Journal of Engineering Science and Technology
Special Issue on AASSEEEC2020, December (2020) 19 - 29

THE IMPORTANCE OF TEACHING VISCOSITY USING EXPERIMENTAL DEMONSTRATION FROM DAILY PRODUCTS ON LEARNING PROCESS ESPECIALLY FOR STUDENTS WITH SPECIAL NEEDS

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Abstract

The purpose of this study is to demonstrate the strategies in teaching viscosity using experimental demonstration for students with special needs. This study used the single subject research method with Pre-test and Post-test research design. The subjects of this study were students with special needs (students with intellectual disabilities and students with hearing impairment) at vocational high schools in Kuningan District, Indonesia. In this study, the learning process used experimental demonstration supported by recorded videos as learning media. The video showed the experimental activities of the viscosity level on eight substances (i.e. syrup, cooking oil, hand soap, liquid detergent, floor cleaner liquid, condensed milk, and mineral water). Results of the experiments in the videos indicate that condensed milk has the highest level of viscosity and mineral water has the lowest level of viscosity. The results of this study show that combination of experimental demonstration and media were very effective in improving the understanding of students with special needs in learning viscosity. This was confirmed by the increasing pre and post test results, supported by interviews. The use of interesting media with simple explanations made it easier for students with special needs to understand the material being taught, particularly in learning science which is considered quite complicated.

Keywords: Experimental demonstration, Learning, Students with special needs, Video-based learning media, Viscosity, Vocational high school.

1. Introduction

Nowadays, many researches discussed learning about viscosity [1-5]. However, researches discussing the learning of viscosity for students with special needs are relatively difficult to find. One of the contributing factors is the students with special needs have behavioral characteristics that cause problems in the learning process [6]. Teachers have difficulty teaching students with special needs, particularly in learning science, which is considered quite complicated, whereas viscosity material is very important to be taught to students because this material is in the national education curriculum [7].

Therefore, the aim of this research is to identify viscosity learning for students with special needs at vocational school in Indonesia. We used daily products, such as syrup, cooking oil, liquid hand soap, dishwashing liquid detergent, floor cleaner liquid, concentrate liquid detergent, condensed milk, and mineral water. The use of daily products gives some advantages such as harmlessness, easily found, students' familiarity with the products, and their opportunities to do it repetitively at home. Thus, students understand the viscosity level of the materials they often see and use. We did the experimental demonstration as well as the experimental video, which is prospective for learning process [8], especially for students with special needs since it makes learning processes more effective.

2. Theoretical Explanation

Figure 1 shows the terminal velocity of an object (marble) that is dropped into a thick fluid (honey). When the marble reaches the liquid honey, it will flow down due to the weight of the object *W* and the gravity of the surface. The marble experiences the frictional force of the *Fa* and the resistance of the *Fs* to the viscosity of the honey liquid. The coefficient of friction is referred to as viscosity.

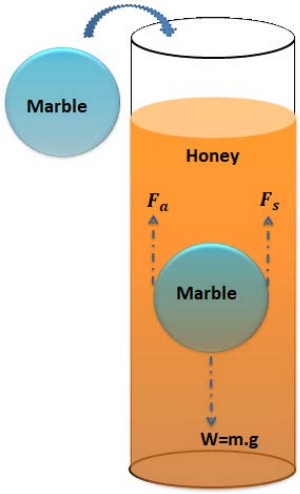

Fig. 1. Illustration of terminal velocity on honey when a marble is dropped.

Spherical events that enter liquid have the formula or equation [9]:

$$\Sigma F_y = 0$$

$$F_a + F_s = W$$
$$\rho f(\frac{4}{3}\pi r^3)g + 6\pi r\eta V = (\frac{4}{3}\pi r^3 \rho b)g$$
$$V = \frac{2r^2 g}{9\eta}(\rho b - \rho f) \quad (1)$$

where V is the terminal velocity (m/s), η is the coefficient of fluid viscosity (Pa s), r is the radius of the ball (m), g is the acceleration due to gravity (m/s^2), ρb is the density of the ball (kg/m^3), and ρf is the density of the fluid (kg/m^3).

The frictional force of the surface of a solid moving with fluid is proportional to the relative velocity of the object that moves to the fluid. The flow barriers within the fluid are caused by the friction between the fluid component attached to the surface of the object and the fluid portion next to it [10]. The frictional force is proportional to the fluid viscosity coefficient (η). Calculation of η using Stokes law is conducted by a falling marble experiment. The marble density is more like the frictional force, and the marble drops at a fixed speed of v [9]:

$$W=F$$
$$mg = 6\pi r\eta V \quad (2)$$

where Fs is the resistance force (N), η is the coefficient of viscosity (kg m^{-1} s^{-1}), r is the radius of the ball (m), π is 22/7, v is the relative rate of objects in the fluid. The law of Stokes formula F_s can be derived namely [10]:

$$F = 6\pi r\eta V \quad (3)$$

Figure 2 illustrates the phenomena happening due to the use of different viscous liquid (i.e., water and syrup). Mineral water has lower viscosity than syrup. Consequently, the object in the syrup requires more time to reach the surface. The greater the level of viscosity the greater the frictional force produced.

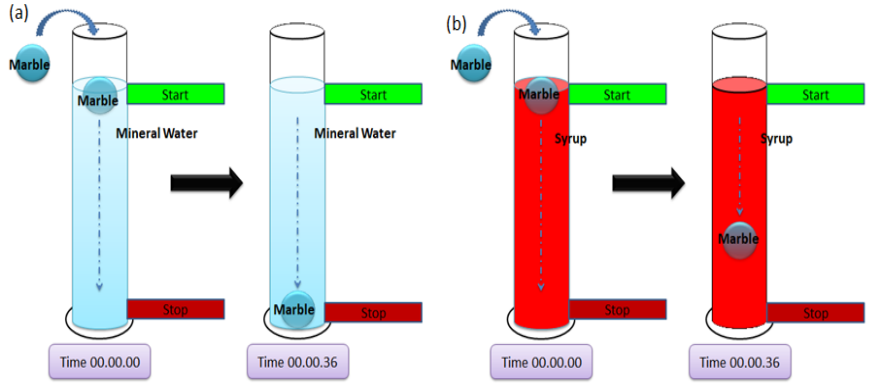

Fig. 2. Illustration to determine the difference in viscosity of (a) mineral water (b) syrup.

Table 1 explains the state of the art in the teaching media regarding viscosity. What distinguishes this study is the individual approach and the use of experimental demonstration. In addition, the media used were daily products and the research subjects were students with special needs.

Table 1. State of the art for teaching viscosity .

Reference	Approach	Media	Subject
Perez-Sanchez et al. [2]	-classical -Induktif method (talk method)	Viscometer and water	not students with special needs
Reid et al. [3]	-classical -experiment method	Viscometer organic particles	not students with special needs
Pande et al. [4]	-classical -talk method	Micro swimmers	not students with special needs
Tagavifar et al. [5]	-classical -experiment method	Oil, brine, surfactant, and cosolvent	not students with special needs
This study	- individual -experimental demonstration method	Viscometer (Zhun Cup #2) and daily Products	students with special needs

3. Materials and Methods

Figure 3 describes the materials and stages of the research method. The first stage is starting the study by determining the research subject. The second stage is making learning videos by providing tools and materials and conducting experiments. The third stage is carrying out the learning stages.

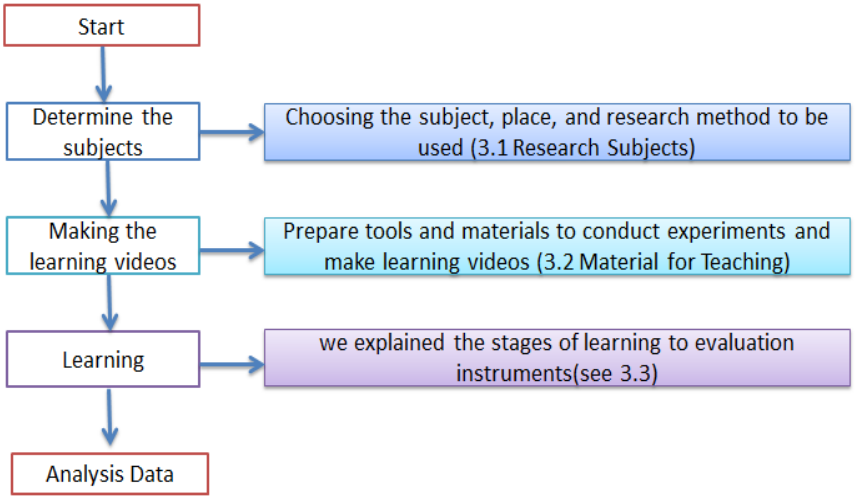

Fig. 3. Materials and stages of research method.

3.1. Research subjects

This study used an experimental method (single subject research) and A-B (Pre-test and Post-Test) design. The subjects of this study were three students with special needs (students with intellectual disabilities and students with hearing impairment) at a vocation school in Kuningan, Indonesia. At the beginning, we conducted interviews with the class teachers to get information about the students' abilities such as their intelligence level, concentration, communication, and their motor skills. We also collected data about the students' knowledge academically, specifically on Indonesian Language, Mathematics, Natural Sciences, and Civics

Education subjects. We then used the data to develop research instruments. All the information assessed using a score of 5 on a scale of 0 (do not know anything), 1 (not good), 2 (less good) 3 (good enough), 4 (good), 5 (very good).

3.2. Materials for Teaching

We used eight ingredients namely syrup (Marjan Cocopandan, PT. Lasallefood, Indonesia), cooking oil (Kunci Mas, PT. Smart Tbk, Indonesia), liquid hand soap (Nosy, PT. Sparindo Mustika, Indonesia), dishwashing liquid detergent (Mama Lemon, PT.Wings Surya, Indonesia), floor cleaner liquid (SoKlin Lantai, PT. Wings Surya, Indonesia), concentrate liquid detergent (SoKlin Liquid, PT.Wings Surya, Indonesia), condensed milk (Frisian Flag, PT. Frisian Flag, Indonesia), and mineral water (Le Minerale, PT. Tirta Fresindo Jaya, Indonesia)

In the experimental learning process, we put the liquid in a 100-ml-chemical measuring tube. Then, we put a marble with 1 cm diameter into the chemical measuring tube containing 100 ml liquid, and calculated the time that the marble took to reach the bottom surface of the chemical measuring tube using the mobile stopwatch. Besides marble, we also used a pearl brooch with 0.75 cm diameter and applied the same stages.

We used viscometer (Zhan cup- #2 ASTMD 4142, China) to measure the viscosity level. We put 120 ml liquid inside a plastic glass (210 mL). Then, we put the Zhan cup inside the plastic glass and waited for five minutes. After that, we lifted the Zhan cup and calculated the time needed until the flow stopped dripping from the Zhan cup hole. The results can be calculated manually using a formula or ElcoCalc application. The calculation formula is:

$$K(t - C) = V \tag{4}$$

where K and C are the constant and concentration given in the Zahn Cup table, respectively. K is 3.5 (for Zhan Cup #2), C is 14 (for Zhan Cup #2), t is the flow time in seconds, and V is the kinematic viscosity in cSt.

3.3. Learning Method

The teacher conducted experimental activities and made it in the video. This was conducted in such a way in order to enable the students with special needs to understand the material provided by the teacher easily. After that, the teacher asked parents to help by asking them to give the pre-test and post-test to students by asking a few questions to assess the effect of the use of experimental video on the level of understanding of students with special needs in learning the viscosity of the fluids (see Table 2). We made 18 polar questions and analysed it as 0 for no and 1 for yes. If students answered yes to all the questions then the total score would be 100. We simplified the analysis of students' level of understanding and all information obtained was assessed using a scale score.

Table 2 shows 18 polar questions related to the level of viscosity of substances given to the students. We compared the results of the teaching process with experimental video (W) and without (W0) experimental video media. Each question has a maximum score of 1. If the students answer 18 questions correctly, the maximum score obtained is 100.

Table 2. Questions and scores about the viscosity given to the students.

No.	Question	Student A		Student B		Student C	
		W0	W	W0	W	W0	W
1	Definition of liquid	1	1	1	1	1	1
2	Definition of molecules in liquid	0	1	1	1	1	1
3	Definition of fluid	0	1	1	1	1	1
4	Viscosity of syrup, cooking oil, the hand soap, the dishwashing detergent, the floor cleaner detergent, the concentrate detergent, condensed milk, and mineral water?	0	1	1	1	1	1
5	Syrup is thicker than water?	0	1	1	1	1	1
6	Syrup is thinner than condensed milk?	1	1	1	1	1	1
7	Water is thinner than dishwashing liquid detergent and floor cleaner liquid?	0	1	1	1	1	1
8	Condensed milk is thicker than cooking oil?	0	1	1	1	1	1
9	Cooking oil is thinner than hand soap	1	1	1	0	1	1
10	Definition of viscosity	0	1	0	1	0	1
11	Factors affecting viscosity	0	0	0	1	0	1
12	Size, shape, and interaction of molecules, and temperature affecting the viscosity?	0	0	0	1	0	0
13	A liquid with low viscosity flows easily?	0	1	0	1	0	1
14	A liquid with high viscosity flows slowly?	0	0	0	1	0	1
15	Formula for calculating viscosity?	0	0	0	1	0	1
16	An object takes more time to reach the bottom of liquid with high viscosity?	0	0	0	1	1	1
17	An object takes less time to reach the bottom of the liquid with low viscosity?	0	1	0	0	1	1
18	Benefits of studying viscosity?	0	0	0	1	0	1
Number of correct answer		3	12	9	16	11	17
Score		16.7	66.7	50	88,9	61.1	94.4

*Note: W0 = without experimental video, and W = with experimental video

4. Results and Discussion

4.1. Student demographics

Figure 4 shows the level of students' abilities in developmental areas, namely the level of intelligence, concentration, communication, and motor skills. Figure 5 shows the level of students' knowledge in academic aspects. Students A and C did not have good academic abilities in Indonesian language, mathematics, natural

sciences, and civic education. The students with intellectual disabilities had low concentration and the intelligence level was below average and so this affected the learning outcomes. While student B had a fairly good level of academic ability in Indonesian language, mathematics, natural sciences, and civic education. Students with hearing impairments did not have problems in the intelligence aspect although they had communication problems which made them difficult to understand the information given during the learning process [11].

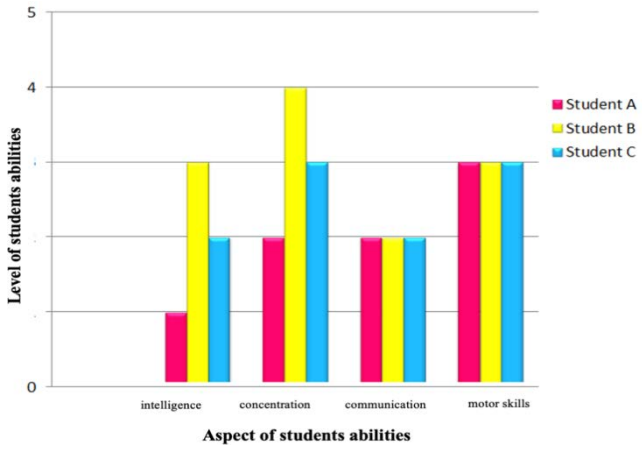

Fig. 4. Students' conditions.

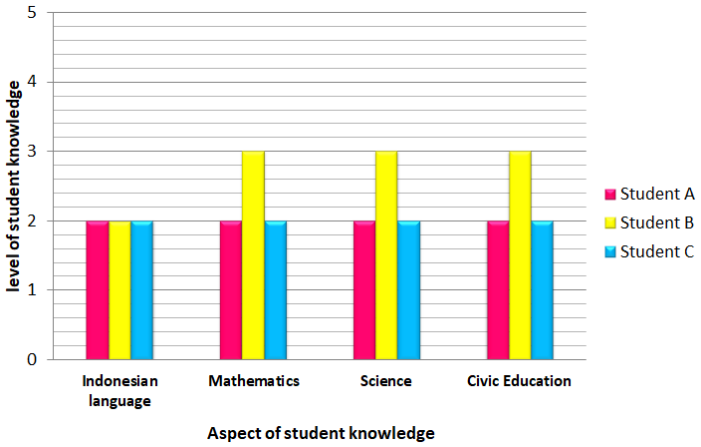

Fig. 5. Students' knowledge and understanding.

4.2. Teaching process

Table 3 shows the viscosity level of the fluids tested. There were eight types of fluids tested. Based on the experiment, condensed milk had the highest level of viscosity, marble took 16.52 seconds and pearl brooch took 19.79 seconds to reach the surface of the chemical measuring tube. Whereas water had a low viscosity level because the marble took 0.36 seconds and the pearl brooch took 0.41 seconds to reach the surface of the chemical measuring tube. As for the viscosity level from highest to lowest, they

were condensed milk, concentrate liquid detergent, dishwashing liquid detergent, hand soap, floor cleaner liquid, syrup, cooking oil, and mineral water respectively.

Table 3. Viscosity level of eight types of substances.

No.	Material Type (Substance)	Colour	The time from start (green sign) to finish (red sign)		Viscosity order
			Marble	Pearl brooch	
1	**Syrup**	Red	0.76	1.13	6
2	**Cooking oil**	Yellowish	0.47	0.51	7
3	**Hand soap**	Yellow	4.77	4.11	4
4	**Dishwashing liquid detergent**	Green	5.36	8.22	3
5	**Floor cleaner liquid**	Blue	1.54	2.64	5
6	**Concentrate liquid detergent**	Purple	6.41	9.06	2
7	**Condensed milk**	Whitish Cream	16.52	19.79	1
8	**Mineral Water**	Clear	0.36	0.41	8

Table 4 shows the results of the fluids tested using the ElcoCalc application. The highest viscosity level is condensed milk with 1621.03 cSt and the lowest is mineral water with 10.78 cSt. The viscosity learning process using an experimental video was conducted for 90 minutes.

The first session was 45 minutes where the teacher did viscosity learning using the conventional method without using any media. After that, the teacher gave a pre-test by giving 30 questions to students. In the second session, the teacher taught using experimental videos as learning media. After that, the teacher gave a post-test by giving 30 questions to students.

The learning process using experimental videos as learning media affected students' learning outcomes. Before using experimental video media, all students' learning outcomes (pre-test) were below 70. After the teacher used experimental video, they improved (above 70).

Table 4. Viscosity level of eight types of substances from ElcoCalc.

No.	Material Type (Substance)	Colour	Time (second)	Kinematic viscosity (cSt)	Viscosity order
1	**Syrup**	Red	36.13	77.46	6
2	**Cooking oil**	Yellowish	25.15	39.03	7
3	**Hand soap**	Yellow	226.16	742.56	4
4	**Dishwashing liquid detergent**	Green	414.14	1400.49	3
5	**Floor cleaner liquid**	Blue	163.13	521.13	5
6	**Concentrate liquid detergent**	Purple	424.17	1435.60	2
7	**Condensed milk**	Whitish Cream	477.15	1621.03	1
8	**Mineral Water**	Clear	17.8	10.78	8

4.3. Analysis Data

Figure 6 shows the pre-test and post-test scores obtained by students. Student A got 16.70 at the pre-test and 66.7 at the post-test. Student B got 50 at the pre-test and 88,9 at the post-test. Student C got 61,1 at the pre-test and 94,4 at the post-test. Learning science, in the context viscosity, is considered difficult. However, it can be taught to students with special needs in vocational schools. On the other hand, some things need to be considered before starting the class such as learning methods [12], learning media and tools, and materials which also must be adapted based on students' needs.

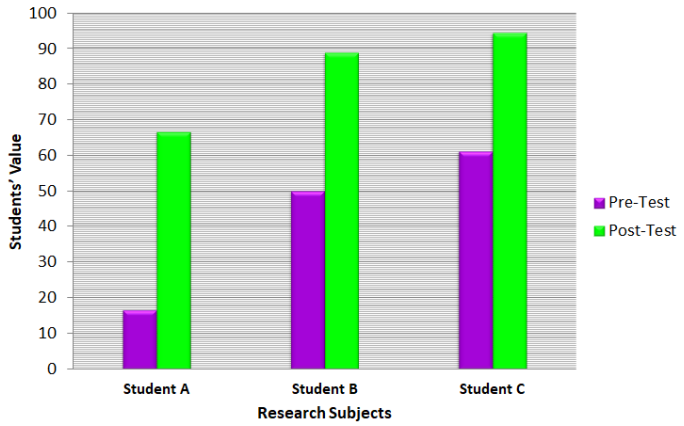

Fig. 6. The pre-test and post-test scores obtained by students.

Based on the results of the study, using experimental video as learning media is effective when learning viscosity for students with special needs. Students with special needs require an effective and attractive learning media in line with their needs. The use of video had shown a positive effect on increasing student knowledge. This can be seen from the post-test scores. Each of the students got a score above 70. Student B was enthusiastic during the learning because students with hearing impairment had visual learning characteristics. Students with hearing impairments received information through the visual senses easily [13]. Students A and C were also enthusiastic about seeing the experimental videos during learning. Therefore, interesting learning videos, simple explanations, and materials used in daily life help students with intellectual disabilities to easily understand viscosity. This proven that students with intellectual disabilities need simple explanations and concrete media in the learning process [13, 14]. In learning, students with intellectual disabilities' age do not affect the level of their understanding. This could be seen in student A. Despite having an older age than student C, student A had a lower grade than student C.

4.4. The Contribution of Video Media of study the Viscosity

The selection of learning media used is very important when studying viscosity material. Experimental video media facilitate students with special needs in understanding the material of the viscosity being studied. It is important to teach viscosity material because it is on the curriculum. Also, because vocational school students study viscosity material as an initial knowledge for learning more complex

material. Therefore, studying viscosity has many advantages; one of which is as a provision for students when entering the workforce.

5. Conclusion

The results of this study show that combination of experimental demonstration and media was very effective in improving the understanding of students with special needs in learning viscosity. This was verified by the students' post-test scores; all students had a post-test score above 70. We hope that this study would produce more new studies on learning media for students with special needs. This was confirmed by the increasing pre and post test results, supported by interviews. The use of interesting media with simple explanations made it easier for students with special needs to understand the material being taught.

Acknowledgements

The authors would like to express their appreciation to Sekolah Pasca Sarjana for supporting this study. The authors also thank the teachers and parents of vocational high school (SMK) in Kuningan, Indonesia for assisting this experiment.

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