© Universiti Tun Hussein Onn Malaysia Publisher's Office

JTET

http://penerbit.uthm.edu.my/ojs/index.php/jtet
ISSN 2229-8932 e-ISSN 2600-7932

Journal of Technical Education and Training

Collaborative Practicum with Experimental Demonstration for Teaching the Concept of Production of Bioplastic to Vocational Students to Support the Sustainability Development Goals

Asep Bayu Dani Nandiyanto[1,*], Meli Fiandini[1], Siti Nur Hofifah[1], Risti Ragadhita[1], Dwi Fitria Al Husaeni[1], Dwi Novia Al Husaeni[1], Rina Maryanti[1], Alias Masek[1,2]

[1]Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229, Bandung, 40154, INDONESIA

[2]Universiti Tun Hussein Onn Malaysia, Parit Raja, 86400 Batu, Pahat, Johor, MALAYSIA

*Corresponding Author
DOI: https://doi.org/10.30880/jtet. 2022.14.02.001
Received 08th July 2022; Accepted 28th August 2022; Available online 30th September 2022

Abstract: The purpose of this study was to find out collaborative practicum using conventional learning methods and experimental demonstrations to teach the concept of bioplastics fabrication to vocational students. Understanding bioplastics is good to possess the young generation, especially facing Sustainability Development Goals (SDGs). The subjects of this study were 40 students of class XI in vocational schools which were divided into two classes, namely the control and the experimental classes. Treatment given to experimental class was by providing learning with an experimental demonstration using learning videos, while control class learning was done using conventional teaching method. Learning outcomes of both classes were evaluated from the pre-test and post-test scores as well as the N-Gain value. The data analysis technique used was the analytical technique of descriptive data, including the mean and standard deviation. The analysis requirement test was carried out using a normality test. To test the hypothesis of differences in student learning outcomes, a non-parametric test was used. Based on descriptive analysis, learning outcomes with the experimental demonstration method are more effective than that with the conventional method. This result is evidenced by the experimental class's N-Gain value which is greater than those of the control class. The results were also confirmed by statistical analysis using the Mann-Whitney non-parametric test, showing a significant difference in learning outcomes between the control and the experimental classes. In short, the results of the study showed an increase in achievement and significant student learning using the experimental demonstration method. The experimental demonstrations using available materials make students more interactive because students want to try the process by themselves. Using the experimental demonstration method, students are expected to be able to find, prepare, and carry out the learning process. Thus, students get good learning outcomes. This study is expected to have an impact on the further teaching of experimental demonstration research which is believed to provide good learning success for students.

Keywords: Bioplastic, collaborative practicum, SDGs, starch, teaching, vocational student

Corresponding author: nandiyanto@upi.edu

1. Introduction

Practicum is a learning activity that observes experiments or tests in the laboratory followed by analysis and conclusions about the results of these observations (Darmaji et al., 2019). Practical activities provide experience to students, especially vocational students (Ana, 2020). This is because vocational students must have the skills to be better prepared to work in fields that are following their fields (Sivia et al., 2021). In addition, because vocational schools are currently being developed by the government to produce graduates who are excellent in doing practical work, ready to use, and able to compete in the industrial world (Rosina et al., 2021), the practicum is an important activity to be implemented in vocational schools. Learning activities through this practicum are intended to allow students to apply theories or scientific investigations as well as prove them in certain subjects (Ana, 2020). Practicum learning facilities are one of the supporting factors in achieving optimal learning outcomes. For example, in teaching the engine tune-up practicum, adequate learning facilities are very important to improve and develop the quality of the teaching and learning process. In essence, practicum activities in vocational schools are needed since students must have competencies according to their needs in industry and the business world thus practical learning supports students in applying what they have learned in real-world learning (Groller et al., 2020). Learning activities such as practicum require a communication system or interactive learning media to support learning activities and make students more enthusiastic about learning (Groller et al., 2020).

Many choices of learning media can be used to create interactive communication systems that can support the learning process. Learning media is a tool that can help the learning process by clarifying the meaning of the message conveyed (Anggraeni & Maryanti, 2021). This makes effective and efficient learning to be achieved (Wiana, 2018). One of the learning media is to make experimental demonstrations using video media. Experimental demonstration is an effort or practice using demonstrations (Hidayat et al., 2020). It makes it easier for students to understand and practice what they have learned in the theoretical class (Babincakova & Bernad, 2020). Experimental demonstration is suitable to be used in vocational high school students because it provides students with certain skills training (Jossberger et al, 2010). Experimental demonstration learning media can also be used in the learning process of chemistry subjects. In addition to the chemistry learning process, experimental demonstration learning media can also be used as a tool in the machine learning process. Several studies use experimental demonstrations in the learning process, including the use of experimental demonstration in machine-learning learning (Zhou et al., 2019), a graphene-based thin film absorber's experimental demonstration of ultrafast THz modulation (Tasolamprou et al., 2019), and experimental laboratory with video to teach engineering course students (Chowdhury et al., 2019).

One of the interesting subjects to be taught to vocational students is bioplastic. Bioplastic is a popular topic since it can solve current issues in the plastic waste problem (Consebit et al., 2022; Duruin et al., 2022). This is in line with Sustainability Development Goals (SDGs), while in the real class, chemistry learning at school is not yet correlated with sustainability issues. Thus, when students understand, they can apply bioplastic not only in the industry but also in the real world. Indeed, it can help to preserve and maintain the environment. Here, this study was conducted to know the effect of using experimental demonstrations on collaboration in chemistry subjects for vocational high school students, especially in the manufacture of bioplastics. Considering that it is very important to make bioplastic to suppress plastic waste that is difficult to decompose (Khoo et al., 2021). Bioplastic can reduce the production of carbon dioxide and is biodegradable plastic (Triawan et al., 2020). Bioplastics can also be made into biomass, which is a fully renewable resource (Coppola et al., 2021).

2. Theoretical Framework

2.1 Issues in Polymer Material in Chemistry Subjects in Vocational School

Learning about polymer concepts is related to environmental education, a branch of scientific education that has grown dramatically in the last 25 years (Ardoin et al., 2018). The goal of this course in vocational school is to give students prior knowledge of polymers, and a broad understanding of polymer chemistry principles, and applications at an intermediate level. This includes developing a basic knowledge of polymer synthetic techniques, characterization, and topics on the many applications of polymeric materials. The basic competencies of learning chemistry in class XI on the topic of polymers integrate the structure, nomenclature, properties, and classification of polymers with the uses of polymers in daily life. Many types of equipment around us are made of polymers. Among the application of polymer is plastic, which is known as food wrappers, containers beverages, for school, office, automotive, and various other sectors (Ford, 2017). This is because plastic has superior properties such as being light but strong, transparent, and waterproof, as well as the price is relatively cheap and affordable (Nurprasetio et al., 2017). But, in addition to having enormous benefits in all areas of life, plastic polymers have a negative impact on the environment and health (Evode et al., 2021). Plastic is inert and has a very large molecular size, making it difficult to be broken down by microorganisms and needed a very long time to degrade plastic (Pebrianti & Salamah, 2021; Soegoto et al., 2021). The negative impact of using polymers can be overcome by reducing the use of plastic polymers, not throwing garbage in any place, choosing tools that are easier to decompose, and collecting plastic waste for recycling and using biodegradable plastic.

Biodegradable plastic is a type of plastic that can be used just like conventional plastics, but it can be broken down by the activity of microorganisms after being used up and discharged into the environment (Triawan et al., 2020). Understanding bioplastics is good to possess the young generation, especially facing SDGs, while in the real class, chemistry learning at school is not yet correlated with sustainability issues, causing the students not to realize the application of chemistry in solving environmental issues (Sevian et al., 2018). In attempts to overcome these problems, there is a need for a learning model to help students in improving science skills, which is not only to understand the concept of chemistry and polymer but also how to solve environmental issues and give efforts to overcome them through chemistry lessons in vocational schools.

This study refers to the national curriculum document for chemistry used in vocational schools. Table 1 describes the science education curriculum (especially for chemistry subjects) used in vocational schools. The curriculum is important to ensure the successful teaching and learning process (Maryanti et al., 2021a; Maryanti et al., 2021b; Maryanti & Nandiyanto, 2021). The curriculum defines two core competencies: competency 3 for knowledge and competency 4 for skills (Maryanti & Nandiyanto, 2021). The two core competencies are translated into several basic competency points, containing science education materials.

Table 1- Curriculum for science education curriculum (especially for chemistry subject) in vocational school

Core Competency 3 (knowledge)		Core Competency 4 (skills)	
3	Understand, apply, analyze, and evaluate factual knowledge, conceptual, basic operational, and appropriate metacognitive with field and scope Simulation and Communication Digital, and Field Basics Technology and Engineering at a technical level, specific, detailed, and complex, regarding with science, technology, art, culture, and humanities in context self-potential development as part of the family, school, world of work, citizens national, regional and international communities.	4	Carry out specific tasks using tools, information, and work procedures that are commonly carried out and solve problems following the scope of Simulation and Digital Communication, and Basic Technology and Engineering. Showing performance below guidance with measurable quality and quantity according to work competency standards. Showing skills in reasoning, processing, and presenting effectively, creatively, productive, critical, independent, collaborative, communicative, and giving solutions in the abstract related to development from what they have learned in school, and can carry out specific tasks at school under direct supervision. Showing skills in perceiving, readiness, imitating, getting used to, proficient motion, making natural movements in the concrete realm related to the development of what they learn in school, as well as being able to carry out specific tasks under supervision direct.
Basic Competencies 3		**Basic Competencies 4**	
3.11.	Analyze the structure, nomenclature, properties, classification, and use of polymers	4.11.	Integrating usability polymer in life daily with structure, nomenclature, character, polymer classification

2.2 Bioplastic Concept

Bioplastic is an environmentally friendly plastic, which can be decomposed by the activity of microorganisms (Consebit et al., 2022). The basic materials commonly used in the manufacture of bioplastics are natural polymers such as protein, starch, cellulose, and fat. The availability of basic materials in the form of natural polymers is very abundant with a variety of non-toxic structures (Nandiyanto et al., 2020). This renewable material has high biodegradability, making it potentially used. Bioplastic can be used as packaging because it is not easily penetrated by water vapor and can be used as a packaging material to replace ordinary plastic.

Different from burning plastic that needs special treatment (Pebrianti & Salamah, 2021), burning bioplastics do not produce harmful chemical compounds. In addition, the quality of the soil will increase in the presence of bioplastics because the decomposition products of microorganisms increase the nutrients in the soil (Folino et al., 2020). One of the most widely used basic materials for making bioplastics is starch due to its abundance, low price, and easy to find. Starch is generally formed from two polymers of glucose molecules, namely amylose and amylopectin (Jiang et al., 2020). The content of amylose and amylopectin affects the physicochemical properties, including water absorption, solubility, degree of starch gelatinization, and swelling power. The higher the amylopectin content, the starch tends to absorb less water, wetter and stickier. On the other hand, starch with high amylose content tends to absorb more water, is drier, and has less adhesion (Gutiérrez & González, 2016).

3. Materials and Methods

3.1 Experimental Design

In this experimental design, students were divided into two sample classes: the experimental and control classes. The implementation of this research was preceded by the provision of a pre-test first in both classes, given treatment in the form of learning using an experimental demonstration model equipped with learning videos in the experiment class. The control class was done using a conventional learning model. The post-test was held to determine student learning outcomes. Based on the previous mention, the assessment was carried out based on the results of the pre-test and post-test using 15 identical pre-test and post-test questions. The type of question used is a question with a true or false answer. In short, if the student answers the question correctly then the score is 1, and if the student answers the question incorrectly then the score is 0. This analysis has a maximum score of 100. The correct answer was then calculated using Equation (1):

$$\text{Score\%} = \frac{score\ obtained\ by\ student}{maximum\ score} \times 100\% \quad (1)$$

To support the results of the assessment, students' initial data were collected regarding IQ scores and average scores for Mathematics, Chemistry, Physics, Indonesian Language, Vocational Training, and Biology. The paired t-test was done for statistical calculations to determine the significance level of the experimental demonstration learning method.

3.2 Research Subjects

The subjects were 40 students of class XI vocational schools which were classed into two classes, namely the control and experimental classes. The control class consisted of 20 students and the experimental class consisted of 20 students.

3.3 Treatment Procedure

The control and experimental groups were given different treatments, in the control group we gave a conventional teaching approach, where the teaching session started with a pre-teaching session. Students were asked to fill out pretest questions to identify their prior knowledge about bioplastics. Furthermore, students were given conventional learning with presentations and explanations from the teachers. Then, students were asked to fill out post-test questions to measure the increase in student understanding after learning. The closing session of the lesson ended with a question and answer session to conclude the lesson. The summary of conventional teaching is shown in Table 2.

Table 2 - The summary of the conventional method of teaching delivery

Delivery Method	Description	Role action
Pre-teaching	Pre-test	Student
Content delivery	Material presentation	Lecture
Pra-teaching	Post-test	Student
Conclusion	Question and Answer	Lecture-student

In the experimental group, the teaching session both started with a pretest. Then students watch experimental demonstration videos, students not only watch but are directed to observe the tools and materials used, identify the process of making bioplastics, and identify the bioplastics produced. After that, students were asked to fill in the post-test questions. The end of the session is closed with a question and answer session to conclude the lesson. The summary of the learning of the treatment group is shown in Table 3.

Table 3 - The summary of the experimental method of teaching delivery

Delivery Method	Description	Role action
Pre-teaching	Pre-test	Student
Content delivery	watching the experimental demonstration video	Student
Post-teaching	Post-test	Student
Conclusion	Question and Answer	Lecture-student

3.4 Data Analysis

Equation (2) expresses the N-Gain to understand the increase in student understanding:

$$N - Gain = \frac{((post-test\ score)-(pre-test\ score))}{((score\ ideal)-(pre-test\ score))} \times 100 \quad (2)$$

Table 4 shows how the N-Gain value can be used to categorize increasing students' conceptual understanding after using the learning model. Validity and reliability tests were also carried out to assess the accuracy of each question used. The 15 questions were tested on 40 students. The validity of each question was determined using the product moment correlation formula, while the reliability was determined by the Kuder Richardson-20 (KR-20) formula. The results of the validity test are shown in Table 5. Most of the questions are valid and can be used. Only 4 questions need improvement before being used. The results of the reliability test are shown in Table 6. r_{count} was only 0.37, indicating the level of reliability is low. But, all questions are still reliable to use. We also analyzed the difficulty of the pre-test and post-test questions. The difficulty analysis was carried out based on the calculations of Robert L. Thorndike and Elizabeth Hagen's level. The results of the difficulty analysis are shown in Table 7. The classification of each question in difficulty level is briefly shown in Table 8. Furthermore, the data analysis technique used on student learning outcomes is to use statistical methods. The statistical method used is the pre-test and post-test data prerequisite test in the control and experimental classes. The normality test is done by the Skewness test. This normality test was conducted to determine whether the data collected were normally distributed or not. This Skewness test shows whether the data is skewed on one side or not. Data that are normally distributed have criteria if the Skewness curve is symmetrical like a bell. To test the hypothesis of differences in student learning outcomes, the Independent sample T-Test (if data is normally distributed) was used. To support the analysis, we used SPSS Ver. 26. Detailed information for the use of SPSS is explained in Afifah et al. (2022).

Table 4 - N-Gain index category

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

Table 5 - Validity test on the item questions

Type	Note
Number of question	15 items
Number of students	40 students
Valid question number	1, 2, 3, 4, 5, 6, 8, 11, 12, 13, 15
Number of valid questions	11

Table 6 - Reliability test on the item question

Type	Note
r_{count}	0.37
Category	The level of reliability on the item questions is low

Table 7 - Difficulty level of pre-test questions

Question	Number of correct answers	Total students	Difficulty index value	Question category
1	40	40	1.000	Easy
2	40	40	1.000	Easy
3	35	40	0.875	Easy
4	26	40	0.650	Medium
5	28	40	0.700	Medium
6	28	40	0.700	Medium
7	37	40	0.925	Easy
8	32	40	0.800	Easy
9	39	40	0.975	Easy
10	35	40	0.875	Medium
11	27	40	0.675	Medium
12	23	40	0.575	Medium
13	33	40	0.825	Easy
14	27	40	0.675	Medium
15	36	40	0.900	Easy

Table 8 - Classification and Percentage of Difficulty Level

Category	Question Items	Total (items)	Percentage (%)
Easy	1, 2, 3, 7, 8, 9, 13, 15	8	53.33
Medium	4, 5, 6, 10, 11, 12, 14	7	46,67
Difficult	0	0	0

4. Results and Discussion

4.1 Students Demographic

Previously in this study, data was collected as initial information to determine students' basic abilities which contained IQ levels, and average scores in Mathematics, Indonesian language, and Chemistry. Figure 1 is an illustration of the average percentage IQ score of 40 students. Based on the illustration results, it is known that students have IQ intelligence levels that are classified into 6 categories, namely intellectual disability class (6%), below average (17%), average (50%), above average (19%), and superior (8%). Table 9 is the average value of vocational students' subjects. The average score of 20 students in Mathematics, Indonesian Language, Chemistry, Biology, Physics, and Productive is above 79. This shows that the learning abilities of vocational students are good.

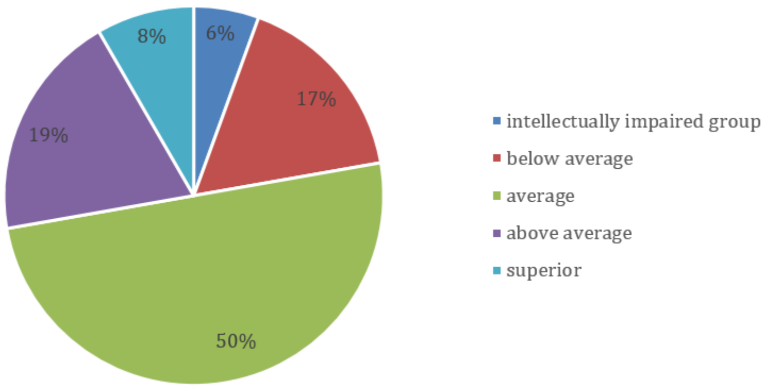

Fig. 1- Students' IQ score

Table 9 - Average score of subjects

No	Subject	Average Score	Standard deviation
1.	Mathematics	79.19	6.68
2.	Indonesian Language	83.69	5.89
3.	Chemistry	80.05	4.50
4.	Physics	84.60	7.30
5.	Biology	83.69	3.25
6.	Productive	81.00	7.34

4.3 Descriptive Analysis of Control and Experiment Class Learning Outcomes

Before analyzing the students' scores, we examined and compared the post-test answers in the control and experimental groups (see Table 10). Table 10 includes a classification of questions based on Bloom's Taxonomy. There are 3 question items (namely items numbered 1, 2, and 3) with the same percentage score for both classes (control class and experimental class). It indicates that the understanding of concepts in the control class and the experimental class is equally good for these three concepts. For the other items (except item number 6, 7, 11, and 13), the experimental class had a higher post-test score than the control class. This increase in score indicates that the experimental demonstration learning method improves students' understanding. In items number 6, 7, 11, and 13 which are marked with an asterisk (*), the control class score is higher than the experimental class. The analysis of misconceptions derived from the decrease in scores are:

(i) Students do not understand the concepts and components for bioplastic fabrication because the components that makeup bioplastics are chemically mentioned, whereas vocational students are not too familiar with chemicals (item number 6)

(ii) Students in the experimental class did not focus thus they were fooled by the form of questions with negative sentences (item number 7)

(iii) Some students are still perplexed by the concept of gelatinization. This motivates educators to provide additional examples and lessons for this definition (item number 11).
(iv) Students in the experimental class know that plasticizers do not make bioplastics elastic. This bioplastic requires a plasticizer material. Thus, students assume that this plasticizer material does not need to be used for bioplastic fabrication (item number 13).

Table 10 - Post-test score of each item question from control and experiment classes

No	Problems	Bloom Taxonomy	Post-Test Control Class Score (%)	Post-Test Experiment Class Score (%)
1	Bioplastics are plastics or polymers that naturally can be easily degraded either through the attack of microorganisms or by the weather	C2	100	100
2	Bioplastic is an example of a polymer.	C1	100	100
3	The function of cornstarch in the mixture is as a polymer	C1	85	90
4	The plasticizer in the mixture does not make the bioplastic elastic.	C4	25	100
5	Acetic acid is used to break the bonds of amylopectin branches found in starch so that starch molecules can bind to glycerol	C2	50	85
6	Bioplastics are made from a mixture of corn, glycerol, acetic acid, and distilled water.	C3	75	70*
7	Distilled water in the production of bioplastics does not function to dissolve the material.	C3	100	85*
8	Biomass that is often used to make bioplastics is starch.	C2	80	80
9	Starch is widely used as a raw material for making bioplastics because it is cheap and easy to find.	C3	100	100
10	Bioplastics are cooked at 60°C.	C4	90	95
11	The process of making bioplastics requires heating to a temperature of 60 °C. Heating serves to damage the starch crystals so that gelatinization occurs.	C3	100	60*
12	Biodegradable bioplastics are characterized by the growth of fungi	C5	35	70
13	Plasticizer materials commonly used in the manufacture of bioplastics are glycerol or glycerine	C1	80	75*
14	Starch contains amylopectin and amylose. The higher the amount of amylopectin, the better the quality of the bioplastic because the amylopectin molecules can bind to each other to form long chains so that the resulting bioplastic is not sticky.	C4	50	85
15	Degraded bioplastics are characterized by the growth of fungi	C1	85	90

The results of the pre-test and post-test in the control class and the experimental class are presented in Tables 11 and 12. Before analyzing the pre-test and post-test scores of the two classes, we determined the ideal score that could be achieved was 100 and the minimum score that could be achieved was 70.

Based on Table 11, in the control class, 12 students did not pass the pre-test. After the learning process with the conventional method was carried out, we tested the post-test. The number of students who did not pass in the initial stage of the pretest did not decrease significantly. The number of students who did not pass was 10 students. Meanwhile, based on Table 12 regarding the experimental class, before the learning process was carried out, 19 students did not pass the pre-test. The number who did not pass the pre-test was higher than the control class. After the learning process was carried out using the experimental demonstration method, many students experienced an increase in scores during the post-test. But, we found only 1 student who did not pass the post-test, which can be acknowledged due to a personal issue. Also in the experimental class, 5 students got the ideal post-test score of 100. These results indicate a significant increase in the experimental class. That is, there is a significant effect of the experimental demonstration method on the learning process.

Table 11 - Pre-test and post-test scores of the control class

No	Student Code	Pre-Test Control Class	Post-Test Control Class	N-Gain	Category
1	A1	53.33	60.00	0.14	Low
2	A2	60.00	73.33	0.33	Moderate
3	A3	73.33	73.33	0	Low
4	A4	80.00	93.33	0.67	Low
5	A5	46.67	53.33	0.12	Low
6	A6	73.33	80.00	0.25	Low
7	A7	60.00	66.67	0.17	Low
8	A8	93.33	86.67	-0.99	Low
9	A9	53.33	73.33	0.43	Moderate
10	A10	80.00	80.00	0.00	Low
11	A11	46.67	66.67	0.37	Moderate
12	A12	70.00	80.00	0.33	Moderate
13	A13	46.67	73.33	0.50	Moderate
14	A14	80.00	93.33	0.67	Moderate
15	A15	60.00	66.67	0.17	Low
16	A16	53.33	80.00	0.57	Moderate
17	A17	70.00	80.00	0.33	Moderate
18	A18	60.00	73.33	0.33	Moderate
19	A19	66.67	93.33	0.80	High
20	A20	66.67	93.33	0.80	High
Mean Score Control Class		**64.67**	**77.00**	**0.30**	
Standard Deviation		**2.95**	**11.05**	**0.38**	

Table 12 - Pre-test and post-test scores of the experiment class

No	Student Code	Pre-Test Control Class	Post-Test Control Class	N-Gain	Category
1	**X1**	60.00	100	1.00	Low
2	**X2**	60.00	86.67	0.67	Moderate
3	**X3**	93.33	86.67	-0.99	Low
4	**X4**	66.67	66.67	0.00	Low
5	**X5**	53.33	73.33	0.43	Low
6	**X6**	46.67	73.33	0.50	Low
7	**X7**	60.00	80.00	0.50	Low
8	**X8**	40.00	80.00	0.67	Low
9	**X9**	46.67	73.33	0.50	Moderate
10	**X10**	53.33	73.33	0.43	Low
11	**X11**	60.00	73.33	0.33	Moderate
12	**X12**	66.67	80.00	0.40	Moderate
13	**X13**	60.00	100	1.00	Moderate
14	**X14**	46.67	100	1.00	Moderate
15	**X15**	60.00	100	1.00	Low
16	**X16**	53.33	100	1.00	Moderate
17	**X17**	40.00	93.33	0.88	Moderate
18	**X18**	46.67	86.67	0.75	Moderate
19	**X19**	60.00	86.67	0.66	High
20	**X20**	66.67	86.67	0.60	High
Mean Score Control Class		**57.00**	**85.00**	**0.57**	
Standard Deviation		**11.64**	**10.72**	**0.47**	

Detailed data related to the highest, lowest, minimum, ideal, and average scores, as well as the standard deviation of the pre-test and post-test in the control and experimental classes are presented in Table 13. The different values between the highest and the lowest scores of the pre-test and post-test of the two classes were not so much different. Further analysis of the N-gain values is shown in Table 14 for both classes.

The N-gain value of student learning outcomes in the experimental class was 0.57 which was higher than the control class was 0.24. The N-gain value of student learning outcomes in the experimental class is in the moderate category. Meanwhile, the N-Gain value of student learning outcomes in the control class is in a low category. Based on the results of the N-Gain score. Learning with the video demonstration method is effective in increasing the understanding of the concept of making bioplastics for vocational students.

Table 13 - The detail scores in the control and experiment classes

Data Type	Pre-test Control Class	Post-test Control Class	Pre-test Experiment Class	Post-Test Experiment Class
Respondent	20	20	20	20
Highest score	93.33	93.33	93.33	100
Lowest score	46.67	53.33	40	66.7
Ideal score	100	100	100	100
Minimum score	70	70	70	70
Average score	64.67	77	57	85
Standard Deviation	12.95	11.04	11.64	10.72

Table 14 - Data related to the value of N-Gain for both classes

Class	N-Gain	Category
Control	0.24	Low
Experiment	0.57	Moderate

4.3 Statistical Analysis of Control and Experiment Class Learning Outcomes

To confirm the results of the descriptive analysis on the learning outcomes of the control class and the experimental class, statistical analysis was carried out. Before the significance test for both learning models, normality tests for pre-test and post-test scores in both classes were carried out.

Figure 2 shows the results of the normality test. Based on the Skewness curve, the slope pattern of the data distribution is relatively symmetrical and relatively perfect resembling a bell shape. Because the Skewness curve shows symmetry, the data forms a normal distribution.

After the prerequisite test is met, the next step is to test the hypothesis by using the Independent Sample T-Test at a significance level of 5% to determine whether or not there is an effect of the application of learning methods on the value of student learning outcomes where the null hypothesis and hypothesis 1 follow:

(i) H0 = there is no difference in the gain value between the control and experiment groups.
(ii) H1 = there is a difference in the gain value between the control and experiment groups.

Table 15 shows the results of the Independent Sample T-test. The results show that H0 is rejected and H1 is accepted because of the value of sig. (2-tailed) < 0.05, meaning that there is a significant difference between the students' gain scores in the control class and the experimental class. Based on the test results, it is known that the learning method using the experimental demonstration method is effective because the students' knowledge has significantly increased.

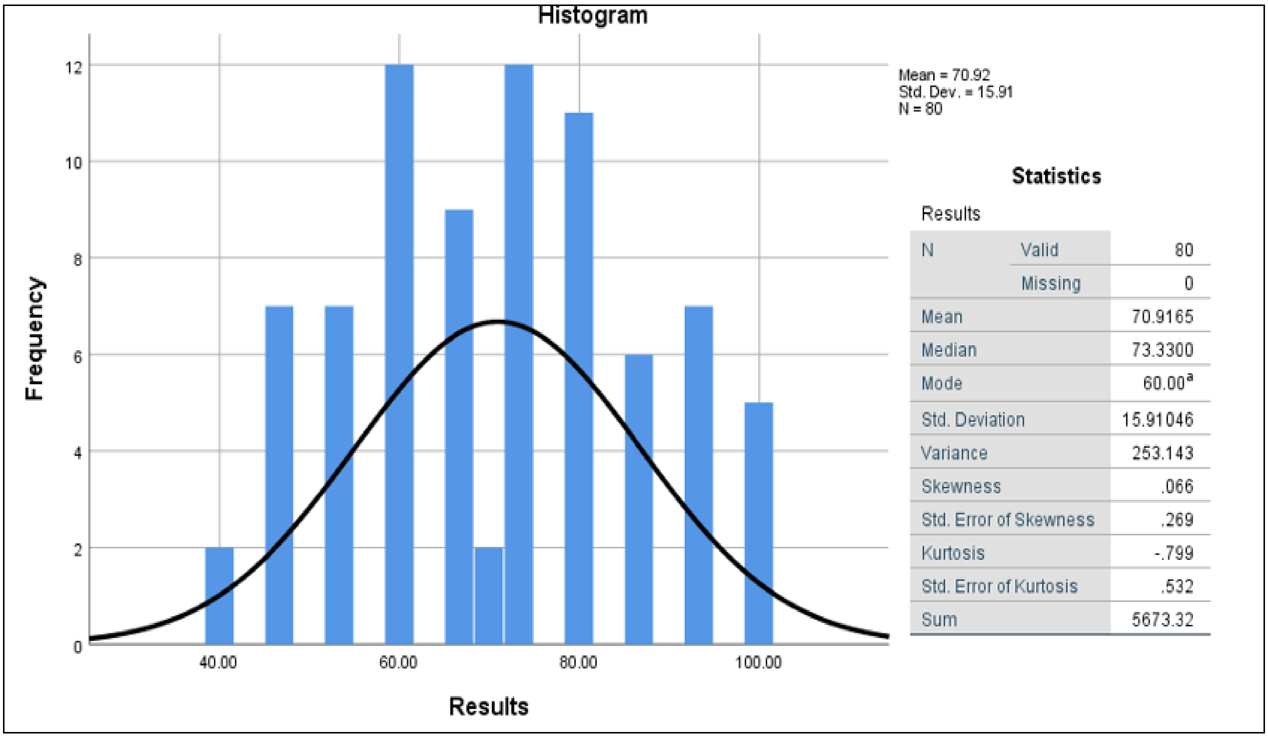

Fig. 2 - Normality test using Skewness test

Table 15 - Independent sample t-test results

	Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of The Difference	
Results	**F**	**Sig.**	**T**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
Equal Variances with "Assumption"	0.007	0.932	-2.265	38	0.029	-8.0010	3.5326	-15.152	-0.849
Equal Variances with "no Assumption"			-2.265	37.966	0.029	-8.0010	3.5326	-15.152	-0.849

5. Discussion

Based on the findings, the experimental demonstration method is proven to increase the knowledge of vocational students (Hidayat et al., 2020). This result is evidenced by the difference in the N-Gain value between the control class and the experimental class. In general, the experimental class has a higher N-Gain value than the control class. N-Gain in the experimental class is in the moderate category. Meanwhile, the N-Gain in the control class is in a low category. This result was also confirmed through a statistical significance test. The statistical test results also showed a significant difference in the N-Gain value between the control class and the experiment class. The results of this study indicate that the use of demonstrations helps students to better understand the learning material. Learning videos and presentation of material about demonstrations improve student achievement and understanding because students are trained to understand lessons using observing various demonstrations as well as simple tools and materials to apply the concepts (Fadillah & Maryanti, 2021). The experimental demonstration involves students and attracts students' attention. This is supported by simple tools for experiments, making students' creativity to be improved (Wahyu et al., 2018; Ariyanti & Maryanti, 2021). Thus, students are actively involved in the learning process. Students do not only hear but also watch what happened directly.

These results are in line with research conducted by Shao et al. (2021) regarding the use of demonstration experimental through learning videos, showing an increase in student motivation which has an impact on better learning outcomes. This is because the demonstration video learning that is presented does not only contain material but also audio and animated videos that are packaged interestingly. In addition, short demonstration videos encourage students to remember what they have learned and encourage students to study continuously to meet their learning needs so that students are motivated to learn it (Zhu et al., 2020). Therefore, the mastery of concepts and post-test results improved, which is better than the pre-test and previous results (Nuhu & Onojah, 2022). The demonstration videos can complement the basic experiences of students and explain the process accurately and repeatedly (Wong et al., 2019). Through demonstration videos, students are expected to get the same and correct perception and understanding. Learning with experimental demonstration methods builds intelligence abilities, interests, talents, creativities, language abilities, and motivations that can improve learning outcomes (Costa & Faria, 2018; Agarry et al., 2022). Someone with a good intelligence ability above the average must be easier and faster to understand something. It is not only in terms of intelligence, interests, talents, creativity, and language ability student motivation but also affects student learning outcomes (Mulyanto et al., 2018).

The demonstration experimental learning method has several advantages when compared to the conventional method. With experiments, students are trained to use the scientific method in dealing with all problems, thus students are not easy to believe in something that is not yet certain, and it is not easy to believe what people say before they prove the truth. Students practice being more active in thinking and doing, which is highly desired by modern teaching and learning activities, where students are more active in learning on their own with teacher guidance (Andhini & Sakti, 2021; Lathifah & Maryanti, 2021). The experimental demonstration method teaches students to prove the truth of a theory for themselves (Husni, 2020). In addition, the demonstration experimental method is a method that is suitable for use in science learning. The experimental demonstration method also has more advantages compared to the conventional method (Sever et al., 2013). The use of experimental demonstration methods in the learning process can help in developing students' thinking skills and creativity optimally (Ekamilasari & Pursitasari, 2021). Through this method, students are allowed to develop their concepts in their cognitive structure, which can be applied in their life. Another reason why this method is superior to other methods is that students practice directly and then the results of the experiment will be presented to the class and will be evaluated by the teacher (Agustin et al., 2021). Therefore, one way that teachers might be able to help students improve their learning outcomes is by increasing their learning knowledge. One way to increase student learning outcomes is by applying a variety of interesting presentation methods such as demonstrational video (Priantini, 2020).

5. Conclusion

The results showed that there was a significant difference in student learning outcomes between the control class and the experimental class for vocational school students. The results show that vocational students can easily understand the material about bioplastics after learning using the experimental demonstration method. These results were confirmed using statistical analysis with the non-parametric Mann-Whitney test. Experimental demonstration videos significantly increase knowledge and accelerate the understanding of vocational students. In addition, the benefits of the method of providing experimental demonstration videos to vocational students can provide different and varied learning experiences to stimulate vocational students' interest in learning. The increase in knowledge and understanding has an impact on student learning outcomes in science courses. This study can overcome problems of the need for a learning model that helps students in improving science skills, which is not only to understand the concept of chemistry and polymer but also how to solve environmental issues and give efforts to overcome them through chemistry lessons in vocational schools and how to improve in the industrial world after they graduate from the vocational school. This work is expected to have an impact on future demonstration research instructions, which are considered to provide useful learning. This study also can bring a good impact on possessing young generation, especially those facing SDGs.

Acknowledgement

We acknowledged RISTEK BRIN Grant Penelitian Terapan Unggulan Perguruan Tinggi and Universitas Pendidikan Indonesia grant Bangdos.

References

Afifah, S., Mudzakir, A., and Nandiyanto, A. B. D. (2022). How to calculate paired sample t-test using SPSS software: From step-by-step processing for users to the practical examples in the analysis of the effect of application anti-fire bamboo teaching materials on student learning outcomes. *Indonesian Journal of Teaching in Science*, *2* (1), 81-92.

Agarry, R.O., Omolafe, E.V., Animashaun, V.O., Babalola, E.O. (2022). Primary education undergraduates' competency in the use of artificial intelligence for learning in Kwara State. *ASEAN Journal of Educational Research and Technology*, *1* (2), 111-118.

Agustin, N. W., Sarwanto, S., and Supriyanto, A. (2021). Problem based learning on newton's law: can it improve student creativity?. *Jurnal Pendidikan Sains Indonesia*, *9* (4), 528-539.

Ana, A. (2020). Trends in expert system development: A practicum content analysis in vocational education for over grow pandemic learning problems. *Indonesian Journal of Science and Technology*, *5* (2), 246-260.

Andhini, A. B., and Sakti, A. W. (2021). Impact of distance learning on reading and writing ability in elementary school students. *Indonesian Journal of Multidiciplinary Research*, *1* (2), 393-398.

Anggraeni, R., and Maryanti, R. (2021). Implementation of video learning media in Islamic Religious Education subjects. *Indonesian Journal of Multidiciplinary Research, 1*(2), 257-266.

Ardoin, N. M., Bowers, A. W., Roth, N. W., and Holthuis, N. (2018). Environmental education and K-12 student outcomes: A review and analysis of research. *The Journal of Environmental Education*, *49* (1), 1-17.

Ariyanti S, N.D., Maryanti, R. (2021). Developing the creativity of elementary school students in Cimahi, Indonesia through online learning media during the covid-19 pandemic. *Indonesian Journal of Teaching in Science*, *2* (1), 7-16.

Babincakova, M., and Bernard, P. (2020). Online experimentation during COVID-19 secondary school closures: Teaching methods and student perceptions. *Journal of chemical education*, *97* (9), 3295-3300.

Chowdhury, H., Alam, F., and Mustary, I. (2019). Development of an innovative technique for teaching and learning of laboratory experiments for engineering courses. *Energy Procedia*, 160, 806-811.

Consebit, K.L., Dermil, K.C., Magbanua, E.Y., Racadio, F.J., Saavedra, S.V., Abusama, H. and Valdez, A. (2022). Bioplastic from Seaweeds (Eucheuma Cottonii) as an alternative plastic. *ASEAN Journal of Science and Engineering*, *2*(2), 129-132

Coppola, G., Gaudio, M. T., Lopresto, C. G., Calabro, V., Curcio, S., and Chakraborty, S. (2021). Bioplastic from renewable biomass: a facile solution for a greener environment. *Earth Systems and Environment,* 5(2), 231-251.

Costa, A., and Faria, L. (2018). Implicit theories of intelligence and academic achievement: A meta-analytic review. *Frontiers in Psychology*, *9*, 1-16.

Darmaji, D., Kurniawan, D. A., and Suryani, A. (2019). Effectiveness of basic physics ii practicum guidelines based on science process skills. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *4* (1), 1-7.

Duruin, A.A., Lalantacon, X.F., Leysa, J.G., Obena, R.A., Sapal, A., Leysa, M., Valdez, A. and Abusama, H. (2022). Potential production of bioplastic from water hyacinth (Eichornia crassipes). *ASEAN Journal of Science and Engineering*, *2*(2), 139-142

Ekamilasari, E., and Pursitasari, I. D. (2021). Students' critical thinking skills and sustainability awareness in science learning for implementation education for sustainable development. *Indonesian Journal of Multidiciplinary Research*, *1* (1), 121-124.

Evode, N., Qamar, S. A., Bilal, M., Barceló, D., and Iqbal, H. M. (2021). Plastic waste and its management strategies for environmental sustainability. *Case Studies in Chemical and Environmental Engineering*, *4*, 100142.

Fadillah, I. N., and Maryanti, R. (2021). Application of learning videos and quizizz in increasing students interest in learning english in middle schools. *Indonesian Journal of Multidiciplinary Research*, *1* (2), 329-336.

Folino, A., Karageorgiou, A., Calabrò, P. S., and Komilis, D. (2020). Biodegradation of wasted bioplastics in natural and industrial environments: A review. *Sustainability*, *12*(15), 1-27.

Ford, W. T. (2017). Introducing the journal of chemical education's "Special Issue: Polymer Concepts across the Curriculum". *Journal of Chemical Education*, *94* (11), 1595-1598.

Groller, K. D., Adamshick, P., and Petre, K. (2020). Embracing evidence-based nursing and informational literacy through an innovative undergraduate collaborative project. *International Journal of Nursing Education Scholarship*, *17* (1), 20190138.

Gutiérrez, T. J., and González, G. (2016). Effects of exposure to pulsed light on surface and structural properties of edible films made from cassava and taro starch. *Food and Bioprocess Technology*, *9*(11), 1812-1824.

Hidayat, D. S., Rahmat, C., Fattah, N., Rochyadi, E., Nandiyanto, A., and Maryanti, R. (2020). Understanding Archimedes law: What the best teaching strategies for vocational high school students with hearing impairment. *Journal of Technical Education and Training*, *12*(1), 229-237.

Husni, H. (2020). The effect of inquiry-based learning on religious subjects learning activities: An experimental study in high schools. *Jurnal Penelitian Pendidikan Islam*, *8* (1), 43-54.

Jiang, T., Duan, Q., Zhu, J., Liu, H., and Yu, L. (2020). Starch-based biodegradable materials: challenges and opportunities. *Advanced Industrial and Engineering Polymer Research*, *3*(1), 8-18.

Jossberger, H., Brand-Gruwel, S., Boshuizen, H., and Van de Wiel, M. (2010). The challenge of self-directed and self-regulated learning in vocational education: A theoretical analysis and synthesis of requirements. *Journal of Vocational Education and Training*, *62* (4), 415-440.

Lathifah, N. N., and Maryanti, R. (2021). Basic arithmetic learning through math online games for elementary school students during the pandemic. *Indonesian Journal of Multidiciplinary Research*, *1* (2), 379-384.

Maryanti, R., and Nandiyanto. A. B. D. (2021). Curriculum development in science education in vocational school. *ASEAN Journal of Science and Engineering Education, 2(1),* 151-156.

Maryanti, R., Hufad, A., Sunardi, S., and Nandiyanto, A. B. D. (2021a). Analysis of curriculum for science education for students with special needs in vocational high schools. *Journal of Technical Education and Training*, *13*(3), 54-66.

Maryanti, R., Nandiyanto, A. B. D., Hufad, A., and Sunardi, S. (2021b). Science education for students with special needs in Indonesia: From definition, systematic review, education system, to curriculum. *Indonesian Journal of Community and Special Needs Education, 1*(1), 1-8.

Mulyanto, H., Gunarhadi, G., and Indriayu, M. (2018). The effect of problem-based learning model on student mathematics learning outcomes viewed from critical thinking skills. *International Journal of Educational Research Review*, *3* (2), 37-45.

Nandiyanto, A. B. D., Fiandini, M., Ragadhita, R., Sukmafitri, A., Salam, H., and Triawan, F. (2020). Mechanical and biodegradation properties of cornstarch-based bioplastic material. *Materials Physics and Mechanics*, *44*(3), 320-391.

Nuhu, K. M., and Onojah, A. O. (2022). Effect of webinar multimedia platform on students' academic performance in selected educational technology concepts in University of Ilorin, *Indonesian Journal of Multidiciplinary Research*, *2* (1), 9-20.

Nurprasetio, I. P., Budiman, B. A., and Triawan, F. (2017). Failure investigation of plastic shredding machine's flange coupling based on mechanical analysis. *Indonesian Journal of Science and Technology*, *2*(2), 124-133.

Pebrianti, M., and Salamah, F. (2021). Learning simple pyrolysis tools for turning plastic waste into fuel. *Indonesian Journal of Multidiciplinary Research, 1*(1), 99-102.

Rosina, H., Virgantina, V., Ayyash, Y., Dwiyanti, V., and Boonsong. S. (2021). Vocational education curriculum: Between vocational education and industrial needs. *Asean Journal of Science and Engineering Education, 1* (2), 105-110.

Sever, S., Oguz-Unver, A., and Yurumezoglu, K. (2013). The effective presentation of inquiry-based classroom experiments using teaching strategies that employ video and demonstration methods. *Australasian Journal of Educational Technology*, *29* (3).

Sevian, H., Dori, Y. J., and Parchmann, I. (2018). How does STEM context-based learning work: What we know and what we still do not know. *International Journal of Science Education*, *40* (10), 1095-1107.

Shao, L., Migimatsu, T., Zhang, Q., Yang, K., and Bohg, J. (2021). Concept2robot: Learning manipulation concepts from instructions and human demonstrations. *The International Journal of Robotics Research*, *40* (12-14), 1419-1434.

Sivia, A., MacMath, S., and Britton, V. (2021). Letting the Light In: A Collaborative Self-Study of Practicum Mentoring. *Studying Teacher Education*, *17*, 1-17.

Soegoto, E. S., Ramana, J. M., and Rafif, L. S. (2021). Designing an educational website regarding recycling of plastic waste into roads. *ASEAN Journal of Science and Engineering Education, 2(1),* 135-140.

Tasolamprou, A. C., Koulouklidis, A. D., Daskalaki, C., Mavidis, C. P., Kenanakis, G., Deligeorgis, G., and Soukoulis, C. M. (2019). Experimental demonstration of ultrafast THz modulation in a graphene-based thin film absorber through negative photoinduced conductivity. *ACS Photonics*, *6*(3), 720-727.

Triawan, F., Nandiyanto, A. B. D., Suryani, I. O., Fiandini, M., and Budiman, B. A. (2020). The influence of turmeric microparticles amount on the mechanical and biodegradation properties of cornstarch-based bioplastic material: From bioplastic literature review to experiments. *Materials Physics and Mechanics*, *46* (1), 99-114.

Wahyu, W., Suryatna, A., and Kamaludin, Y. S. (2018). The suitability of William's creativity indicators with the creativity-based worksheet for the junior high school students on designing simple distillation tool. *Journal of Engineering Science and Technology*, *13* (7), 1959-1966.

Wiana, W. (2018). Interactive multimedia-based animation: A study of effectiveness on fashion design technology learning. *Journal of Physics: Conference Series*, *953* (1) 012024.

Wong, G., Apthorpe, H. C., Ruiz, K., and Nanayakkara, S. (2019). An innovative educational approach in using instructional videos to teach dental local anaesthetic skills. *European Journal of Dental Education*, *23* (1), 28-34.

Zhou, L., Xiao, Y., and Chen, W. (2019). Machine-learning attacks on interference-based optical encryption: Experimental demonstration. *Optics Express*, *27* (18), 26143-26154.

Zhu, Y., Zhang, J. H., Au, W., and Yates, G. (2020). University students' online learning attitudes and continuous intention to undertake online courses: A self-regulated learning perspective. *Educational technology research and development*, *68* (3), 1485-1519.