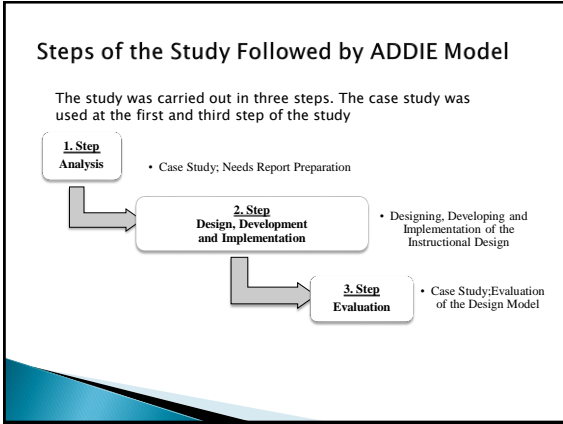
In this design based research (DBR), we developed an instructional design to narrow the gap between theory and practices. DBR focuses on developing theory and a methodology of designing, and DBR uses design research at a higher abstraction level



## 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





### Sample of the study

Two different sample groups were studied. Both of sample groups were studied same school for visually impaired students.

	Students Code	Gender	Visual Acuity
Needs Analysis phase Sample Group	SNA1	Male	Low vision
	SNA2	Male	Low vision
	SNA3	Female	Low vision (advanced)
	SNA4	Female	Low vision
	SNA5	Male	Low vision
	SNA6	Female	Low vision
Implementation Phase Sample Group	S1	Female	Blind
	S2	Female	Low vision (advanced)
	S3	Female	Low vision
	S4	Male	Low vision
	S5	Male	Low vision
	S6	Male	Low vision
	S7	Male	Blind

### Data collection tools

**Semi-structured interviews, Achievement tests and observations** were used as the data collection means.

The same achievement test was applied before and after the implementation of the study as the pre-test and post-test.

### Findings

► In this section, the findings obtained from the descriptive analysis of data gathered from achievement test and interviews will be shown

- ### List of the learning outcomes
- LO1:** Classify materials in terms of heat conduction (Conceptual knowledge/ Understanding dimension)
  - LO2:** Discuss the importance of heat insulation in buildings with regard to the effective use of resources, family and country economies (Conceptual knowledge/ Analyze dimension)
  - LO3:** Determines the selection criteria of thermal insulation materials used in buildings (Conceptual knowledge/ Understanding dimension)
  - LO4:** Develop alternative thermal insulation materials Conceptual knowledge/ Create dimension)
  - LO5:** Classifies fuels as solid, liquid and gaseous fuels and gives examples of widely used fuels (Conceptual knowledge/ Understanding dimension)
  - LO6:** Investigates and presents the effects of different types of fuels on heat, human and environment (Procedural knowledge/ Apply dimension)
  - LO7:** Investigate precaution to be taken regarding stove and natural gas poisoning (Procedural knowledge/ Apply dimension)

### The result of pre-test-post-test analysis

Learning Outcomes	Dimension	Students														Question Based Achievement (%)		Outcome Based Achievement (%)			
		S1		S2		S3		S4		S5		S6		S7		Pre Test	Post Test	Pre Test	Post Test		
		Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test								
LO1	4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	11.1	66.6			
	5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	11.1	22.2			
	20	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	22.2	77.7	22.2	66.6	
LO2	8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	77.7			
	12	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	88.8			
	9	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	44.4			
LO3	18	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	77.7			
	15	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	11.1	66.6	25.9	61.0	
	2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	88.8			
LO4	6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	66.6	29.6	66.6	
	10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	22.2	44.4			
	11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	22.2	16.6	33.3	
LO5	13	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0	44.4			
	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0	11.1	1.7	44.1	
	14	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	11.1	55.5			
LO6	16	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	44.4			
	17	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	44.4	22.2	44.4	
	19	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	22.2	66.6	22.2	66.6	
LO7	20	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	22.2	66.6	22.2	66.6	
	7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	44.4			
	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33.3	44.4			
Pre-Test: Achievement (%)		20	45	20	55	20	70	10	50	50	75	0	75	45	65	38.8	44	57.7	20.4	55.1	
Post-Test: Achievement (%)																					

### Students achievements identified through Interviews

Learning Outcomes	Question	Students									Question based Achievement (%)	LO based Achievement (%)		
		S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	S 9				
LO1	1	✓	✓	Did not participate the interview	✓	✓	✓	✓	✓	✓	✗	87.5	93.7	
	2	✓	✓		✓	✓	✓	✓	✓	✓	✓	100		
	3	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		93.7
LO2	4	✓	✓		✓	✓	✓	✓	✓	✓	✓	87.5	93.7	
	5	✓	✓		✓	✓	✓	✓	✓	✓	✓	100		
LO3	6	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	93.7	
LO4	No questions asked for this outcome													
LO5	7	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	81.2	
LO6	8	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	93.7	
LO7	9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	81.2		
Average Achievement (%)		94.4	77.8		100	100	88.9	100	94.4	72.2	90.9	89.5		

### Analysis of the students' responses to the 3rd question:

Example of Heat Conductors and Insulators	Right Answers	Partially Right Answers
Air	S7 : insulator S8 : insulator	S1 : thermal insulator
Copper	S7 : conductor S8 : conductive	
Wood	S7 : insulator S8 : insulator	
Chaff	S7 : insulator S8 : insulator	
Concrete	S7 : insulator S8 : insulator	
Polystyrene board	S7 : insulator S8 : insulator	
Aluminum	S7 : conductor S8 : conductive	S1 : insulator, thermal conductor transfer heat
Cotton	S7 : insulator S8 : insulator	
Iron	S7 : conductor S8 : conductive	
Platinum	S7 : conductor S8 : conductive	
Plastic	S7 : insulator S8 : insulator	
Glass	S7 : conductor S8 : conductive	

### Analysis of students' responses to the 4th question:

What does heat insulation mean?  
 -How to provide thermal insulation in buildings?  
 -What are the thermal insulation materials?

Right Answer	Partially Right Answer
<ul style="list-style-type: none"> <li>What does thermal insulation mean?</li> <li>S5: The material which does not transmit heat well is called thermal insulator. For example, if I hold something in hand but this doesn't warm up my hand that means it is made with a thermal insulator material</li> <li>S8: Thermal insulator can protect us for heat of something</li> <li>How is thermal insulation provided in buildings?</li> <li>S5: Mmm by placing Styrofoam between the walls, mmm or by using double glazed window</li> <li>S8: Thermal insulation in the buildings occurs on the walls. We cover the walls of buildings</li> <li>What are the thermal insulation materials?</li> <li>S5: Thermal insulation materials are fabric, polystyrene board, glass wool, silicone</li> <li>S8: Cotton, double glazed window, perforated wall</li> </ul>	<ul style="list-style-type: none"> <li>What does thermal insulation mean?</li> <li>S9: something that is thermal insulator</li> <li>S2: I don't know, it is called as polystyrene board in the buildings</li> <li>How is thermal insulation provided in buildings?</li> <li>S9: My teacher, they are tiling from the outside</li> <li>S2: I don't know, it is called as polystyrene board in the buildings</li> <li>What are the thermal insulation materials?</li> <li>S9: Heat insulation materials: Styrofoam, glass wool</li> <li>S2: Insulation materials at the same time are heat insulation materials: mmm for example polystyrene board, sand, double glazing, concrete</li> </ul>

### Comparison of interview and post-test achievements

Outcomes	Learning Level of Outcomes (%)										General Achievement of the Class (%)									
	S1	S2	S3	S4	S5	S6	S7	S8	S9											
LO1	40	83.3	60	100	100	60	100	80	100	80	100	100	40	100	40	66.6	66.6	93.7		
LO2	100	100	66.6	75	66.6	0	100	100	100	100	66.6	100	33.3	100	33.3	75	63.0	93.7		
LO3	33.3	33.3	33.3	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6		
LO4	0	100	0	100	50	50	100	100	33.3	100	66.6	50	100	0	50	50	100	33.3	93.7	
LO5	66.6	100	33.3	50	66.6	33.3	100	33.3	100	66.6	50	66.6	100	0	50	100	0	50	48.1	81.2
LO6	0	100	100	50	50	100	100	50	100	50	100	0	100	50	100	0	100	44.4	93.7	
LO7	50	100	100	50	50	50	100	100	100	50	50	100	50	100	50	100	50	50	66.6	81.2
Achievement (%)	41.4	97.2	51.4	70.8	64.3	51.4	100	75.7	100	70.9	83.3	57.1	100	43.8	91.6	39.0	73.6	55.5	89.5	

## Results and discussion

- Visual sense is important in teaching science. But while teaching science to individuals who are blind or have low vision, the activities and instructional materials should be designed by considering the different senses like as smelling, tasting, hearing and touching
- According to results of question-based achievement score analysis of pre-test (38.8%) and post-test (57.7%).
- On the other hand outcome-based analysis of achievement of post-test shows that the students showed higher achievement in question related LO1, LO3 and LO7 learning outcomes.
- The achievement score these outcomes is 66.6%.
- On the other hand, the Gain Score analysis (0.44) that done between pre-test and post-test show that our the instructional design model has 44% success on students' understanding concept of unit.

## Results and discussion

- Totally nine questions asked at interview and some of them are in-depth questions. According to question-based analysis of interviews, students had much better achievement as 90.9%. The same is true for outcome-based analysis as 89.5%.
- As a result, in the study, activities and materials that designed considering the students' unique needs has meaningful and significant contribution on students learning of the science concepts. At the same time the interview is one of the best assessment tools to assess students leaning.

Thanks for your attention

Questions?

Contact: [sozbilir@atauni.edu.tr](mailto:sozbilir@atauni.edu.tr)

Project web page: <http://efe.atauni.edu.tr> in  
Turkish but summary in English

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