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WHEAT FLOUR AS A THERMAL INSULATOR FOR LEARNING MEDIA FOR STUDENTS WITH HEARING IMPAIRMENT

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Abstract

The goal of this study was to investigate the effectiveness of wheat flour that is potentially used as a thermal insulator for teaching and learning material for students with hearing impairment. Experiments were carried out on wheat flour that was put on the wall and heated by a bulb lamp. We also tested the lamp with various intensities (i.e., 8, 10, and 12 W) to confirm the successfulness of heat insulation when there is a heat transfer (i.e., heat radiation from a bulb lamp). According to the results, wheat flour is an excellent thermal insulator, which were corroborated by a test that demonstrated a drop in the temperature value in the insulator testing instrument. The wheat flour prevented the heat radiation from the lamp within the box. The phenomenon in the heat radiation was discussed, as well as the change in heat absorbed by wheat flour. The findings are intended to aid teachers in assisting students in comprehending the prevalence of thermal insulators, particularly for students with hearing impairment.

Keywords: Heat transfer, Radiation, Special needs students, Teaching, Thermal insulation.

1. Introduction

A thermal insulator is a substance that prevents heat from being transferred. Thermal insulators are commonly used as heat separators in culinary equipment. A material with a low thermal conductivity rating is ideal for use as a thermal insulator. The requirement of the material as thermal insulator is having a low thermal conductivity, a low density, and a low compressive strength [1, 2]. Learning about heat-insulating materials is crucial since they are frequently encountered and utilized in everyday life, such as thermal insulators.

There are a variety of heat-insulating materials that may be utilized to limit heat leakage and temperature dissipation [1, 2]. Polyester and glass wool are two examples of heat-insulating materials. In the case of polyester, the technique of producing polyester heat-insulating fibers is not ecologically friendly since polyester is made from petroleum. Regarding glass wool, the technique of creating glass wool is believed to be less ecologically friendly as it takes a lot of energy to attain a temperature of about 1500-1700°C for manufacturing glass fiber. Furthermore, if thermal-insulating materials are employed as a teaching medium, the instructor will have difficulties obtaining the teaching materials. It is true when facing the fact that the teaching and learning process takes place in an area with limited transportation options. As a growing and archipelago country, Indonesia is a good example for the possible facing this transportation problem. In reality, comprehending the science content is critical, particularly for vocational institutions that need experiments and practicum [3].

Students may have a basic understanding of thermal insulator. Students with special needs, on the other hand, require solid medium and straightforward explanations [4, 5]. Students with special needs, particularly those with hearing impairment, have challenges in both developmental and academic areas. As a result, they have an influence on learning issues. Special education and assistance are required for them [6, 7]. For students with hearing impairments, methods and media must be modified to aid in the teaching and learning process. Objects that students come across frequently in their everyday lives are employed as teaching and learning media, particularly for students with hearing impairment.

Based on our previous studies [1, 2], wheat flour was employed as one of the alternate learning media in this study. Despite the fact that numerous studies have looked into thermal insulators, none have looked into the usage of wheat flour as a thermal insulator for teaching and learning media in students with hearing impairment. Wheat flour is, in reality, readily available in everyday life. Because of its non-toxic qualities, it may be utilized as a learning medium by students. The studies involved using wheat flour as an insulator, which was placed on the wall and exposed to various levels of light intensities from a bulb lamp (i.e., 8, 10, and 12 W). We observed and analysed the temperature variations that occur over a given time period using a thermocouple analysis tool in this investigation.

2. Methods

Research subject and student demographics

The utilization of wheat flour as a thermal insulator for teaching and learning media, especially for teaching and learning students with special needs) was the main subject of this study. The method used in this study is depicted in Fig. 1, which includes the planning stage (preparation of various instruments and materials), the implementation stage (performing experimental activities), and ultimately the data analysis stage (observing and analysing the data obtained).

We prepared instruments and supplies for use in experimental activities, such as flour, mineral water, lights, spoons, stopwatches, thermocouples, and boxes, during the planning stage.

This research conducted tests utilizing the tools and resources given during the implementation stage. The procedure was observed in detail, documented, and reported. While at the data analysis stage, this study analysed the data obtained from the results of experimental activities.

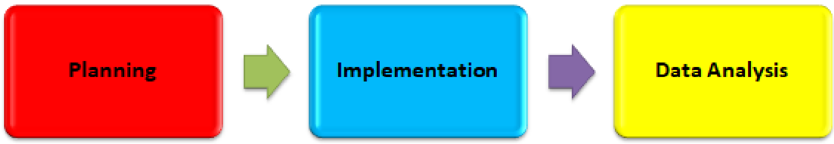

Fig. 1. Research procedure.

The main components were wheat flour (Kunci Biru, PT Bogasari, Indonesia) that was diluted by water (AQUA, PT Tirta Investama, Indonesia). Light bulbs (PT Philips Indonesia, Indonesia; 8, 10, and 12 W), a 250-mL measuring cup with scales (Nankai, PT Rohartindo Nusantara Luas, Indonesia), a spoon, a timer, a digital thermocouple, and a testing toolbox were among the instruments utilized. The concept of heat transmission idea was adopted from previous research [8] (see Fig. 2).

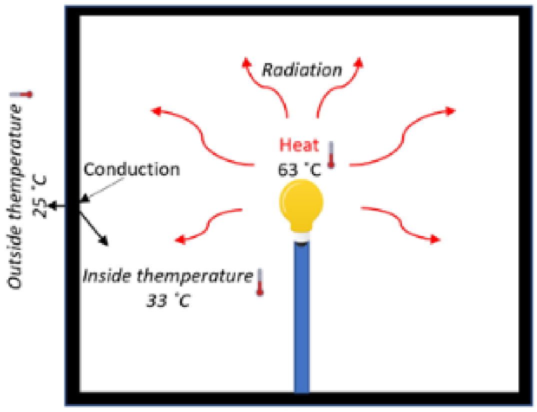

Fig. 2. The concept of the equipment (heat transfer by the light bulb).

The procedure steps were: (i) Weighing wheat flour (200 g), (ii) adding water (250 mL) into a measuring cup, (iii) adding and mixing wheat flour and water to form dough, (iv) pasting and drying the dough on the wall in the testing toolbox (thickness of 5 mm), (v) testing using a light bulb (i.e., 8, 10, or 12 W) in the toolbox, (vi) measuring each thermocouple temperature change (in the range of time of 0, 5, 10, 15, 20, 25, 30, 35, 40, and 45 minutes) and record the data findings.

The heating phenomena from the heat radiation of a lamp (placed within the box) to the walls was seen during the experimental demonstration (that were patched by wheat flour). The box's measurements were 30 x 30 x 30 cm in length, breadth, and height, correspondingly. The walls of this box were designed to be changed with other materials and insulators of the identical thickness and area. A lamp was used to generate heat radiation within the box (at the center), with a single button to make turning on/off the light simple.

Several thermometers were placed in various points in the box to examine the heat transmission phenomenon, and temperatures were monitored every 5 minutes. Four thermometers were installed on the interior of the box (one of which was affixed to the inner wall), and two thermometers were installed on the outside of the box to measure heat loss. The heat transmission by radiation and conduction were measured using the thermometers that were strategically positioned. By comparing the thermometers on the inside and outside of the box, the notion of conduction and heat loss was discovered.

The thermocouples were set with a 5 cm interval between them to ensure the evaluation of heat emitted by the lamp. In addition, cloth tape was used to seal the openings between the linked walls, preventing air from entering the heating system.

The specifications for the thermocouples used are:

(i) Temperature between -50 and 110°C with resolution of 0.1°C;

(ii) Operating voltage is 1.5 V with battery (LR44 Buttoned Batteries);

(iii) Thermometer dimension was fixed at 48 x 28.6 x 15.2 mm, compiled with monitoring screen (using LCD with dimension of 46 x 27 mm).

3. Results and Discussion

3.1. Analysis data experiment wheat flour as a thermal insulator for teaching and learning media for students with hearing impairment

The experimental setup utilized in this work is shown in Fig. 3. The tests were carried out by measuring the change in temperature as a result of heating time. The heating process was the result of heat radiation from the bulb light, as measured by thermometers. The experimental concept is to study the heat transmission phenomena utilizing an insulator testing box made of iron. The dimensions of the toolbox were 30×30×30 cm. We then patched wheat flour dough on each side on all four sides. A light bulb was installed on the upper side. The heat-emitting light bulb was positioned and hanged from the top of the box. We ensured to put the lamp in the center of the toolbox. The thermocouple was utilized to measure the change in temperature on each of the toolbox’s walls in four sides. On the exterior, two thermocouples on each side with a spacing of 5 and 10 cm measure the temperature outdoors.

Figure 4 depicts the idea, displaying the insulator testing experimental instrument (taken from above side). Heat was released by the bulb lamp. Thermometers (i.e., TA1, TB1, TC1, and TD1) were placed as a result of this. Wheat flour was used as an insulator on all four sides (i.e., A, B, C, and D). Two thermometers with a distance of 5 cm (i.e., TA2, TB2, TC2, and TD2) and 10 cm (i.e., TA2, TB2, TC2, and TD2) were mounted on each exterior wall (i.e., TA3, TB3, TC3, and TD3).

Three different light power settings were used in this investigation (8, 10, and 12 W). The results for wheat flour as an insulator utilizing an 8-W lamp power are shown in Table 1. The temperature test sites in this study were four within the insulator testing toolbox (i.e., TA1, TB1, TC1, and TD1) and eight outside locations with varied points of 5 cm (i.e., TA2, TB2, TC2, and TD2) and 10 cm (i.e., TA3, TB3, TC3, and TD3).

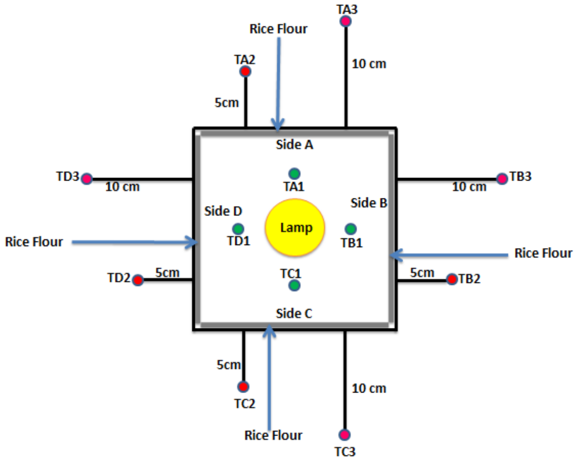

Fig. 3. The 2-dimensional layout of the heat transfer box. Layout was aken from the top of the box.

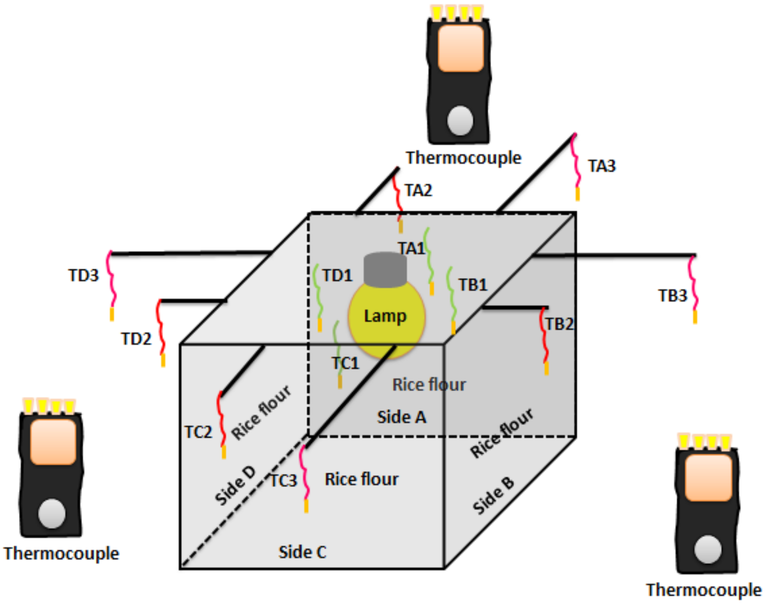

Fig. 4. The 3-dimensional layout of the heat transfer box.

Experimental results are:

(i) According to the results of the analysis, the four points in the testing box (i.e., TA1, TB1, TC1, and TD1) had the identical values from the beginning of the test (i.e., 25.70°C at 0 min) and to the completion of the test (24.70°C at 45 min). During the 45-minute test, the temperature in the toolbox remained steady, averaging 26.83°C.

(ii) The temperature values of four places outside the testing toolbox with a distance of 5 cm (i.e., TA2, TB2, TC2, and TD2) were identical from the beginning of the test (22.40°C at 0 min) to the conclusion of the test (22.20°C at 45 min). During 45 minutes of testing, the temperature outside the test equipment box appears to be constant, with an average temperature of 22.34°C.

(iii) The temperature values of four places outside the testing toolbox with a distance of 10 cm (i.e., TA3, TB3, TC3, and TD3) were identical at the beginning of the test (22.10°C at 0 min) to the completion of the test (22.10°C at 45 min). During the 45-minute test, the temperature outside the testing toolbox appears to be constant, with an average temperature of 22.15°C.

The temperature results were in good agreement with the data on the other side of the box. Tables 2 and 3 provide more information about the temperature. Table 4 then shows the comparative temperature data when there is a change in the light power.

Table 1. Testing results of wheat flour insulator using an 8-W lamp. T_{ave} is the average temperature.

Sample	Temperature (°C) at the testing time (min)										
	0	5	10	15	20	25	30	35	40	45	T_{ave}
TA1	25.70	27.60	28.20	28.60	29.20	26.20	26.70	26.70	24.70	24.70	26.83
TA2	22.40	22.70	22.40	22.30	22.30	22.30	22.00	22.30	22.50	22.20	22.34
TA3	22.10	22.50	22.20	22.10	22.20	22.10	21.90	22.20	22.10	22.10	22.15
TB1	25.70	27.60	28.20	28.60	29.20	26.20	26.70	26.70	24.70	24.70	26.83
TB2	22.40	22.70	22.40	22.30	22.30	22.30	22.00	22.30	22.50	22.20	22.34
TB3	22.10	22.50	22.20	22.10	22.20	22.10	21.90	22.20	22.10	22.10	22.15
TC1	25.70	27.60	28.20	28.60	29.20	26.20	26.70	26.70	24.70	24.70	26.83
TC2	22.40	22.70	22.40	22.30	22.30	22.30	22.00	22.30	22.50	22.20	22.34
TC3	22.10	22.50	22.20	22.10	22.20	22.10	21.90	22.20	22.10	22.10	22.15
TD1	25.70	27.60	28.20	28.60	29.20	26.20	26.70	26.70	24.70	24.70	26.83
TD2	22.40	22.70	22.40	22.30	22.30	22.30	22.00	22.30	22.50	22.20	22.34
TD3	22.10	22.50	22.20	22.10	22.20	22.10	21.90	22.20	22.10	22.10	22.15

Table 2. Testing results of wheat flour insulator using a 10-W lamp. T_{ave} is the average temperature.

Sample	Temperature (°C) at the testing time (min)										
	0	5	10	15	20	25	30	35	40	45	T_{ave}
TA1’	26.50	26.20	25.10	25.40	25.50	25.60	25.80	25.60	25.70	25.90	25.73
TA2’	22.30	23.80	22.90	22.80	23.10	23.10	23.10	23.10	23.50	23.20	23.09
TA3’	22.20	22.30	22.40	22.50	22.60	22.60	22.60	22.60	22.50	22.30	22.46
TB1’	26.50	26.20	25.10	25.40	25.50	25.60	25.80	25.60	25.70	25.90	25.73
TB2’	22.30	23.80	22.90	22.80	23.10	23.10	23.10	23.10	23.50	23.20	23.09
TB3’	22.20	22.30	22.40	22.50	22.60	22.60	22.60	22.60	22.50	22.30	22.46
TC1’	26.50	26.20	25.10	25.40	25.50	25.60	25.80	25.60	25.70	25.90	25.73
TC2’	22.30	23.80	22.90	22.80	23.10	23.10	23.10	23.10	23.50	23.20	23.09
TC3’	22.20	22.30	22.40	22.50	22.60	22.60	22.60	22.60	22.50	22.30	22.46
TD1’	26.50	26.20	25.10	25.40	25.50	25.60	25.80	25.60	25.70	25.90	25.73
TD2’	22.30	23.80	22.90	22.80	23.10	23.10	23.10	23.10	23.50	23.20	23.09
TD3’	22.20	22.30	22.40	22.50	22.60	22.60	22.60	22.60	22.50	22.30	22.46

Table 3. Testing results of wheat flour insulator using a 12-W lamp. T_{ave} is the average temperature.

Sample	Temperature (°C) at the testing time (min)										
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	T_{ave}
TA1”	25.50	25.70	25.60	25.50	25.40	25.80	25.40	25.50	25.50	25.70	25.56
TA2”	23.50	22.60	23.30	23.80	23.40	24.10	23.10	23.60	23.30	23.30	23.40
TA3”	22.60	22.30	22.00	23.00	23.20	22.70	22.80	22.70	22.50	22.60	22.64
TB1”	25.50	25.70	25.60	25.50	25.40	25.80	25.40	25.50	25.50	25.70	25.56
TB2”	23.50	22.60	23.30	23.80	23.40	24.10	23.10	23.60	23.30	23.30	23.40
TB3”	22.60	22.30	22.00	23.00	23.20	22.70	22.80	22.70	22.50	22.60	22.64
TC1”	25.50	25.70	25.60	25.50	25.40	25.80	25.40	25.50	25.50	25.70	25.56
TC2”	23.50	22.60	23.30	23.80	23.40	24.10	23.10	23.60	23.30	23.30	23.40
TC3”	22.60	22.30	22.00	23.00	23.20	22.70	22.80	22.70	22.50	22.60	22.64
TD1”	25.50	25.70	25.60	25.50	25.40	25.80	25.40	25.50	25.50	25.70	25.56
TD2”	23.50	22.60	23.30	23.80	23.40	24.10	23.10	23.60	23.30	23.30	23.40
TD3”	22.60	22.30	22.00	23.00	23.20	22.70	22.80	22.70	22.50	22.60	22.64

Table 4. Effects of lamp power on temperature. T_{ave} is the average temperature.

Lamp power	Position	Temperature (°C) at the testing time (min)										
		0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	T_{ave}
8 W	Inside box	25.70	27.60	28.20	28.60	29.20	26.20	26.70	26.70	24.70	24.70	26.83
	Outside box: 5 cm	22.40	22.70	22.40	22.30	22.30	22.30	22.00	22.30	22.50	22.20	22.34
	Outside box: 10 cm	22.10	22.50	22.20	22.10	22.20	22.10	21.90	22.20	22.10	22.10	22.15
10 W	Inside box	26.50	26.20	25.10	25.40	25.50	25.60	25.80	25.60	25.70	25.90	25.73
	Outside box: 5 cm	22.30	23.80	22.90	22.80	23.10	23.10	23.10	23.10	23.50	23.20	23.09
	Outside box: 10 cm	22.20	22.30	22.40	22.50	22.60	22.60	22.60	22.60	22.50	22.30	22.46
12 W	Inside box	25.50	25.70	25.60	25.50	25.40	25.80	25.40	25.50	25.50	25.70	25.56
	Outside box: 5 cm	23.50	22.60	23.30	23.80	23.40	24.10	23.10	23.60	23.30	23.30	23.40
	Outside box: 10 cm	22.60	22.30	22.00	23.00	23.20	22.70	22.80	22.70	22.50	22.60	22.64

The results showed the temperature differential within and outside the insulator testing tool's box. Between the start time and the 45-minute testing, the average five test sites revealed an increase in temperature. This proves that the lamp's power had an effect on heat radiation. The higher the lamp power, the hotter the room. This investigation also discovered that the temperature dropped over time as the lamp's power dwindled. The amount of battery power available to switch on the lights starts to dwindle. However, the average temperature of each test tends to be consistent.

According to this result, wheat flour has the potential to act as a thermal insulator. The smaller temperature differential outside the box compared to the temperature inside the box is the reason behind this. The temperature differential between the spots within and outside the box is 4.68°F in tests with an 8-W bulb.

The temperature differential between the interior and exterior of the box during testing with a 12-W bulb is 2.92°C. Because distance impacts heat radiation, the temperature outside the box, which is 10 cm away, is lower than the temperature within the box, which is 5 cm away [8].

3.2. Analysis Wheat flour as a thermal insulator for teaching and learning media for students with hearing impairment

Wheat flour as an insulator, as well as video of experimental demonstration activities, can be utilized as learning medium for students, particularly those with hearing impairments. Students with hearing impairment have issues with hearing, particularly in verbal communication [9, 10]. These issues caused various difficulties in the learning process, necessitating the use of special education services [12-14]. Students' requirements must be satisfied using materials, techniques, and media [15].

Hearing impaired students have difficulty comprehending abstract and complicated material [16]. They employ their visual senses to comprehend information throughout the learning process [6, 10]. Documenting experimental activities of flour as a thermal insulator might result in learning material such as movies, PowerPoints, and picture cards. Because the equipment and materials are solid, the use of wheat flour as a thermal insulator makes it easier for pupils to grasp the material knowledge being taught. Wheat flour is readily available in everyday life, providing advantages for use in the teaching and learning process. Functional and appropriate materials are required for pupils with unique needs [7, 17]. Students with hearing impairments require concrete, straightforward, and engaging media [6,7,10]. Students with hearing impairments can utilize the outcomes of the experimental activities as a learning medium. This corresponds to their requirements. In the implementation of further research, this learning media will use the direct demonstration experimental method by utilizing the media from the results of experimental activities.

4. Conclusion

The utilisation of wheat flour as a thermal insulator for teaching and learning media for students with special needs was effectively studied. Specifically, the teaching process was done to students with hearing impairment. Experiments were carried out by placing wheat flour on the wall and heating it with a bulb lamp of various powers (8, 10, and 12 W). Wheat flour is a strong thermal insulator, according to the findings. The notion of heat radiation was discussed as well as the shift in heat adsorbed by wheat flour that may be improved further for teaching and learning media for students with special needs. The wheat flour prevented the heat radiation from the bulb within the box from dissipating fully. The findings should aid teachers in assisting students in comprehending the existence of thermal insulators.

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