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EXAMINING UNDERSTANDING PERFORMANCE OF FLUID FLOW AND VISCOSITY THROUGH EXPERIMENTAL DEMONSTRATION FOR STUDENT WITH SPECIAL NEEDS

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Abstract

The purpose of this study was to instil students' understanding of the liquids flow rate and viscosity through an experiment. The experiment was carried out on 18 grade 3 elementary school students consisting of 2 students with special needs (hearing impairments (HI)) and 6 students categorized as slow learners. The method used was the single subject method by doing pretest and post-test. The experiment's equipment was an aquarium pump machine, likens the heart that was connected to a 5mm diameter hose pipe likens the blood vessels. Then, the protractor was used to measure the degree of height. It illustrated the destination of blood flow delivered to several parts of the body and a ruler and stopwatch as measurement tools. The tools were used to measure the distance, height, and duration when the fluid was pumped out. The results show that the flow rate with a high viscosity level took a longer time than the low viscosity level. The demonstration could be understood by all 3rd-grade elementary school students, including the students with special needs. Further, the demonstration method impacted students' understanding in choosing foods and drinks healthy for the body.

Keywords: Demonstration experiment, Fluid flow, Student with special needs, Viscosity.

1. Introduction

Understanding fluid flow and viscosity through demonstrated experiments for children with special needs is an alternative for understanding abstract concepts. Several references state that delivering effective learning to children with special needs required the method that involved the students directly [1], flexible, creative [2], using tools as a practical approach, and finding solutions when solving the problem in the learning process.

The fluid is a substance that can flow that can be a liquid or a gas [3]. The liquid may change continuously due to the influence of the friction force of the media that is passed. Also, it is closely related to physical conditions and the viscosity effect in the liquid. In Indonesia, fluid flow and viscosity are usually studied by students who are at high school level, especially in physics or chemistry subjects [4]. It is also studied at vocational high school level in the health department and or prospective medical personnel who was closely related to the fluids flow in the body [5].

Teachers of physics subject have an important role in delivering abstract materials such as physics subject. The materials have to be understood by the students. The results of her study showed that through moving activities and group discussions, students' understanding of the fluids was increased. It was proved by the completeness of the scores obtained [4]. However, those learning activities were still focused on reading texts and listening to teacher explanations. These conditions demanded the teacher to seek alternative learning methods that could increase student understanding and activeness [4]. The same research was also carried out in increasing the motivation and understanding of physics teachers in delivering the moving fluids subject [6]. Some researchers applied the research with experimental group activities in Madrasah Aliyah teachers for motivating and educating the physics concept, especially in moving fluid.

Based on the above studies, no study discussed the teaching of fluid flow and viscosity to elementary students, including the presence of students with special needs. Even though this fluid flow and viscosity material are interesting to deliver for students in elementary school, students can find out the fluency, pressure, and smoothness of a liquid when it passes through a medium/pipe. Fluid flow and viscosity material can be connected to the next grade education level. Then, the concept of the effect of consuming food and beverage on body health. Food and beverage digested in the digestive system become the nutritive food essence. The nutritive food essence transforms into blood liquid which then circulates around the body. The liquid inside the body, such as blood, mostly red blood cells contained food juices would affect the blood viscosity. The blood viscosity impacted on blood pressure and speed [7]. That fact needed to be conveyed to students in early education. It was expected they had a real imagination about the food and beverage consumed will affect the smooth supply of food substances throughout the body.

Through earlier education related to nutritious food intake, it can prevent bad diseases in the future. It is also in line with what has been conveyed by the international call about food intake prevention through nutrition education in schools [8]. Therefore, this study aimed to instil students' understanding of fluid flow and viscosity of liquids associated with the effects of food and beverages on body health. This study was aimed at providing students with special needs to have a clear picture of this material through these experiments. It also helped build new

knowledge and think critically about the flow of liquid substances and the viscosity of the food they consume. Therefore, they could choose the best food and beverages for themselves [9].

2. Logical Framework

2.1. Definition of fluid flow and viscosity

Fluid Flow is the flow of liquid through a medium, usually through a pipe or hose. Fluid viscosity may change depending on physical properties and also friction. The fluid has several properties, namely 1) compressibility, which would change in volume when compressed, 2) related to flow speed, 3) rotation, and 4) viscosity. Thick fluids will be difficult to flow [3].

Figure 1 illustrates how the fluid flows from left to right (where A1, A2 are respectively the large diameter of the pipe, as well as V1 and V2 are respectively representative fluid flow in the large diameter pipe section).

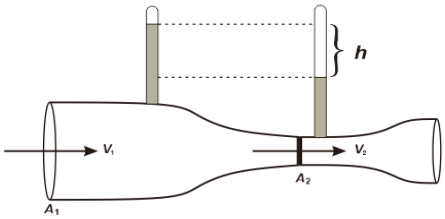

Fig. 1. Fluid flow in a pipe.

2.2. The comparison of the liquid flow rate with the viscosity level

Each liquid had a different viscosity (thickness). This difference causes the flow power of each liquid was different. Then, if a liquid flowed quickly means the viscosity of the liquid was low. If liquid flows slowly, the liquid has a high viscosity level (for example, cooking oil). Viscosity can also be measured by liquid velocity passing through a cylindrical tube. This method is one of the simplest, most accessible, and most usable ways to measure the liquid and gas viscosity. The viscosity value determines the liquid flow speed [10].

The flow rate of the liquid can be influenced by the volume of the substance, such as a particle diameter that is rather large to maintain pressure in the pipe [11]. The liquid characteristic greatly influenced viscosity. Food viscosity is the main parameter used as a formulation due to its rheological properties [12]. The important relationship between flow rate, pressure, and flow height can be found in the Bernoulli equation.

Figure 2 explains that if the cross-sectional area of the two sides is different it will affect the fluid flow rate. If one section of the cross-section has a different size, it will affect the pressure of the fluid flow rate. Therefore, energy and pressure are needed for the fluid flow in the pipe. The formula for the force at different sections is $w = PAL$ where F is the force (w) and P is the pressure.

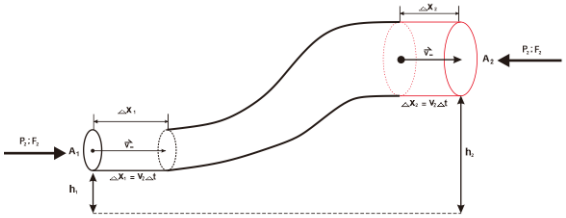

Fig. 2. Fluid flow in cross-section.

3. Research Methods

3.1. Research subject

This study used a single-subject design by conducting a pretest-posttest. The study involved 18 students from 3rd grade class in elementary school, with different student diversity characteristics, namely, six female students and 12 male students. The abilities and characteristics of their learning needs also varied. In the class, there were 2 students with hearing impairments (HI), 6 students with slow learning characteristics/Slow Learner (SL), the rest were non-disabled (ND). Figure 3 shows the percentage composition of the students' numbers.

3.2. Materials and method

The materials used in this experiment were a small aquarium pump machine, a small rectangular glass aquarium, a plastic pipe with a length of 1m and a diameter of 5mm, and a protractor. As for media with various liquid substances, including mineral water (Aqua, PT Unilever), fruit juice/mango juice (purchased at the Yogyakarta market), food extract (containing elements of vegetables, carbohydrates/rice, and protein/chicken meat), whole cow's milk (UHT, ultra milk, Ultrajaya, Indonesia), cooking oil and sugar water. The materials used in this experiment were materials that were familiar to children. It was to provide experiments with materials that were accessible or easy to obtain, familiar to children, and children could do it at home.

At first, we prepared the materials to be used as a trial. The researchers were weighing all liquids by the same measurement, namely 365 g. Then, the researchers also measured the volume with a measuring cup. One by one, the liquid was poured into a small glass aquarium. Placing the peak pipe into measured height using a protractor, then the pump engine was started. The sprayed liquid was marked first for measurement, as well as the height reached by the liquid. The stopwatch would calculate the time the liquid bursts until the liquid runs out of the tank. The description of this experimental process was passed in 4 stages. Namely, 1) preparation by taking a direct approach such as conducting interviews to the class teacher related to student characteristics and designing media, 2) preparing a video about the implementation of the experiment using various liquids, namely mineral water, fruit juice, food extract (vegetables, carbohydrates, and chicken meat protein), whole milk, cooking oil and sugar water. The teacher or examiner took note of the experimental results such as distance, altitude, and also the flow rate of each liquid. The video began by providing an initial illustration about the water

flowing from a hosepipe, followed by the testing results in each liquid (Fig. 3), 3) conducting a pretest to reveal students' initial understanding, 4) using the video by sharing video links. Parents conducted direct observations regarding student responses; 5) a post-test was conducted to determine whether there was a change in students' understanding.

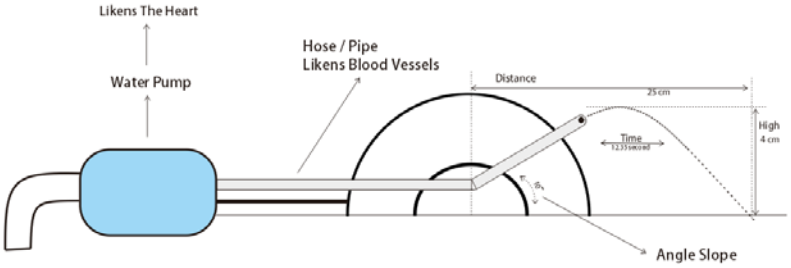

Fig. 3. The measurement results of mineral water.

4. Result and Discussion

4.1. Experiment results

Table 1 shows the results of trials in which mineral water, fruit juice, vegetable juice, protein and carbohydrates, and milk had almost the same distance, height, and duration spray. This case was influenced by the absence of other substances that increase viscosity, such as liquid sugar or cooking oil. The viscosity will be directly proportional to the concentration of the solution. If the solution has a high concentration, the viscosity will be higher, too. This result is the same with the concept of viscosity [10]. The time required to pump the liquid was varied. It proved a high concentration of a solution with a large number of dissolved substance particles. This case caused the friction between the particles, which were getting higher, causing the slow rate of the liquid being flowed [10].

Observation of liquid flow rate provides a real picture of how blood flow in the body. The blood flow in the body will be driven by the work of the heart [5], and in this case, the water pump will represent the heart that will push the fluid to flow faster. A small diameter pipe hose with a diameter of 5 mm also likens an artery.

4.2. Students' demographic data

Students' interest are religion of 28.60%, Math of 28.60%, Linguistic of 21.40%, Art of 28.60%, Science of 21.40%, Social Science of 14.30% and Sport of 42.90%. This interest is closely related to the models selection, strategies, and learning media [13, 14]. Paying more attention to student interests will foster internal motivation in learning a material [15]. The interest in the subject shows that the most attractive major was sports. Most students have kinesthetic learning styles. Understanding the students' learning style can affect in determining the most suitable methods, strategies and learning media [16]. Then, by submitting videos of the experiments also becomes an effort to improve experience-based skills [17].

Table 2 illustrates and increment of the student understanding than the beginning and after viewing the video. Some points seem to decrease, but not so much, especially on whether drink had an impact on the body health. The beverage

variations need to be tested further so that it will strengthen this point. Meanwhile, in the section related to the liquid flow, the effect of the viscosity level on the smooth flow had a significant increase.

The learning process that has a significant impact on changing student behaviour is the learning process based on the school curriculum and combined with the experimental learning [13, 14]. In addition, the right learning strategy chosen by the teacher will significantly impact the changes in children's habits and behaviour patterns.

Table 1. Measurement results for liquid substances.

Liquid Type	Weight (g)	Volume (ml)	Degree (°)	Spray Distance(cm)	Height Distance(cm)	Time (s)
Mineral Water	365	390	20	27	7	12
			40	26	10	11.89
			60	12	14	12.08
			80	8	14	12.02
			90	0	16	13.43
Vegetable juice, protein, and carbohydrate	365	365	20	32	9	13.75
			40	27	13	11.29
			60	23	14	13.09
			80	2	15	12.18
			90	0	16	11.24
Juice	365	410	20	29	7	12.73
			40	30	10	15.67
			60	26	13	14.87
Milk	365	365	20	25	7	14.14
			40	23	9	15.33
			60	15	12	14.6
			80	11	15	12.64
			90	0	15	13.38
Cooking oil	365	420	20	10	4	9.23
			40	7	3	25.59
			60	0	0	13.54
			80	0	0	24.98
			90	0	0	35.47
Sugar liquid	365	340	20	31	5	20.97
			40	29	9	32.51
			60	26	13	19.77
			80	10	14	17.54
			90	0	16	18.39

Table 2. Pretest-postest result.

Question	Pretest	Postest	Gain
Definition of healthy food and beverages	100	100	0.00
Influence of food on your health	100	100	0.00
Influence of beverage on your health	100	94.70	-5.30
Definition of blood flow	88.90	94.40	5.50
Effects of food type on blood flow	88.90	94.70	5.80
Effects of the beverages on blood flow	83.30	94.70	11.40
Blood as liquid/fluid	88.90	94.70	5.80

Question	Pretest	Postest	Gain
Definition of viscosity	72.20	72.20	0.00
Viscosity in liquid	44.40	77.80	33.40
Effects of food on viscosity of the blood	72.20	83.30	11.10
Effects of beverages on blood viscosity	77.80	83.30	5.50
Effects of viscosity on blood flow	55.60	77.80	22.20
Correlation of viscosity and movement of fluid	55.60	66.70	11.10
Effects of drinking water on blood viscosity	77.80	72.20	-5.60
Effects of drinking fruits on blood viscosity	77.80	83.30	5.50
Adding more fruits for decreasing blood viscosity	66.70	77.80	11.10
Effects of fried food on blood viscosity	88.90	83.30	-5.60
Effects of milk on blood viscosity	72.20	88.90	16.70
Fluid flow of milk and cooking oil	72.20	94.40	22.20
Viscosity of water and syrup	72.20	77.80	5.60
Viscosity of milk and fruit juice	66.70	88.90	22.20
Viscosity of milk, fruit juice, cooking oil, and syrup	72.20	77.80	5.60
How blood viscosity affects blood flow	50.00	72.20	22.20
Correlation of viscosity and fluid flow in body	33.30	83.30	50.00
Correlation of viscosity and angle of flow	38.90	72.20	33.30
Effects of blood viscosity on heart	83.30	83.30	0.00
Effects of blood viscosity on heart work	50.00	88.90	38.90
The heart work would be lighter when the blood viscosity is lower	77.80	77.80	0.00

4.3. Teaching result

Based on the pretest and post-test results in Table 3, it is clear that there was a very significant development in scores between understanding before observing the experiment and after observing the experiment. Although several points had the same score or even slightly drop, the resulting score was not so far different. Through the pretest-posttest, it can be clearly explained how students understand the concept [18].

After the t-test was done, the t-test was used to check more validly. Then, there was a difference between the average value before and after the action was given. The t-test result was -1.76426, while the t-table was 1.99773. While the Ho determination criterion was accepted if t-table <t-count <t-table. Based on the results of the t-count. There was a difference between the average score before and after demonstrating the experiment.

4.4. Qualitative analysis

During the experimental process, while all the students were watching the videos, their parents carried out observations about students' attitudes and interests in understanding the content of the material. The questions given were related to students' observations, namely, "were the students interested and enthusiastic when seeing the video sent?" All parents answered that the children were interested and enthusiastic. Some tried doing their trials with materials at home. Their curiosity could be explored in their way. Some parents gave testimony that after watching the experimental video, their children were able to choose good food for their bodies. Indeed, this method was very beneficial in building the students' metacognition [18].

The results of the post-test were significant (see Table 2). The student's understanding of viscosity and the significant effects of smoothness in liquid

viscosity in the body increased [10]. The lower the viscosity of the fluid, the faster and smoother the fluid could flow and be conveyed to other parts of the body. Also, students could understand that a high level of viscosity was very influential in the hearth work. The result illustrates that all students could understand the material clearly. The student diversity in the class could access those materials easily.

5. Conclusion

The demonstrated fluid flow experiment and liquid viscosity substances were able to build children's metacognition. The selection of learning strategies were friendly and accessible to all children, including children with special needs. The direct experimental demonstration method was proven to increase the students' understanding and critical thinking. The students were able to relate the demonstration method with the understanding about the food that impacts the body's health that they have mostly learned with the memorization and abstract.

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