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Family Support on Teaching Heat Radiation Transfer to Children with Visual Impairment

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ABSTRACT

This study aimed to provide the ability of family members to teach heat radiation transfer through radiation to children with visual impairment in the family environment. This study used an experimental demonstration method. The subjects in this study were two children with visual impairment. Heat material was given to families who taught blind children about heat transfer through radiation. Besides, these family members also demonstrated experimental experiments explaining heat radiation transfer. The results of this study indicate that the ability of children with visual impairment to understand heat increases compared to the ability before being given intervention from the family. The success in understanding radiation heat transfer is caused by patience in teaching children with visual impairments. The learning environment in the child's home allows children to learn heat radiation transfer calmly and comfortably. Family support can be a solution in helping children learn, especially about heat transfer through radiation.

Keywords:
Family support; heat transfer; radiation; visual impairment

1. Introduction

Heat radiation is the transfer of heat from one place to another [1]. This lesson about heat transfer will help someone with visual impairments in orientation and mobility. One of the conditions that must be fulfilled by them is to understand the clues in the environment so that they can find out their current position. Family support is an emotional bond such as a feeling of affection that sticks with someone else, especially parents and other family members and financial [2,3]. Family support in helping other family members can affect their psychology so that they can have a positive effect on doing something [4,5]. The results of research conducted by Zeng show that family support can improve family quality of life who have autism spectrum disorder [6]. This emotional bonding is used to teach heat radiation to children with visual impairment.

Children with visual impairment are children who experience obstacles in their vision [7,8]. Blind children were divided into two parts, namely low vision (acuity less than 6/18 = 20/60) and totally

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blind as a refractive corrected visual acuity of 3/60 (20/400) or below in the better eye or a central visual field of less than 100 around the point of central fixation [9]. In children with low vision, they still have a residual vision that can be maximized in carrying out their daily life. While they are totally blind, they have no vision left. In living their daily lives, totally blind children need tools such as a cane for a walk and a braille alphabet to present symbolic information [10]. This may result in individuals being developmentally delayed in gross and fine motor skills as well as visual perception. It is characterized by a poor visual performance that cannot be corrected by conventional methods such as surgery, medical treatment, or refractive correction [11] by spectacle wear (this is known as corrected acuity) [12].

Bayu *et al.,* heat radiation describes heat transfer in 31 vocational students. The results of this studied indicate that students' understanding increases in understanding heat transfer using light bulbs [1]. The results of research conducted by Widodo *et al.,* show that teacher collaboration can improve the ability of children with special needs (slow learners) to understand heat transfer. This study used a demonstration method which is conducted collaboratively by regular teachers and special teachers in introducing heat to slow learner children [13]. Jayanti and Hasanah also researched heat transfer in class X. through the true-experimental design method, showed the result that students showed a good response to learning outcomes regarding heat transfer [14]. Furthermore, Witanecahya and Jatmiko's research about heat transfer in high school students as many as 114 students. This research used a descriptive quantitative method. Their results indicate that the guided inquiry model can reduce misconceptions in heat transfer material [15].

Based on the results of the research described above, no study discusses heat transfer through radiation carried out to children with visual impairment. Rey-Galindo *et al.,* said that one way to get important information for blind children were through touch [16]. To prepare children with visual impairments to be able to independently live their daily lives, they must be able to carry out their daily activities without the help of others. They require early access to intervention and rehabilitation, aimed at improving functioning in daily life and social participation, and perhaps more general well-being aspects such as quality of life and psychosocial functioning [17]. Such as cooking rice, washing clothes, and ironing clothes. The challenge given to teachers is how to teach them to be independent in doing simple things in their daily activities. One of the activities that can be given to blind children is introducing heat and understanding the heat transfer. Even though we can provide a demonstration video, the child cannot see the process taking place. This is because they can't see the video and can only hear it. They need practice / demonstration in understanding this heat transfer. Therefore, the aim of this study is family support in teaching heat transfer through radiation to children with visual impairments. To support this research, we used two children with visual impairment.

2. Logical Framework of Heat Transfer Materials

2.1 Conduction is the Process by Which Heat is Transferred in a Solid

Figure 1 shows if pot is heated, thermal energy is imparted to the atoms or molecules locally at the point of heating. This causes those atoms to become excited (increases their internal vibrations or oscillations). These excited atoms impart some of their newly acquired energy to neighbouring atoms that in turn impart energy to other neighbouring atoms and so on until the unheated (grip the pot) end of the rod begins to warm. In this way the energy of thermal motion (phonons) is passed along from one atom to the next, always from the hotter to the cooler end of the rod. The actual mechanism for the energy exchange depends on the material of the rod.

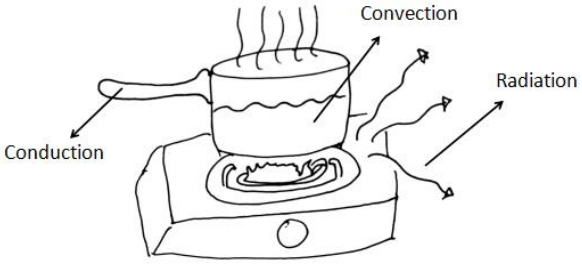

Fig. 1. Heat transfer process

The heat flow is always from the point with the highest temperature to the point with the lowest temperature or from the warmer object to the cooler object. In its most basic form the rate of conduction (dQ/dt) is determined by the differential form of the Fourier equation [18].

$$dQ= -kA(dT/dx)\ dt \quad (1)$$

dQ is the heat conducted in the direction x during the time interval dT, k is the thermal conductivity, and A is the cross-sectional area of the conducting surface. The rate of conduction is important in that we will be relying on it to bring thermal uniformity to the background. The thermal conductivity, k (W/m-K), is a material property, and if k is small (air, 0.023 W/m-K) or large (copper, 385 W/m-K) the rate of conduction will be high or low if all else is the same. Real objects in the field will have values of k somewhere in between: wood ~ 0.2 W/m-K, water ~ 0.6 W/m-K, and rock ~ 4 W/m-K [18].

2.2 Convection is the Process Whereby Heat is Exchanged and Transported from One Place to Another through the Actual Motion of Material (Liquid, Air)

When a solid at temperature TS and a fluid at temperature TF are in contact there are a plethora of factors involved in determining the rate of heat transfer. At the Figure 1, the fluid molecules are heated by conduction from the surface of the solid and in turn these molecules give up heat to adjacent molecules during the mixing [18]

$$dQ/dT=hA(TS-TF) \quad (2)$$

Eq. (2) gives a simplified expression for the rate of convective heat transfer (dQ/dt). It is simply proportional to the temperature difference at the solid/fluid interface. In the field TF would represent all possible fluids (e.g., water, air, mud) that have flow properties [18]. The value of h increases dramatically as forced convection takes over from flowing water from pot in Figure 1.

2.3 Figure 1 shows that Gas/Air Objects can also Deliver Heat Through the Radiation Process, in Which the Transfer of Heat in the Form of Electromagnetic Waves

The expression of radiation is using the Stefan-Boltzmann Law as [13].

$$p = \frac{Q}{t} = e\sigma AT^4 \quad (3)$$

The explanation of heat transfer through radiation will be more difficult to explain in children with visual impairment. They cannot see the source of heat and its effect on the ambient temperature. Children with visual impairment, only focus on their sense of perception.

3. Material and Methods

The tools used in this study were a rangefinder using a meter, a Thermo gun, a gas stove, and a room thermometer. The method used a demonstration experiment. we used two children with visual impairment (initials Ak and Nv) in Padang City as subjects in this study. They were categorized as totally blind. This research used a gas stove in their home. Each subject will be accompanied by a family member. Family members accompanying the children are given a video demonstration of an experiment about the transfer of heat through radiation. Furthermore, the family members assist the blind children in conducting demonstration experiments in knowing the transfer of heat through radiation. Each child will be interviewed during the baseline phase. The intervention will be carried out after the baseline data is obtained. The intervention stage starts at different times between children.

The intervention stage was carried out by family members who had watched videos and understood the heated material. Family members take the children to the kitchen and explain the functions and uses of the stove. Furthermore, family members explain heat transfer which is divided into three types, namely conduction, convection, and radiation. Experiments were carried out by turning the stove into three parts and at different distances. The amount of fire was divided into three parts:

i. Minimum 25%
ii. median 50%
iii. a maximum of 100%.

Meanwhile, the child's position is divided into three positions:

i. 50 cm distance from the fire source
ii. 100 cm from the fire source
iii. 150 cm from the fire source.

Before doing the demonstration, the kitchen room temperature will be measured. The temperature in the kitchen is measured using a room thermometer. While the temperature of the fire on the stove is measured by a Thermo gun.

Figure 2 showed the first stage of the demonstration, children with visual impairment and family members turn on the stove only up to 25% and the first position is at a distance of 50 cm, then move away from the stove by 100 cm, and the last step is away from the stove to a distance of 150 cm.

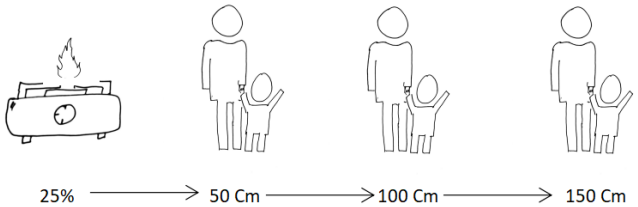

Fig. 2. Demonstration process phase (25%)

Figure 3 showed the second stage of the demonstration, children with visual impairment and family members turn on the stove by 50% and the first position is at a distance of 50 cm, then move away from the stove by 100 cm, and the last step is away from the stove to a distance of 150 cm.

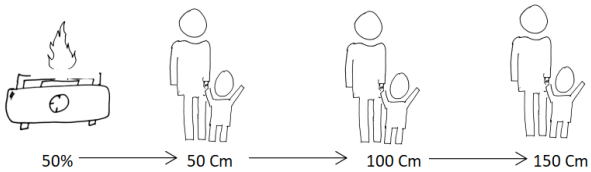

Fig. 3. Demonstration process phase (50%)

Figure 4 showed the final demonstration, blind children and family members turn on the stove to 100% and the first position is at a distance of 50cm, then move away from the stove up to 100 cm, and the last step is away from the stove to a distance of 150 cm. In the second stage of the demonstration, children with visual impairment and family members turn on the stove by 50% and the first position is at a distance of 50 cm, then move away from the stove by 100 cm, and the last step is away from the stove to a distance of 150 cm.

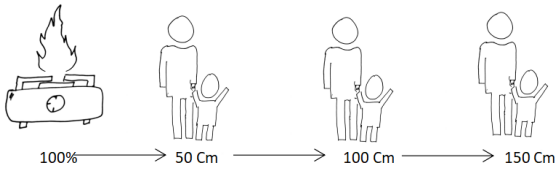

Fig. 4. Demonstration process phase (100%)

4. Result and Discussion

4.1 Demographic Data of Student with Visual Impairments

Figure 5 shows the child's ability in the concept development stage (Body Concepts, Spatial concepts, environmental concepts), sensory (Vision, Auditory), and communication (Tactile Maps) [19]. This information was very important because it shows the child's ability in developmental stages that can be useful in providing material about heat radiation transfer. Demographic data show that the developmental stages of the two subjects are not too much different from one another.

Student Ak and Nv were categorized into totally blind where the children had no remaining sight. The results of Figure 5 explain the developmental aspects of students Ak and Nv where they have good developmental stages. But in the vision, there were differences. Student Ak had no remaining sight. Meanwhile, Student NV can still distinguish between dark and light but this has been categorized as totally blind.

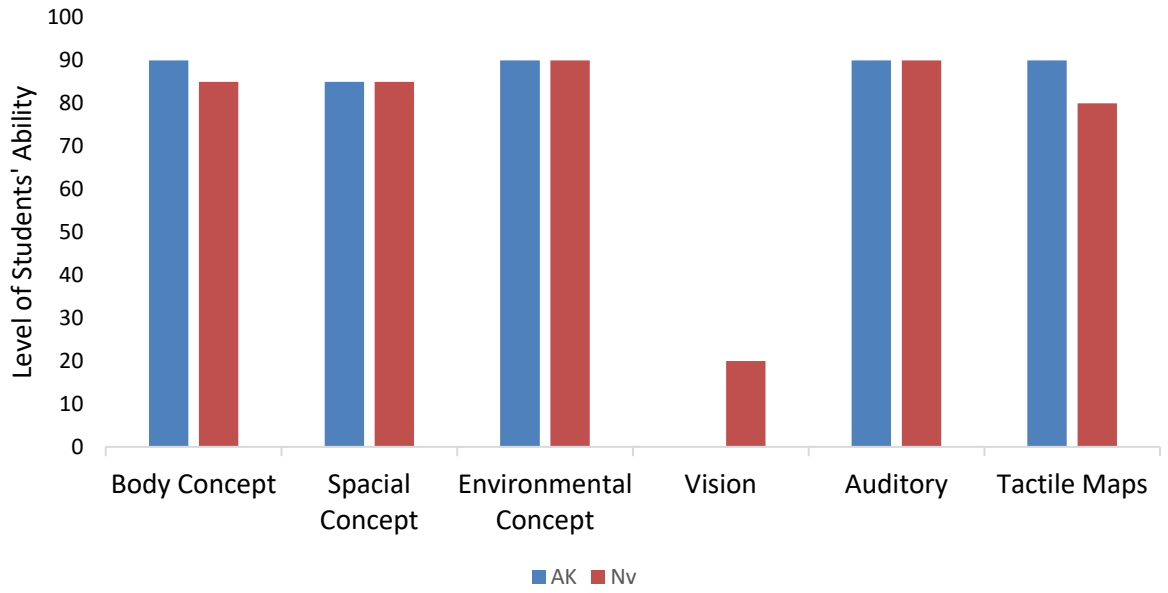

Fig. 5. Demographic data for children with visual impairment

Figure 6 describes the academic abilities of students Ak and Nv in the subjects of language, mathematics, science, and social science. This data was taken from the results of children's academic report in the previous semester. Based on these results, it can be seen that students Ak and Nv have very good scores.

The results of the stages of development and academic ability were shown in Figure 5 and Figure 6. based on their result, Students Ak and Nv can receive material about heat radiation transfer. However, because this is a demonstration experiment, the child will have difficulty experimenting due to obstacles to their vision. Based on these problems, family support is needed in carrying out this activity [20].

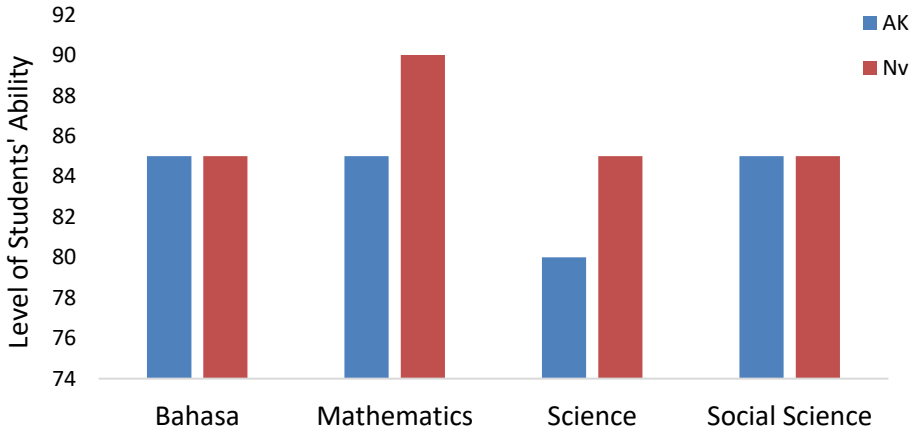

Fig. 6. Academic scores

4.2 Heat Radiation Transfer Learned to Students with Visual Impairment

Radiation is heat transfer without an intermediate agent [21]. Examples of radiation: the sun's heat reaches the earth even though it is through a vacuum, the body feels warm when it is near a fire source, incubates poultry eggs with a light, and clothes dry when dried in the sun. Table 1. showed the temperature differences that occur when we were in different positions and with different fire percentages. The farther we are from the heat source, the lower the temperature and the smaller the percentage of fire on the gas stove, the lower the temperature will be [18]. When we turn on the gas stove, we will feel the heat near the gas stove. The heat you feel when you are close to a gas stove is hot air generated from a gas stove fire.

Table 1
The result of heat measurement through fire on a gas stove

Fire Percentage (%)	Distance (centimetre)	Temperature (Celsius)
25	50	77,4
	100	32,4
	150	29,5
50	50	90.3
	100	34.0
	150	30.3
100	50	96.0
	100	66.0

The rate of heat radiation transfer was found to be proportional to the area of the object and the power of four of the object's absolute temperature (Kelvin scale). An object that has a larger surface area has a greater heat transfer rate than an object with a smaller surface area. This result was discovered by Josef Stefan in 1879 and derived theoretically by Ludwig Boltzmann about five years later.

Based on Eq. (3). several factors can affect heat transfer such as the amount of heat, time, the surface area of the object, and the absolute temperature of the object. Students with visual impairments still get information through senses other than sight, so in teaching heat transfer radiation transfer we directly conduct experiments in the kitchen using a gas stove.

4.3 Teaching Process

The learning process is based on the demographic results, developmental stages, and the results of the academic abilities of Ak and Nv students. The demonstration experimental method is used to attract students' interest in learning [22]. The ability of students who experience obstacles causes experimental demonstration activities to be difficult if carried out by students. So help from families is needed to assist students in carrying out demonstration experiments [5]. This method begins by providing understanding to family members about the material to be given. Furthermore, family members and students do this together in the kitchen, bringing the necessary equipment. Students with visual impairments will find it difficult to carry out activities in the kitchen. Besides that, based on Table 2. Explaining that students have never turned on a gas stove. It also carries a very high risk if students do it alone without being supervised by family members. Teaching is carried out in 5 stages. This is done so that we can analyse the learning process and students' abilities. In the first stage, we pretest by asking eight questions related to heat radiation transfer. We make the results of this pretest as the basis for providing the subject matter.

In the second stage, we provide video learning materials to family members. The video explains the material about heat transfer through radiation along with a demonstration of the experiment. After family members understand the material that has been given. The activity was continued to the next stage. In the fourth stage, family members invite students to conduct experimental demonstrations. The experimental demonstration begins with introducing temperature measuring devices (Thermo gun and room thermometer) and a gas stove. Furthermore, family members teach students how to turn on the stove and carry out experimental demonstration activities to completion. In the fifth stage, students are given post-test questions with the same questions at the pretest.

Table 2 shows the pretest and post-test results obtained in this study. Student Ak at pretest got a result of 0%. Meanwhile, Student NV got 12.5% results in answering the questions that had been given. After intervening in the form of experimental demonstration activities regarding heat radiation transfer, student Ak got a score of 87.5%, and Nv got a score of 62.5%. If we compare the results obtained between student Ak and Nv, then the ability of Student Ak is much improved compared to student Nv. However, all students showed significantly higher scores than the pre-intervention scores.

Table 2
Question about heat radiation transfer

Question	Students			
	Ak		Nv	
	Pr	Po	Pr	Po
Do you know about heat?	0	1	0	1
Do you know about the temperature?	0	0	0	0
Do you know a temperature measuring device?	0	1	1	1
Have you ever felt heat transfer through radiation?	0	1	0	1
Does distance affect temperature?	0	1	0	0
Do you know how to use a gas stove?	0	1	0	0
Did you know that heat transfer occurs when cooking water using a gas stove?	0	1	0	1
ow does fire on a gas stove transmit heat?	0	1	0	1
Total Score	0	87.5%	12.5%	62.5%

The success of students in understanding the material regarding heat transfer through radiation is supported by good academic abilities and developmental stages for each student [23]. Besides, family support that helps deliver material is also very important for student success. The experimental method can provide excellent information for students with visual impairments. The process of receiving information obtained from demonstration experiments further enhances the sensory abilities of students with visual impairments. This sensory ability will be more useful in developing the self-development abilities of children with visual impairments such as writing braille, orientation, and mobility.

5. Conclusion

The results of this study indicate that the ability of blind children to understand heat increases compared to the ability before being given intervention from the family. Apart from the child's demographics and the methods used, family support can be one solution in helping children learn, especially about heat transfer through radiation. This is due to the difficulty of children in their eyesight. So that the experimental demonstration at home must be assisted and accompanied by family members.

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