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Best Practice in Distance Learning with Experimental Demonstration on the Concept of the Automotive Brake Pad Fabrication from Domestic Waste to Vocational Students for Supporting Education for Sustainable Development

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Abstract: The aim of this study was to determine the best practice of using distance learning with conventional teaching methods and experimental demonstration methods to teach vocational students about the concept of fabricating automotive brake pad systems from domestic waste. This study employs an experimental design with pre- and post-test control groups to class-XI vocational students. We taught vocational students about brake pad fabrication and its industrial applications. Conventional methods of instruction were used in the control class, while the experimental demonstration method with learning videos was used in the experimental class. The learning videos used in the experimental class during the learning process contain basic theory and experiments on related materials. The results of the pre-test and post-test scores were analysed and measured to determine student learning outcomes. The findings revealed differences in learning outcomes between the control and experimental groups. Students in the experimental group comprehended the concept of fabricating brake pads more thoroughly than students in the control group. Students can get concrete examples from the teacher or instruction through experimental demonstration. Practical experience can help to form strong memories and skills. This success can be attributed to the availability of learning videos that students can watch repeatedly. Students are also more enthusiastic about learning videos because we teach something that can be applied in the industry. The addition of experimental demonstrations using commercially available materials increases student interest by increasing students' ability to experiment on their own. In addition, we also explain the concept of recycle and reuse agricultural waste for fabricating brakepad that can support current sustainable development goals (SDGs). Further learning applications using experimental demonstration methods are expected to be carried out because this method is proven to be effective for student learning.

Keywords: Brake pad, demonstration experimental method, learning media, SDGs, vocational student

1. Introduction

Learning in vocational high schools provides students with practical support media to help them improve their skills and learn new ones (Sudjimat & Permadi, 2021). The characteristics of vocational education emphasize students' preparation to enter the workforce and develop a professional attitude. In short, because the relationship between vocational education and the workforce is close (Maryanti, Hufad, Sunardi, & Nandiyanto, 2021), vocational education necessitates up-to-date

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practicum facilities. As a result, in vocational schools, in particular, students must be taught vocational training skills. Vocational training skills are one of the factors that become learning objectives in vocational education (Ana, 2020; Handayani, Ali, & Mukhidin, 2020a; Handayani, Ali, Wahyudin, & Mukhidin, 2020b).

Vocational training skills in agricultural development cover a variety of topics or competencies, including material handling, product processing, and the basis of quality control of agricultural products. In addition, vocational students majoring in agriculture must be able to manage waste, both agricultural waste, livestock waste, and domestic waste, for example managing the waste into fertilizer. These skills are important to make sure the graduated vocational students are ready for industry, and further can create a job (Al-Najar, Khalil, and Rahayu, 2019).

In addition to the competence of the study program, learning how to process and utilize waste is taught in science learning in vocational schools (Nizaar, 2020). Understanding how to reuse and recycle waste is good to possess the young generation, especially facing Sustainability Development Goals (SDGs) (Ekamilasari & Pursitasari, 2021). As a result, the teacher can make an effort to educate students with an awareness of environmental maintenance and waste management by teaching natural science. However, teachers who teach science topics at vocational schools frequently face learning challenges since students regard adaptive group subjects (such as science) as useless and do not require scientific skills in their world of work. The majority of teachers focus only on topics connected to practice. As a result, having the correct learning technique or learning media to promote issue resolution is essential (Buhori & Karnawati, 2022). One of the excellent strategies for overcoming these issues is learning science through experimental demonstration (Nandiyanto, Raziqi, Dallyono, & Sumardi, 2020).

Learning media is a tool that can aid the learning process by clarifying the meaning of the message conveyed, allowing students to achieve learning objectives more effectively and efficiently (Puspitarini & Hanif, 2019). In addition to requiring appropriate learning media, currently, physical distancing policies in Indonesia have been implemented to prevent the spread of COVID-19 (Fahrannisa, Muktiarni, & Mupita, 2022). The existence of this policy makes academic activities diverted from the face-to-face method to the online method (Sangsawang, 2020). Students must adapt to the new system which has several challenges in its implementation such as the internet network and the number of internet quotas must be stable and sufficient, the delivery of lecture material is not as clear as face-to-face lectures, and the academic schedule is delayed (Adebayo & Ochayi, 2022). To ensure that learning activities run well during online learning, every teacher is required to be able to design effective learning media by utilizing online media.

Learning using the experimental demonstration method is one effort to make learning materials more accessible to students. The experimental demonstration method is a teaching method by the uses demonstrations to clarify an understanding as well as to show how a certain formation process goes for students. Relevant research on the use of experimental demonstration models for teaching media was shown by several previous researchers. Maryanti, Hufad, Tukimin, Nandiyanto, & Manullang (2020) explained the combination of experimental demonstration and media was extremely effective in improving the understanding of students with special needs in learning viscosity. Rusyani, Maryanti, Muktiarni, & Nandiyanto (2021) explained that although deaf students optimize their sense of sight in the learning process only and have difficulty understanding complex and abstract information, the experimental demonstration method shows that the method is effective because it successfully increases students' understanding. Hidayat, Rahmat, Fattah, Rochyadi, Nandiyanto, & Maryanti (2020) educated students with special needs using experimental demonstration methods to determine the best teaching strategies for them to understand better. The experimental demonstration, as expected, improved students' understanding. According to Widodo, Hufad, Sunardi, & Nandiyanto (2020), the experimental demonstration learning method focuses on students with slow learning on their ability to capture the material being taught. The experimental demonstration method is very effective in helping students understand the subject matter and increasing student interest in learning (Handayani, Ali, & Mukhidin, 2020a). However, less research has been conducted on experimental methods for teaching materials about brake pads to vocational students.

Based on the description above, knowledge about the utilization and treatment of agricultural and domestic waste, especially for the fabrication of brake pads, is not taught, while it is well-known that vocational students will have direct contact with the industry, either as employees or by starting a business (Rosina, Virgantina, Ayyash, Dwiyanti, and Boonsong, 2021). As a result, someone's expertise in the fabrication of brake pads can be used to start a business (Yohana, Dania, & Prihandono, 2021). Therefore, teachers should create learning media to help students learn how to fabricate their brake pads by learning how to utilize, handle, and process waste. Therefore, the purpose of this study was to determine the best practice of using distance learning with conventional teaching methods and experimental demonstration methods on the concept of fabricating automotive brake pad systems from domestic waste to vocational students. The novelty of this research is to teach vocational students about brake pad system fabrication by utilizing domestic waste to produce environmentally friendly brake pads. Based on our previous studies (Nandiyanto, Raziqi, Dallyono, & Sumardi, 2020; Nandiyanto, Fiandini, Hofifah, Ragadhita, Al Husaeni, Al Husaeni, Maryanti, & Masek, 2022), we delivered an experimental demonstration to support the successful teaching and learning process. The study is expected to be useful for demonstrating specific skills, promoting explanation and teaching skills, having a positive impact on students, and being able to improve student learning outcomes.

2. Theoretical Framework

2.1 Brake Pad

Brake pads are particulate composites made up of reinforcing and bonding materials in a matrix. The reinforcing material is composed of particles that are uniformly distributed in a matrix and act as a binder to form a compact structure. The brake pad is an essential component of a vehicle's braking system. The braking system on a vehicle converts kinetic energy into heat by rubbing the brake disc with the brake pads when the two components come into contact. The friction material used in the brake pad manufacturing process typically determines the quality of the brake pads (Krishnan, Jayakumari, Babu, & Suresh, 2019). Depending on the filling material, brake pads can be metallic, semi-metallic, or non-metallic. Asbestos is commonly used as a brake pad filling material. Asbestos is cheap and widely available, and it extends the life of brake pads. However, asbestos material is extremely hazardous to human health. Thus, an alternative is needed to replace asbestos material (Idris, Aigbodion, Abubakar, & Nwoye, 2015). Many studies have recently developed non-asbestos organic material (NAO) brake pads from agro-industrial and domestic wastes such as rice husk, sawdust, palm shells, periwinkle shells, cocoa beans, corn husks, and chicken bone wastes. The use of agricultural and domestic waste supports proper strategies not only for growing economic value but also for reconciling environmental issues (Nurjamil, Wolio, Laila, Rohmah, Nandiyanto, Anggraeni, & Kurniawan, 2021). These organic wastes are the center of interest. Direct disposal of organic agricultural and domestic waste can create new environmental issues such as garbage accumulation, destruction of scenery, and the introduction of unpleasant smells. The study of brake pad fabrication by utilizing agricultural and domestic waste is one of the supports for sustainable development programs. This study can bring efforts to prevent or reduce the dangers of pollution due to toxic and dangerous chemicals that cause environmental problems.

2.2 Education for Sustainable Development Related to Material Chemistry Teaching

The main focus of Education for Sustainable Development (ESD) is to prepare the younger generation to become responsible citizens of the future. ESD is important, making it to be added as the national goal (Suryani & Hamdi, 2021). Sustainable development is the use of the environment for development by paying attention to, protecting, and preserving the environment to create a sustainable earth. ESD also must be related to creation and creativity (Theophilus, 2023). This sustainable development is in line with the principle of green chemistry which plays an important role in efforts to prevent or reduce the dangers of pollution due to toxic and hazardous chemicals that cause environmental problems (Kopnina, 2020; Handayani, Ali, Wahyudin, & Mukhidin, 2020). One of the main foundations for sustainable development is education because environmental problems can be solved if the community has a high awareness of the environment where this high awareness can be obtained through strengthening environmental education in schools. In short, education has a major role in achieving sustainable development goals (Kioupi & Voulvoulis, 2019). Science education is critical to ESD. The problem that persists in the high school science, education is that it emphasizes content rather than process, which does not support the goals of sustainable development. One concrete action to focus ESD on science learning is a laboratory experiment to solve scientific social problems using a scientific approach, one of which is the problem of excessive agricultural and domestic waste polluting the environment. The handling of agricultural and domestic waste that is popular so far is only through the combustion process (Obi, Ugwuishiwu, & Nwakaire, 2016). Even if the waste is not harmful, if it is processed through the combustion process, it still produces air pollution as a result of the combustion process. Thus, knowledge about handling environmentally friendly agricultural and domestic waste must be known by students (Mukti et al., 2021). Therefore, to support ESD in science learning, we can do converting agricultural and domestic waste into alternative energy sources through a series of certain processes, to reduce environmental pollution problems and not bring new environmental problems. In this study, the process of fabricating brake pads by utilizing agricultural waste can be an example of an experiment applied to science learning to instill education for sustainable development. The production of brake pads by utilizing environmentally friendly materials such as utilizing agricultural and domestic waste is in line with the SDGs.

2.3 Waste Management Learning Topics

The production and transformation of any material usually produce by-products in the form of goods with no commercial value, which these goods are known as waste. Waste can be classified into hazardous, non-hazardous, active, or passive waste, and when disposed of improperly, can contaminate soil, water (surface, underground, etc.), and air (Ramm, Dorscheid, Passos, & Sirtori, 2018). The learning topic about waste management is a topic that is arranged to provide vocational students understanding of maintenance environment and waste treatment, which is in line with the needs for SDGs. The waste management lesson topic aims to enable students to understand the importance of protecting the environment and how to treat the waste in the environment around them. The problem of waste needs to be emphasized to students because the problem of it turned out to have a serious impact on the environment. Learning about waste treatment that is taught thoroughly must meet several criteria aspects thus students understand the relationship between the problem of waste and its impacts environment and its effects on themselves.

The learning topic of waste management is usually taught in science lessons in both high school and vocational schools. According to Permendiknas No. 22 of 2006 in Indonesian Regulation, the science and technology subject group at vocational high schools is meant to use scientific knowledge and technology while developing competencies, skills, and job independence. As a result, learning activities must be oriented to complement their actions in the workplace (Stalmeijer & Varpio, 2021). In vocational schools majoring in agricultural development, learning about waste management is taught in biology subjects. The basic competencies of biology subjects in vocational schools that focus on waste treatment are evaluating various kinds of waste from living things and utilizing various kinds of waste from living things. Although biology subjects are taught about waste treatment, variations in waste treatment still exist not enough. Students should understand the problem of waste and how to process waste which is a by-product of their learning activities. Thus, when students have entered the world of work they can be more sensitive to the situation and environmental problems other than their abilities and competencies in their vocational field. In short, these basic competencies must define the quality achieved by balancing hard skills and soft skills.

The Indonesian national curriculum document for science education used in vocational schools is the subject of this study. Table 1 describes the science education curriculum (particularly for the biology subject) used in vocational schools with Agribusiness Processing Agricultural Products major. The curriculum defines two core competencies: knowledge competency 3 and skills competency 4. The two core competencies are translated into many basic competency points, each of which contains science education materials.

Based on the previously mentioned competencies, students need to know and understand the waste management system. This can educate them to be responsible for the waste that is around them. Efforts to provide students' understanding of maintenance environment and waste management can be provided by the teacher through learning. The solution to these problems is by applying appropriate learning strategies.

Table 1 - Curriculum for science education curriculum (especially for biology subject) in the vocational school.

Core Competency 3 (knowledge)	Core Competency 4 (skills)
3. Understand, apply, analyze, and evaluate factual, conceptual, advanced operational, and metacognitive knowledge in a multidisciplinary manner according to the field and scope of Biology studies at the technical, specific, detailed, and complex levels, concerning science, technology, art, culture, and humanities in the context of developing self-potential as part of the family, school, world of work, national, regional and international community members.	4. Carry out specific tasks using tools, information, and work procedures that are commonly carried out and solve problems in the field of Biology. Show independent performance with measurable quality and quantity following work competency standards. Demonstrate the skills of reasoning, processing, and presenting effectively, creatively, productively, critically, independently, collaboratively, communicatively, and solutively in the abstract realm related to the development of what he learns at school, and can carry out specific tasks independently. Demonstrate skills in perceiving, readiness, imitation, getting used to, proficient movements, making natural movements, up to original actions in the concrete realm related to the development of what they learn in school, and being able to carry out specific tasks independently.
Basic Competencies 3	**Basic Competencies 4**
3.8. Evaluating various kinds of waste from living things and the impact of pollution on environmental and health changes.	4.8. Utilizing various kinds of waste from living things and the impact of pollution on environmental and health changes.

3. Methodology

3.1 Experiment Procedure

Two classes involved in this study: the control class and the experimental class. The transfer of scientific material occurs in several stages, including (i) administering a pre-test to determine early students' learning achievement, (ii) providing teaching treatment (the control class was treated using the conventional model, and the experimental class was treated using the demonstration experimental learning model via learning video), and (iii) administering a post-test to assess students' understanding after the learning process. Both classes were taught the same lesson, which was about using domestic waste to fabricate brake pads. The learning video includes basic theory about agricultural and domestic waste, as well as experiments to fabricate brake pads out of domestic waste. The control class only uses conventional methods of learning, with no use of learning media. Meanwhile, in the experimental class, the experimental method was demonstrated through the presentation of learning videos that explain the fundamentals of material science. Following completion of the learning, both the control and experimental classes were given a pre-test and a post-test to evaluate the learning process. Each question on the pretest and posttest has 15 short answers that can be true or false. The correct answer receives a one, while the incorrect answer receives a zero. If students correctly answer all questions, they will receive a score of 100. The score is obtained by performing the calculation expressed by equation (1).

$$score = \frac{score\ gained}{maximal\ score} \times 100 \quad (1)$$

To assess the accuracy of the test instrument against the concept being assessed, validity and reliability tests were carried out on the item questions. The validity test and reliability test were carried out on 30 students with 15 question items. The validity of each question is determined by the product moment correlation formula and the determination of the reliability of the questions is determined by the Kuder Richardson-20 (KR-20) formula. Tables 2 and 3 show an analysis of the validity and reliability of the items, respectively.

Table 2 - Validity test on the item questions

Number of question	15 items
Number of students	30 students
Valid question number	1, 2, 3, 5, 7, 8, 9, 10, 11, 12, 14, 15
Number of valid questions	12

Table 3 - Reliability test on the item question

r_{count}	0.68
Category	The level of reliability on the item questions s is high.

In addition, difficulty analysis on pre-test and post-test questions was carried out based on the difficulty level of Robert L. Thorndike and Elizabeth Hagen's calculation. Tables 4 and 5 show the difficulty analysis for the pre-test and post-test questions and the classification of the results of data analysis level difficulty in detail, respectively.

Table 4 - Difficulty level of pre-test questions

Question number	Number of correct answers	Total students	Difficulty index value	Question category
1	24	30	0.80	Easy
2	30	30	1.00	Easy
3	19	30	0.63	Medium
4	24	30	0.80	Easy
5	20	30	0.67	Medium
6	25	30	0.83	Easy
7	26	30	0.86	Easy
8	24	30	0.80	Easy
9	24	30	0.70	Easy
10	22	30	0.83	Medium
11	25	30	0.83	Easy
12	25	30	0.83	Easy
13	26	30	0.86	Easy
14	25	30	0.83	Easy
15	29	30	0.96	Easy

Table 5 - Classification and Percentage of Difficulty Level

Category	Question Items	Total (items)	Percentage (%)
Easy	2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	12	80.0
Medium	1	1	6.7
Difficult	4, 5	2	13.3

3.2 Participants

This study included 60 vocational students from Bandung, Indonesia, with a major in Agricultural Development, which were divided into two groups: the control group (30 students) and the experiment group (30 students). A random technique is used to divide groups into two for sampling purposes. The students were chosen at random, with no regard for their characteristics.

3.3 Treatment Procedures

3.3.1 Experimental Group

The experimental demonstration method was used in the experimental group. The teacher explained the basic concepts of domestic waste and how to use it. Following that, the teacher demonstrated to the students how to utilize domestic waste by showing a learning video about brake lining fabrication. The learning video includes basic theory as well as oral and written explanations of each step of the experimental process, allowing students to fully understand the relationship between theory and practice. Students observe and evaluate the process during the demonstration. The summary of the experimental demonstration method of teaching delivery is shown in Table 6.

Table 6 - The summary of the experimental demonstration method of teaching delivery

Delivery method	Description	Role action
Pre-teaching	(i) Explain the purpose of the experiment to students; they must understand the problem to be proven by the experiment. (ii) Given pre-test to students to determine the initial ability of students related to the material to be delivered.	Teacher
Content delivery	• Explain to students about the basic theory of waste management and brake pad-based waste fabrication • Explain to students the tools and materials used in the experiment. • Explain to students the variables that must be controlled • Explain to students the sequence taken during the experiment • Explain to students that during the experimental process students must take notes on important things • Provide opportunities for students to ask questions	Teacher
Group discussion	Students ask questions, propose solutions to problems, and express their opinions.	Teacher and Students
Evaluation	Students are given a post-test to evaluate their learning	Student

3.3.2 Control Group

In the control class, the teacher uses traditional methods to convey learning, namely, the teacher only explains the material about domestic waste and how to utilize it through a video. This video only explains the basic concepts of learning material in the form of pictures to make the description clearer, without providing an experimental demonstration process. In short, the teacher only gives knowledge and students become passive objects as recipients of knowledge. The summary of the experimental demonstration method of teaching delivery is shown in Table 7.

Table 7 - The summary of the experimental demonstration method of teaching delivery

Delivery method	Description	Role action
Pre-teaching	(i) Explain the purpose of the experiment to students; they must understand the problem to be proven by the experiment. (ii) Given pre-test to students to determine the initial ability of students related to the material to be delivered.	Teacher
Content delivery	(i) Explain to students about the basic theory of waste management and brake pad-based waste fabrication (ii) Provide opportunities for students to ask questions	Teacher
Group discussion	Students ask questions, propose solutions to problems, and express their opinions.	Teacher and Students
Evaluation	Students are given a post-test to evaluate their learning	Student

3.4 Data Analysis

Students' basic information on average scores in Mathematics, Chemistry, Physics, Biology, and Adaptive skills were obtained before the start of learning to support the research instrument. The increase in student understanding is one of the descriptive assessments of learning outcomes calculated using N-Gain. Equation (2) expresses the N-Gain:

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

where the ideal score is 100. The category of increasing students' conceptual understanding after applying the learning model can be classified based on the N-Gain value as shown in Table 8.

Table 8 - N-Gain value classification

Limitation	Clasification
g > 0.70	High
0.30 ≤ g ≤ 0.70	Moderate
g < 0.30	Low

Furthermore, the data analysis technique carried out on student learning outcomes is to use statistical methods in the form of prerequisite tests (normality test and homogeneity test) pre-test and post-test data in both groups. The normality test was performed using the Skewness test. The normality test was carried out to find out whether the data that had been collected were normally distributed or not. Skewness is a statistical quantity that shows the slope of the data. This Skewness indicates the data tends to be centered or skewed on one side. The data is said to be normal when the value of the skewness ratio is in the range of values from -2.00 to 2.00. The skewness ratio is calculated by equation (3).

$$Skewness\ Ratio = \frac{Skewness}{Std.Error\ of\ Skewness} \quad (3)$$

Furthermore, to analyze the effect of the experimental demonstration method on student learning outcomes, a paired sample T-test was conducted. To analyze the differences in student learning outcomes between the experimental demonstration method and the conventional method, a paired sample t-test was conducted. The independent sample t-test was also used if the data is normally distributed.

4. Results and Discussion

Experiments were done through teaching and learning processes. The teaching process was done in two groups: the control and experiment groups. All participants were class XI vocational students, which were put in the control and experimental classes. In the experimental class, the experimental demonstration method with learning videos was used. Conventional methods of instruction were used in the control class. The learning videos used in the experimental class during the learning process contain basic theory and experiments on related materials. In this case, we taught vocational students about brake pad fabrication and its industrial applications. Data from the pretest and posttest were screened, and error sample data were exiled. Error data was obtained for students who make random/guessing answers, which can not be accounted for further data analyses. After normalizing the data, we obtained that the control group had 16 students, while the experiment group had 14 students. These data were then further analyzed.

4.1 Student Demographics

Table 9 displays students' basic science scores (Mathematics, Chemistry, Physics, Biology, and Vocation Training). To determine students' knowledge to learn science. According to Table 9, the average science score for all subjects is greater than 80, indicating that students have strong scientific knowledge and skills.

The IQ score of each student is categorized into 6 classifications: 1) if the IQ score is < 69 is categorized as an intellectually impaired group; 2) if 80 < IQ ≤ 89, students are categorized into the group below the average; 3) if 90 < IQ ≤ 109, the student is included in the average category; 4) if 110 < IQ ≤ 109, students are in the above-average group; 5) if 120 < IQ ≤ 129, students are superior group; and 7) if the IQ score > 130 students are included in the very superior group (Anggraeni et al., 2020). Table 10 shows that the average student has an IQ range in the average IQ group and only one student has an IQ above the average.

Table 9 - Students' average scores based on students' school report

No	Subject	Average Score	Standard deviation
1	Mathematics	85.1	5.30
2	Indonesian Language	85.6	6.03
2	Physic	86.0	5.33
3	Biology	84.0	6.02
4	Chemistry	85.4	6.07
5	Vocational Training	87.3	6.52

Table 10 - Acquisition of student IQ scores

IQ score	Category	Total students	Percentage (%)
<69	Intellectually impaired	0	0
70-79	Borderline	2	6.7
80-89	Below average	8	26.7
90-109	Average	16	53.3
110-119	Above average	3	10.0
120-129	Superior	0	0
>130	Very superior	1	3.3

4.2 Descriptive Analysis of Learning Outcomes on Control and Experiment Group

Following the completion of their post-test, the researchers analyzed and compared the percentage of correct answers for each question between the control and experimental groups. Bloom's Taxonomy was used to create the pre-test and post-test items. Table 11 shows a comparison of the percentages of each question between the control and experimental groups. Especially for the analysis in this section, the number of students in the control class is reduced thus the number of students in the control and experimental classes is the same.

According to Table 11, the majority of the item(about 60%) experienced an increase in score after the learning process was carried out in the experimental group using the experimental demonstration method. In terms of the other item items, there are somewhere the answer scores are stagnant (around 13.33%) and decreasing (around 26.67%) in the experimental group, which should be expected to increase in the experimental group. Item numbers 2 and 9 have the same score in both groups. Items 1, 5, 7, and 15 have decreasing scores in the experimental group. Items that have decreased scores in the experimental group are marked with an asterisk (*).

The misconception analysis of why the score decline occurred was due to several possibilities, including:

(i) Some students are still perplexed about how the brake pad works. This encourages educators to provide more explanations for this concept (item number 1).

(ii) Divergent or open-ended questions should be avoided because they elicit a variety of responses that require substantive elaboration from students. Thus, convergent questions should be used by educators to obtain a single "best" response from students (item number 5 and 7).

(iii) Everyone learns differently and may focus on a different part of the topic. Possibly, some students are less focused or less careful in choosing the right answer on this concept (item number 15).

In the control group, all students correctly answered 13.33% of the questions, namely items 2 and 15. All students correctly answered 33.33% of the questions in the experimental group, which included items numbered 2, 4, 11, 12, and 13. The concept of questions 2, 4, 11, 12, and 13 explains a theory that is used in daily life. This helps students understand the material better. The pre-test and post-test scores of students who were taught using the conventional and experimental demonstration methods were analyzed to determine their learning outcomes. The results of the pre-test and post-test data from the control and experimental classes were obtained based on the research, as shown in Tables 12 and 13, respectively.

Based on Table 14, the minimum score was 70. Eight students in the control group did not achieve the required pre-test score. Students who did not meet the minimum score after being taught using the conventional method were reduced to four students, as evidenced by their post-test scores. While in the experimental class, before learning to use certain treatments, four students had a pre-test score that was lower than the minimum value. When learning is done through the experimental demonstration method, there is only one student whose post-test score is still below the minimum score.

Table 11 - Comparison of post-test score from each item question between control and experimental groups

No	Problems	Bloom Taxonomy	Post-Test Control Group Score (%)	Post-Test Experiment Group Score (%)
1	Brake pads are used to absorb the energy possessed by a system or mechanism that moves by employing friction.	C2	92.86	85.71*
2	The energy absorbed by the brake pads is kinetic	C1	100.00	100.00
3	The energy absorbed by the brake pads is converted or converted into heat energy	C1	50.00	85.71
4	The performance of the brake pads depends on the coefficient of friction, the unit pressure between the braking surfaces, and the contact area of the braking surfaces	C4	42.86	100.00
5	Some inorganic materials are used as fillers in making natural fiber brake pads	C2	78.57	50.00*
6	Brake pads are generally composed of inorganic fibers such as asbestos embedded in a polymer matrix along with several other materials	C3	78.57	92.85
7	Fibers, fillers, and binders are not components that make up brake pads.	C3	92.85	78.57*
8	Binder is one of the components that make up the brake pads which serves to bind two or more other materials in the mixture employing adhesion or cohesion.	C2	64.28	92.86
9	Binder is also known as a polymer matrix	C3	85.71	85.71
10	Asbestos is one of the inorganic materials that are generally used as the main filler material for brake pads.	C4	71.42	92.86
11	Domestic waste can be used as a filler material to replace asbestos or other inorganic materials in the production of brake pad	C3	78.57	100.00
12	Durian seeds, rice husks, banana peels, and mangos teen seeds are natural ingredients from agricultural waste that can be used as filler in the manufacture of brake pads because durian seeds have high fiber content.	C5	71.42	100.00
13	Several studies have explained that asbestos is an inorganic material that is commonly used as a brake pad filler. However, asbestos material is dangerous. Therefore, the filler material is replaced by natural materials (e.g., from agricultural waste). The advantages of using natural materials (e.g., from agricultural waste) as filling materials for brake pads include: being cheap, environmentally friendly, easy to find, and containing hazardous-free materials.	C1	85.71	100.00
14	Based on the physical properties of brake pads, brake pads that have a relatively high level of hardness are good brake pads because good hardness causes a small friction coefficient.	C4	85.71	92.86
15	Good brake pad strength results from higher bonding/setting/packing of the filler material by resin	C1	100.00	92.86*

The highest pre-test score in the control group was 86.7, and the lowest pre-test score was 33.3. The highest post-test score was then 100.0, while the lowest post-test score was 60.0. The highest pre-test score in the experimental class was 93.3, and the lowest pre-test score was 46.7. The highest post-test score obtained was 100.0, and the lowest post-test score obtained was 66.7. The control group's average pre-test and post-test scores were 68.3 and 79.2, respectively. The experimental class's average pre-test and post-test scores were 75.2 and 90.7, respectively. The students' scores improved following the experimental demonstration method of learning. Although there is only one student who still gets a score below the minimum. However, the proportion of students of this type is small. We can conclude that this student is not entirely committed to solving the problem. This is evident in the students' post-test results (see Tables 12 and 13). After obtaining the pretest and posttest scores from the scoring results, the N-Gain is used to calculate the average increase in student test results. The difference between the post-test and pre-test scores is referred to as gain. N-Gain denotes an increase in students' understanding or mastery of concepts following teacher-led instruction. Table 15 shows the results of the descriptive analysis of the gain values calculated from the post-test gain values for the two groups. According to the N-Gain value, both methods have a good effect on learning outcomes because both methods have a moderate effect on learning outcomes.

Table 12 - Student learning outcomes from control groups

No	Student Code	Pre-Test Control Group	Post-Test Control Group	Gain (d)	N-Gain	Category
1	X1	66.7	66.7	0.0	0.0	Low
2	X2	80.0	86.7	6.7	0.3	Moderate
3	X3	60.0	73.3	13.3	0.3	Moderate
4	X4	73.3	73.3	0.0	0.0	Low
5	X5	60.0	60.0	0.0	0.0	Low
6	X6	33.3	60.0	26.7	0.4	Moderate
7	X7	40.0	73.3	33.3	0.6	High
8	X8	80.0	93.3	13.3	0.7	High
9	X9	66.7	80.0	13.3	0.4	Moderate
10	X10	80.0	93.3	33.3	0.7	High
11	X11	86.7	93.3	6.6	0.5	Moderate
12	X12	73.3	80.0	6.7	0.3	Moderate
13	X13	80.0	100.0	20.0	1.0	High
14	X14	86.7	80.0	-6.7	-0.5	Low
15	X15	66.7	86.7	20.0	0.6	High
16	X16	60.0	66.7	6.7	0.2	Low
Mean Score Control Group		68.3	79.2	10.8	0.3	
Standard Deviation		14.8	12.0	10.2	0.3	

Table 13 - Student learning outcomes from experiment groups.

No	Student Code	Pre-Test Exp Group	Post-Test Exp Group	Gain (d)	N-Gain	Category
1	X17	46.7	66.7	20.0	0.4	Moderate
2	X18	86.7	100.0	13.3	1.0	High
3	X19	66.7	93.3	26.7	0.8	High
4	X20	60.0	100.0	40.0	1.0	High
5	X21	93.3	93.3	0.0	0.0	Low
6	X22	73.3	93.3	20.0	0.7	High
7	X23	86.7	100.0	13.3	1.0	High
8	X24	73.3	100.0	26.7	1.0	High
9	X25	93.3	86.7	-6.7	-1.0	Low
10	X26	80.0	86.7	6.7	0.3	Moderate
11	X27	73.3	93.3	20.0	0.7	High
12	X28	80.0	80.0	0.0	0.0	Low
13	X29	80.0	96.7	16.7	0.8	High
14	X30	60.0	80.0	20.0	0.5	Moderate
Mean Score Control Group		75.2	90.7	15.5	0.5	
Standard Deviation		12.9	9.4	11.9	0.5	

Based on Tables 12 and 13, detailed data relating to the number of respondents, the highest score, the lowest score, the ideal value, and the minimum score are summarized in Table 14.

Table 14 - Detail data regarding respondents' scores as well as highest, lowest, ideal, and minimum values

Data Type	Pre-test Control Group	Post-test Control Group	Pre-test Experiment Group	Post-Test Experiment Group
Respondent	16	16	14	14
Highest score	86.67	100	93.33	100.00
Lowest score	33.33	60.00	46.67	66.67
Ideal score	100	100	100.0	100.00
Minimum score	70.00	70.00	70.0	70.00
Average score	68.33	79.20	75.20	90.67
Standard Deviation	14.80	12.00	12.90	9.40

Table 15 - Descriptive analysis of N-Gain value

Group	N-Gain Mean	Std. Deviation	Classification
Control	0.3	0.3	Low
Experiment	0.5	0.5	Moderate

4.3 Statistical Analysis of Learning Outcomes on Control and Experiment Group

Before testing the significance of learning outcomes, the data normality test was carried out. The data normality test was performed before testing the significance of learning outcomes. The Skewness ratio was used to analyze the normality of the data. Table 16 shows the Skewness ratio data and other statistical data in detail. According to Table 16, the skewness ratio is in the range of -2.00 to 2.00 thus the results show that the data is normally distributed. The results of the normality test revealed that the data were normally distributed. As a result, Paired sample T-test was used to analyze the effect of demonstration experimental and conventional methods on student learning outcomes. The analysis of the effect of the experimental demonstration and conventional methods on student learning outcomes is shown in Table 17. Based on Table 17, the significance value (2-tailed) of the Paired sample T-test for the two groups is < 0.05 which indicates that the two methods used in this study have an equally influential effect on student learning outcomes. The results of this Paired sample T-test confirm the results in Table 15, showing both methods influence student learning outcomes.

Table 16 - Statistic parameter data of pre-test and post-test from control and experiment group

Statistic Parameter	Pre-Test Control Group	Post-Test Control Group	Pre-Test Experiment Group	Post-Test Experiment Group
Mean	69.05	79.51	75.23	90.71
Median	73.30	80.00	76.65	93.30
Std. Deviation	16.26	12.66	13.43	9.79
Skewness	-1.155	-0.038	-0.586	-1.239
Std. Error Skewness	0.597	0.597	0.597	0.597
Kurtosis	0.739	-0.942	0.011	1.363
Skewness Ratio	-1.00	-0.033	-0.507	-1.073

Table 17 - The results of the test of the influence of the learning method using the Paired sample T-test

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	PreCon-Post Con	-10.464	11.005	2.941	-16.818	-4.109	-3.558	13	0.004
Pair 2	PreEx-PostEx	-15.478	12.364	3.304	-22.617	-8.339	-4.684	13	0.000

Furthermore, to analyze the differences in student learning outcomes between the experimental and conventional demonstration methods, the Independent sample t-test was conducted. In short, this independent sample t-test is used to confirm the results in Tables 15 and 17, where it is used to determine which learning method is superior. The results of the Independent sample t-test are shown in Table 18. The significance value (2-tailed) of the Independent sample t-test is < 0.05 which indicates that the demonstration experimental is the best method.

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Table 18 - 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"	0.983	0.331	-2.618	26	0.015	-11.2	4.2773	-19.9921	-2.4078
Equal Variances with "no Assumption"			-2.618	24.452	0.015	-11.2	4.2773	-20.0193	-2.3806

5. Discussion

The results revealed that the pre-test scores of each group revealed the students' initial understanding before learning with different models. According to Tables 12 and 13, the control and experimental groups' mean pre-test scores were 68.3 and 75.2, respectively. The mean score of the pre-test was relatively low for both groups. However, after learning using a different model, there was a difference in the increase in student learning outcomes between the control group and the experimental group, as evidenced by the post-test average score difference. According to Tables 12 and 13, the control and experimental groups' post-test mean scores were 79.2 and 90.7, respectively.

Aside from the post-test average score (as shown in Tables 12 and 13), the difference in the increase in student learning outcomes can also be seen in the N-Gain value, with the experimental group showing a moderate N-Gain. Meanwhile, the control group has an N-Gain value that falls into the low range (see Table 15). The N-Gain value results show that using the experimental demonstration learning model can improve students' understanding. Students in the control class do not have the opportunity to hone their thinking skills to solve a more complex problem using the Conventional learning model. Because the Conventional learning approach is learning through teacher-based instruction as the center of teaching. The teacher explains theoretical knowledge to the students, who listen and take notes as knowledge is passively received. There was little emphasis on problem-solving, collaborative learning, and learning strategies. As a result, students' motivation and ability to learn independently suffer. Conventional teaching methods have been shown to be less effective than other teaching strategies in terms of practical application and critical thinking skills (Ilkiw, Nelson, Watson, Conley, Raybould, Chigerwe, & Boudreaux, 2017; Dickinson, Lackey, Sheakley, Miller, Jevert, & Shattuck, 2018; Bi, Zhao, Yang, & Wang, 2019). The Independent sample t-test results also revealed a significant difference in student understanding between the two groups (see Table 18). The Independent sample t-test revealed a significant difference in students' understanding before and after the experimental demonstration model learning model was applied, indicating that the experimental demonstration model was more effective than conventional learning models in improving students' understanding.

This finding is consistent with the findings of other researchers who found that students taught using the experimental demonstration model had better conceptual understanding than students taught using the conventional learning model. Because of the presence of video media displayed by the teacher, which students rarely use, the experimental demonstration method has been shown to significantly improve the learning process. It can be stated that student learning activities using this experimental demonstration method demonstrate students' enthusiasm when participating in the learning process (Hidayat, Rahmat, Fattah, Rochyadi, Nandiyanto, & Maryanti., 2020). The presence of various media may motivate students more (Puspitarini & Hanif, 2019; Nicol & Macfarlane, 2006). In contrast to Conventional learning (the teacher explains the material and the students listen), when the teacher explains the material, the students may not be as focused on listening carefully because students must also take notes on important points (Kanninen, 2009; Isomöttönen & Tirronen, 2013). Improved learning outcomes occur because experiments make it easier for students to understand the learning material. The experimental method provides opportunities for students to learn directly, and this ultimately has an impact on improving student learning outcomes (Rahmawati, Achdiani, & Maharani, 2021).

The learning results show that the experimental learning model has a greater influence on student learning outcomes than the conventional model. This is because, even though students are not directly involved in the experiment, by learning with the experimental demonstration model, students can immediately get concrete examples (beginning with material preparation, material making, and material testing) of what the teacher or instruction demonstrates using learning video (Nandiyanto, Raziqi, Dallyono, & Sumardi, 2020). All stages of learning the topic of making brake pads from agricultural waste are thoroughly explained thus students truly understand what they are learning.

6. Conclusion

The experimental demonstration method was successful in improving student learning outcomes significantly. This is because students are fully focused and centered on the subject being demonstrated, providing practical experience that can form strong memories and skills in action, avoiding student errors in concluding, and because students observe directly the course of the demonstration carried out even though they are not directly involved in the experiment. Meanwhile, conventional learning focuses solely on the teacher because students do not actively participate in learning. Students in the control group tended to remain silent while the instructor explained the material. Therefore, fun learning activities such as experimental demonstration models can be carried out by educators in the learning process to be able to generate an understanding of student learning outcomes.

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