Assessing the Impact of Laboratory Activities on the topic of Viscosity and Fluidity in the Classroom through Practical Applications on Everyday Objects for Vocational Students to Support Sustainable Development Goals (SDGs)

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***Abstract*- The purpose of this study was to assess the impact of laboratory activities using everyday objects on the topics of viscosity and fluidity to improve vocational students' understanding of supporting education for sustainable development. The method used in this study was a descriptive quantitative analysis design. The subjects of this study were 23 vocational students in Cimahi, West Java. Data were collected through pretest and posttest activities in the form of comprehension ability questions on the topic of viscosity and fluidity. The results obtained after conducting laboratory activities, there is an increase with a p-value <0.05. These results were analyzed using the calculation of Wilcoxon parametric statistical analysis. Laboratory activities using everyday objects can improve the understanding of vocational students on the viscosity and fluidity of material. This research is also useful to provide awareness to students by using everyday objects in science learning, this can be applied as a form of innovative pedagogy that supports education for sustainable development.**

***Keywords*- Laboratory Activities, Viscosity, Fluidity, Everyday Objects, Education for Sustainable Development**

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I. Introduction

Education for Sustainable Development (ESD) was born out of the need for education to address the growing challenges of sustainability (Solihah et al., 2024; Rasuman et al., 2024; Saraf & Kumar, 2022). ESD applies innovative, action-oriented pedagogy to enable learners to develop knowledge and awareness and take action to transform society into a more sustainable one. The main objective of ESD is to prepare the next generation of the nation to become responsible citizens in the future (Makinde et al., 2024; Suryani & Hamdu, 2021; Ekamilasari & Puspitasari, 2021). Students should be able to engage in a democratic society and contribute to the formation of a sustainable future of society. Based on the idea of sustainable development, they should learn to assume responsibility for present and future generations (Kioupi & Voulvoulis, 2019; Amashi et al., 2021; Naik et al., 2022; Patel et al., 2022).

To support this aspect, students need to learn. According to learning science, students are not only asked to master the concept of science but also pay attention to the process and attitude. The process of science includes scientific procedures in discovering science. Scientific procedures are performed when students construct knowledge that requires a set of skills. The attitude that is built during and after scientific procedures is scientific. The practicum learning model in science learning is very important in facilitating students' scientific skills and attitudes. Prajoko et al. (2016) stated that through practicum, students have the opportunity to develop and apply the process of science skills, as well as scientific attitudes to gain knowledge.

Science learning should ideally be done through practical methods in the laboratory using standardized practical equipment and materials (Ekamilasari & Puspitasari, 2021; Homdijah et al., 2022; Juhanaini et al., 2022; Nwafol et al., 2024). In reality, science practicum is rarely carried out for certain reasons such as lack of infrastructure and laboratory space. The high cost of building laboratory buildings/rooms and procuring laboratory equipment and supplies. This causes most schools in Indonesia to not have laboratory facilities. The Ministry of Education and Culture (2018) states that only 45% of secondary schools in Indonesia have science laboratory facilities. This is an obstacle in carrying out practicum activities that require laboratory equipment. In addition to facilities and infrastructure factors, the quality of teachers is also the cause of non-optimal science practicum activities. There are still many educators who do not carry out practicum activities due to several obstacles.

One solution to this problem is to use local materials as a means of science practicum (Ana, 2020; Supriyanti et al., 2022; Hofifah & Sumiati, 2023). Local materials are materials or equipment that are easily found in everyday life according to the location of the person. Local materials can be materials/equipment that are still used for daily purposes or come from inorganic waste. Not many science teachers are aware of the use of recycled materials for practicum in schools. Whereas the use of local materials is environmentally friendly and can also save capital expenditures from educational institutions.

Some studies suggest that students still have difficulty understanding fluid statics material. Fluid is a substance that can flow, either in the form of liquid or gas. Fluids can undergo continuous changes due to the influence of friction forces that occur when crossing the medium. This is also closely related to the physical properties and effects of viscosity in fluids. Using everyday materials in practicum activities can help students understand the material. The purpose of this study is to assess the impact of laboratory activities using everyday objects on the topic of viscosity and fluidity to improve the understanding of vocational students in support of education for sustainable development.

This study refers to the national curriculum documents for science and social science (IPAS) subjects used in vocational schools. Table 1 describes the science education curriculum (particularly for physics subjects) used in vocational schools. It is important to ensure the success of the teaching and learning process with the curriculum (Maryanti & Nandiyanto, 2021).

Fluid flow is the flow of liquid through a medium, usually through a pipe or hose. Fluid viscosity can change depending on physical properties as well as friction. Fluids have several properties, namely (i) compressibility, which is the volume change when compressed, (ii) related to flow velocity, (iii) rotation, and (iv) viscosity, a thick liquid that is difficult to flow (Plotka-Wasylka, et al. 2020).

The purpose of this study was to to assess the impact of laboratory activities using everyday objects on the topics of viscosity and fluidity to improve vocational students' understanding of supporting education for sustainable development. The novelties of this study were viscosity and fluidity experiment kit. This study gives impacts in adding new ideas and information for supporting sustainable development goals, as reported elsewhere (Nurramadhani et al., 2024; Makinde et al., 2024; Gemil et al., 2024; Haq et al., 2024). This study also gives ideas for improving the current literature in supporting laboratory and practicum for vocational schools, as reported elsewhere (Maryanti & Nandiyanto, 2021; Minghat et al., 2023; Anwar & Minghat, 2024; Hashim et al., 2024).

TABLE I
SCIENCE EDUCATION CURRICULUM (ESPECIALLY FOR PHYSICS SUBJECTS) USED IN VOCATIONAL EDUCATION

	Basic competencies		Basic competencies
3	Apply the laws of static fluid in everyday life	4	Design and conduct experiments that utilize the properties of static fluids, along with the presentation of experimental results and their utilization.
	Indicators of Competence Achievement		**Indicators of Competence Achievement**
3.8	Apply the concepts of surface tension and viscosity in solving problems in everyday life.	4.3	Conduct simple experiments, collect, analyze, and conclude experimental data on surface tension and viscosity.

II. METHOD

This research is a type of quantitative descriptive analysis research. This research was conducted at one of the vocational schools in Cimahi Bandung. Where the population is vocational school students and the sample in this study was 23 students of class X vocational school in Cimahi, Indonesia. Data collection techniques in this study are measurement techniques in the form of written tests (pre-test and post-test) in the form of essays of 5 questions that have been developed previously, and direct communication techniques in the form of unstructured interviews with teachers and students.

Designing learning media is important (Ariyantiand Maryanti, 2021; Nafilah & Sakti, 2022; Hidayat et al., 2022; Azizah et al., 2022; Zafrullah & Ramadhani, 2024). Especially, when people use from local materials or equipment that is easily found in everyday life to create experimental tools related to fluidity and viscosity. Figure 1 and Figure 2 shows the designed tool.

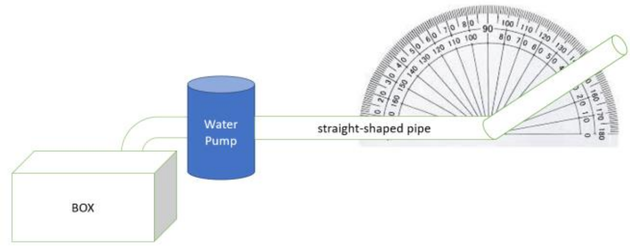


Fig. 1 : Viscosity and Fluidity Experiment Kit Straight-Shaped Pipe Experiment Kit

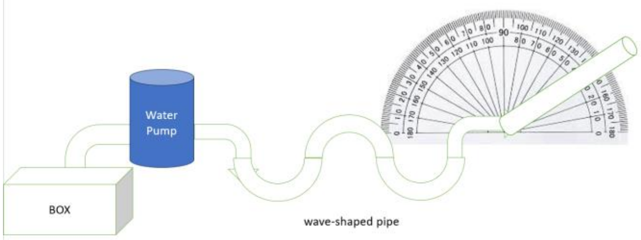


Fig. 2 : Viscosity and Fluidity Experiment Kit Wave-Shapeed Pipe Experiment Kit

The materials used in this experiment were a plastic box, a small water pump, a 5 mm plastic pipe with a length of 1 m, a protractor, a stopwatch, and a plastic ruler. The liquid media materials used were water, fruit juice, vegetable juice, full-cream milk, and oil. The materials used are easily obtained in everyday life by students. The liquid media before being put into the plastic box, weighed first as much as 300 g and measured the volume using a measuring cup. One of the liquids is put into the box to place the end of the pipe adjusted to the height to be measured using a protractor and then the pump machine is turned on. The stopwatch will count the time the liquid bursts until the liquid runs out of the box.

Data analysis in this study includes a normality test, which aims to determine the normality of the distribution of the research data. Data normality was tested using the Shapiro-Wilk test. Followed by a paired sample t-test, if the data is normally distributed, but if the data is not normal, it will proceed with the Wilcoxon test using Lavene Statistic. N-Gain test analysis is used to see the increase in students' conceptual understanding after using the learning model using categories based on table 2. Data analysis was assisted by using Microsoft Excel and SPSS 21. Detailed information for the use of statistical analysis is explained elsewhere (Fiandini et al., 2024; Afifah et al., 2022).

TABLE II
N-GAIN TEST CATEGORIES

Limitation	Category
$g > 0.70$	High
$0.30 \leq g \leq 0.70$	Moderate
$g < 0.30$	Low

III. RESULTS AND DISCUSSIONS

Student demographic data was obtained from previous IPAS scores obtained from the teacher, this is to see an overview of student understanding in IPAS learning. The following presents the results of demographic data in Table 3.

TABLE III
ACHIEVEMENT CATEGORIES OF STUDENTS' IPAS SCORES

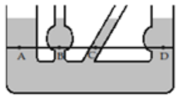
Score	Category	Total of students
86-100	Very Good	0
75-85	Good	1
65-74	Enough	3
55-64	Low	9
0-54	Poor	10

From these data, the average student is still in the category of less and low in learning IPAS or science. Thus, learning media is needed that can help students understand IPAS or science material. Thus, to improve understanding of IPAS material, laboratory activities are carried out using everyday objects on the topic of viscosity and fluidity. The topic of viscosity and fluidity is then made in the form of pretest and posttest questions to measure the level of student understanding presented in Table 4. which has been adjusted to the indicators and classified based on Bloom's Taxonomy.

The questions that have been adjusted to the indicators and classified based on Bloom's Taxonomy are then given to students before learning is carried out or pretested. This is done to determine students' initial understanding of the topic of viscosity and fluidity. After doing the pretest, students are given practicum activities using everyday objects on the topic of viscosity and fluidity. The posttest was given to students after the learning took place. The value data obtained from the pretest and posttest results were then analyzed by the N-Gain test to see the increase in student understanding presented in Table 5.

TABLE IV
INDICATORS OF EACH QUESTION ITEM BASED ON BLOOM'S TAXONOMY

Question Number	Indicator	Bloom Taxonomy	Question
1	Given a comparison of two objects, learners can justify the statement that is consistent with the concept of density of substances.	Understanding (C2)	Correct the statement that 1 kg of iron is heavier than 1 kg of wood, and the statement that 1 kg of iron is heavier than 1 kg of cotton, correct the truth of these statements. ....

Question Number	Indicator	Bloom Taxonomy	Question
2	Given two phenomena of a person in the mountains and a person diving, learners can explain the pressure experienced by the two people.	Analyze (C4)	A mountaineer and a diver experience very different total pressures, How is the total pressure experienced by a mountaineer and a diver ....  Mountain climber  Diver
3	Given the phenomenon of astronauts doing space exploration, learners can explain why astronauts must be equipped with astronaut suits.	Synthesize (C5)	An astronaut will carry out space exploration activities, one of the equipment that must be prepared is astronaut clothing. Why is astronaut clothing a must-bring equipment? (Related to the pressure experienced by astronauts) .... 
4	Given vessels with different cross-sections filled with the same fluid, learners can explain the amount of pressure at a point on the same plane.	Analyze (C4)	 A connected vessel with different cross sections is filled with water, then a straight line is drawn. Thus, points A, B, C, and D are formed. What is the hydrostatic pressure at each point...
5	Given the phenomenon of a person diving at a high depth, learners can explain the bluish phenomenon experienced by the person.	Synthesize (C5)	In 1912, the Titanic sank due to a collision by an iceberg, the victims of the accident numbered more than 1500 people. Most of the victims drowned. Why did the victims drown when the bodies were found bluish? 

Based on Table 5, the average value of learning outcomes before and after learning on the topic of viscosity and fluidity is 37 and 70 out of an ideal value of 100. The increase in learning outcomes is also confirmed by the results of the average N-Gain value of 0.52 which is included in the moderate category for all 23 students. These results show that practicum media has an impact in helping to improve student understanding, especially on the topic of viscosity and fluidity.

TABLE V
N-GAIN DATA FOR STUDENTS' CONCEPT UNDERSTANDING

No	Student Code	Pretest Score	Posttest Score	N-Gain	Category
1	X1	25	60	0.47	Moderate
2	X2	30	65	0.50	Moderate
3	X3	30	65	0.50	Moderate
4	X4	30	65	0.50	Moderate
5	X5	30	65	0.50	Moderate
6	X6	25	60	0.47	Moderate
7	X7	50	75	0.50	Moderate
8	X8	50	75	0.50	Moderate
9	X9	50	75	0.50	Moderate
10	X10	45	70	0.45	Moderate
11	X11	40	70	0.50	Moderate
12	X12	35	70	0.54	Moderate
13	X13	25	65	0.53	Moderate
14	X14	30	70	0.57	Moderate
15	X15	30	70	0.57	Moderate
16	X16	30	70	0.57	Moderate
17	X17	30	70	0.57	Moderate
18	X18	25	70	0.60	Moderate
19	X19	50	75	0.50	Moderate
20	X20	50	75	0.50	Moderate
21	X21	50	75	0.50	Moderate
22	X22	45	75	0.55	Moderate
23	X23	40	75	0.58	Moderate
Mean Pre-Experiment Class		**37**	**70**	**0.52**	**Moderate**

Furthermore, the normality test analysis of the pretest and posttest data was carried out to see whether the data was normally distributed or not. Thus, it could be continued with the paired t-test. The normality test results use the Shapiro-Wilk test on table 6. The basis for decision-making is if the Sig. value is greater than α = 0.05, H0 is rejected, and if the

Sig. value is smaller than the α = 0.05 value, H0 is accepted. The results of the normality test show that the pretest and posttest score data are not normally distributed because the value of Sig. < 0.05.

TABLE VI
NORMALITY TEST RESULTS DATA BASED ON SHAPIRO-WILK

	Statistic	df	Sig.
Pretest Score	0.825	23	0.001
Posttest Score	0.853	23	0.003

The histograms are shown in Figures 3 and Figure 4. They are for the pretest and post-test scores, illustrating the results of the normality test.

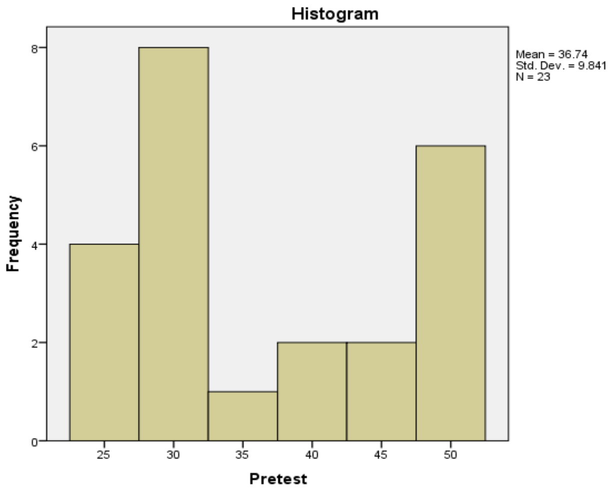


Fig. 3 : Normality Test Results of Pretest Values

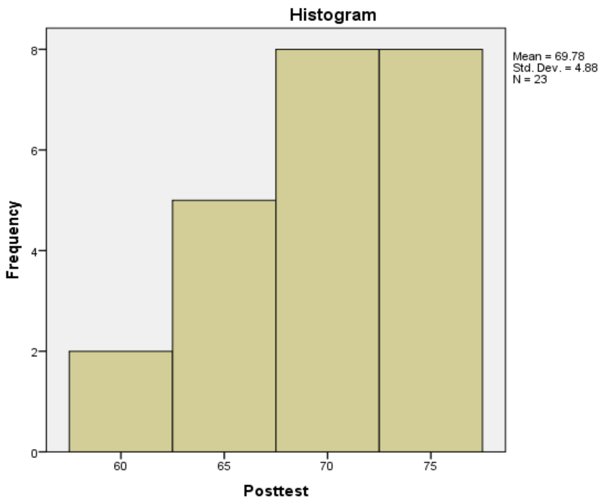


Fig. 4 : Normality Test Results of Posttest Value

Based on the results of the normality test that has been carried out, the Wilcoxon test is carried out, using the Lavene Statistic to test the hypothesis of whether there is a significant difference in learning outcomes before and after learning. The hypothesis in this Wilcoxon test is H0 rejected if the Sig. value is smaller than the α = 0.05 value, and H0 is accepted if the Sig. value is greater than the α = 0.05 value. The Wilcoxon test results are shown in Table 7.

TABLE VII
RESULTS OF WILCOXON TEST ANALYSIS

	Median (min-max)	P Score
Pretest (n=23)	30 (25-50)	0.001
Posttest (n=23)	70 (60-75)	

Based on the Wilcoxon test results, the Sig. (2-tailed) obtained is 0.001. Sig value. (2-tailed) value is smaller than 0.05 which indicates that Ha is accepted, meaning that there is a significant difference in student learning outcomes for pretest and posttest scores using laboratory activities.

Based on the results of the research, shows that practicum activities in the laboratory can improve the knowledge of vocational students. This result is supported by the difference in the average N-Gain value with a score of 0.52 which is included in the moderate category. This is in line with the research of Rini and Aldila (2023) practicum activities can improve science process skills in students. The results of statistical tests with the Wilcoxon test also show a p-value <0.05 which states that there is a difference in students' pretest and posttest scores. Thus, it can be concluded that there is an effect of laboratory activities using everyday objects on the topic of viscosity and fluidity in improving the understanding of vocational students to support education for sustainable development. This is in line with Wati's research (2020) which shows that physics teaching materials based on local wisdom in wetland environments are practically used in learning static fluid material. From the results of the study, students' understanding of viscosity and fluid increased. The lower the viscosity of a fluid, the faster and smoother the fluid can flow and flow to another place. In addition, students are also able to understand that a high level of viscosity is very influential in the process of fluid flow.

The practicum method has several advantages when compared to conventional methods. Practicum teaches students to use a scientific approach when they face any problem. The impact on students is that they do not easily believe in something that cannot be confirmed and do not easily believe what people say before the facts are proven. Experimentation or practicum teaches students to prove for themselves the truth of a theory (Husni, 2020; Hamdani et al., 2019). The practicum method is one of the suitable methods used in learning science or IPAS for vocational students. The practicum method can help students develop science process skills, and critical and creative thinking skills optimally. (Rohmantika & Pratiwi, 2022; Rini & Aldila, 2023; Fitriana & Yuberti, 2019).

CONCLUSION

Practical activities of viscosity and fluidity using everyday objects can improve students' understanding abilities from the results of research that has been done. This practicum method is proven to improve students' understanding and science process skills. This was confirmed by using statistical analysis with the Wilcoxon non-parametric test. Students can connect practicum activities with understanding concepts that are usually only taught through memorization and abstract. This practicum activity provides a different and varied learning experience. Thus, it can stimulate the learning interest of vocational students. This increase in knowledge and understanding can have an impact on student learning outcomes in IPAS subjects. This research is expected to have an impact on future research directions for practicum activities, which are considered to provide useful learning. This research can also have a good impact on the younger generation, especially to support education for sustainable development.

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