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A COMPREHENSIVE STUDY ON BIOCHAR PRODUCTION, BIBLIOMETRIC ANALYSIS, AND COLLABORATIVE TEACHING PRACTICUM FOR SUSTAINABLE DEVELOPMENT GOALS (SDGs) IN ISLAMIC SCHOOLS

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ABSTRACT

This research endeavors to assess the impact of additional practicum sessions and experimental demonstrations through video presentations on students' comprehension in an Islamic boarding school. The study focuses on enhancing students' understanding of the biochar concept, particularly its role as an adsorbent, aligning with contemporary issues related to the Sustainable Development Goals (SDGs) and environmental problem-solving. To substantiate the research rationale, a concise literature review and bibliometric analysis were incorporated. The experiment involved comparing two classes – the experimental class, which received additional practicum and experimental demonstrations using videos, and the conventional class as the control group. The study included 45 students in Class XI of an Islamic boarding school. Learning outcomes were assessed through pre-test and post-test scores, as well as N-Gain calculations. The hypothesis was tested using the Paired Sample T-test. The practical aspect of the

experiment involved carbonizing the skin of jengkol fruit to produce carbon, which was then utilized for adsorbing curcumin. The adsorption phenomena were observed and analyzed.The research findings demonstrated that the experimental demonstration method, particularly when complemented with video presentations, was more effective than conventional methods. This was evident from the N-Gain value of the experimental class and the results of statistical tests. The experimental demonstration method using videos is anticipated to enhance knowledge, provide a more authentic understanding and experience, and yield superior learning outcomes. These findings contribute valuable insights for future research on experimental demonstrations, emphasizing their potential to enhance the overall quality of student learning.

Keywords: Adsorption, Biochar, Collaborative Practicum, Islamic Boarding School, Sustainable Development Goals

ABSTRACT

Penelitian ini bertujuan untuk mengetahui pengaruh praktikum tambahan dan demonstrasi eksperimen menggunakan video terhadap pemahaman siswa di pesantren. Siswa perlu memahami konsep biochar sebagai penyerap, yang sejalan dengan isu-isu terkini dalam tujuan pembangunan berkelanjutan (SDGs) dalam memecahkan masalah lingkungan. Kami membandingkan dua kelas (yaitu kelas eksperimen dan kelas konvensional (sebagai kelas kontrol)) untuk memahami peningkatan pengetahuan tentang konsep produksi Biochar. Untuk menunjang pentingnya penelitian ini, kami menambahkan literature review singkat dan analisa bibliometric. Dalam eksperimen, Subjek penelitian ini adalah 45 siswa kelas XI Madrasah Aliyah. Hasil belajar kedua kelas dievaluasi dari nilai pre-test dan post-test serta N-Gain. Untuk menguji hipotesis menggunakan Paired Sample T-test. Percobaan dilakukan dengan mengkarbonisasi kulit buah jengkol (buah tradisional Indonesia) untuk menghasilkan karbon, bahan yang telah dikarbonisasi digunakan untuk mengadsorpsi kurkumin, dan fenomena adsorpsi diamati dan dianalisis. Hasil penelitian menunjukkan bahwa praktikum dengan metode demonstrasi eksperimen lebih efektif dibandingkan dengan praktikum dengan metode konvensional. Hal ini dibuktikan dengan nilai N-Gain untuk kelas eksperimen dan hasil uji statistik. Metode demonstrasi eksperimen dengan menggunakan video diharapkan mampu meningkatkan pengetahuan, memberikan pemahaman dan pengalaman yang lebih nyata, serta memperoleh hasil belajar yang lebih baik. Hasil penelitian ini dapat memberikan informasi bagi penelitian selanjutnya mengenai demonstrasi eksperimen yang diyakini dapat berpengaruh terhadap peningkatan kualitas belajar siswa.

Kata Kunci: Adsorpsi, Biochar, Praktikum Kolaboratif, Pondok Pesantren, Tujuan Pembangunan Berkelanjutan

INTRODUCTION

The production of biochar holds significant importance in the science curriculum for students in Islamic boarding schools. Biochar, known for its environmental benefits, serves as a versatile material that can function as an adsorbent or an additive in construction materials (Pinassang et al., 2022). The practice of producing biochar from environmental waste has gained widespread attention, particularly for agricultural applications (Wiskandar & Zurhalena, 2023). In essence, biochar is derived from a biomass component containing lignocellulosic elements, undergoing a transformation process to become carbon material. For a more comprehensive understanding, detailed information on biochar production is available in our previous studies (Nandiyanto, 2018; Nandiyanto et al., 2023).

Repurposing environmental waste into biochar proves beneficial for various human needs, aligning with the sustainable development goals (SDGs) concept (Maryanti et al., 2022). The application of biochar in the environment serves to adsorb undesired substances in liquids, involving an adsorption process (Ragadhita & Nandiyanto, 2021). Numerous materials derived from environmental waste, such as corn husks, orange peels, coconut fiber, and banana peels, demonstrate the capacity to adsorb metals and liquids. Functioning as effective adsorbents in the adsorption process, these materials contribute to utilizing environmental waste as a solution to address environmental challenges (Rahayu et al., 2021).

Islamic boarding school students encounter challenges in learning science due to the extensive curriculum, which includes subjects such as aqidah, sharia, and fiqh. This multifaceted curriculum imposes a burden on students, particularly when religious lessons are integrated with science materials. Research findings reveal that students' knowledge levels in science subjects, particularly in chemistry, are subpar, with an average score of 48 categorized as sufficient (Nurwanda et al., 2020). Additionally, there is a consensus that students face difficulty comprehending science materials solely through traditional lecture-based methods (Shofa et al., 2020). Hence, it is imperative to explore more effective and suitable approaches to enhance science learning for students in Islamic boarding schools.

One effective approach to support science learning in Islamic boarding schools is through the implementation of practicums. A practicum is a direct learning experience that holds significant importance in the educational process (Ana, 2020). This learning activity is designed to provide students in Islamic boarding schools with hands-on experience, allowing them to apply theoretical knowledge in laboratory settings or beyond (Suryaningsih, 2017). The practicum method plays a pivotal role in the overall learning approach (Ana, 2020). By engaging in practical learning, students can directly observe and experiment with the subject matter in laboratories, enhancing their understanding and skills (Duda et al., 2019). Practical activities, known to motivate students and cultivate essential experimental skills (Rini & Aldila, 2023), serve as a platform for learning scientific approaches and deepening comprehension of the subject (Putri & Astalini, 2022). Implementing a problem-based learning model through practicums, complemented by authentic assessments, significantly differs from traditional learning models (Duda et al., 2019). Successful practical learning requires specific strategies and media, and interactive learning media is one such tool that can be effectively utilized to facilitate learning experiences for students in Islamic boarding schools (Mardani et al., 2020).

Various learning media can facilitate interactive communication, enhancing the learning process (Nandiyanto et al., 2022). Learning media serves as a tool for teachers to convey information to students, and the incorporation of interactive multimedia is particularly crucial in science education (Shofa et al., 2020). Practical learning media stands as a significant determinant of success, fostering enthusiasm among students in Islamic boarding schools (Wastriami & Mudinillah, 2022). The utilization of learning media fosters engaging interactions during the learning process. Students in Islamic boarding schools benefit significantly from the Interactive Multimedia tutorial model, displaying improved learning activities and outcomes compared to those without Interactive Multimedia. Learning with interactive multimedia enhances students' reasoning, inference, and clarity aspects of thinking. Experimental demonstrations conducted through video media are a noteworthy learning medium. The incorporation of video media in practicums simplifies the understanding of learning materials for students in Islamic boarding schools (Azizah et al., 2022a). Notably, these videos allow students to rewind and revisit the material, offering flexibility in reviewing content as needed.

Based on our previous studies (Nandiyanto et al., 2018; Nandiyanto et al., 2022), here, this research was conducted to find out the influence of collaborative practicum with experimental demonstrations using video in science subjects for Islamic boarding school students in making activated carbon biochar which is useful for the environment. This study provides additional information source on the strategies for how to improve students' comprehension, especially when facing subject difficulties in learning science for students such as in biology studies (Glorifica, 2021; Babalola, 2022; Olumorin et al., 2022; Tipmontiane & Williams, 2022; Hofifah & Sumiati, 2023; Alhassan et al., 2024; Abdussemiu, 2022; Babalola et al., 2023; Ala et al., 2022). Chemistry studies (Francis & Baba, 2023; Putri et al., 2022; Wirzal & Halim, 2022; Barke & Buechter, 2023; Sombria et al., 2023; Swafiyah et al., 2023). Mathematics studies (Hashim et al., 2021; Vijayarani, et al., 2023; Akinoso, 2023; Radiamoda, 2024; Husnah

et al., 2021; Lathifah & Maryanti, 2021; Putri et al., 2022; Marasabessy, 2021; Maryati et al., 2022; Ogunjimi & Gbadeyanka, 2023; Obafemi et al., 2023; Omolafe, 2021). Physics studies (Azizah et al., 2022a; Susilowati et al.; 2023; Ibrahim, 2023; Lestari et al., 2024; Abosede et al., 2024).

Moreover, this study addresses the challenge of insufficient enthusiasm among students for learning science. In essence, direct observation is essential for students to grasp the impact of solving real-life sustainable problems. Through observing how the addition of carbon biochar adsorbent transforms colored solutions into clear solutions, students gain practical insights. Furthermore, an enhanced understanding of the benefits of carbon biochar empowers students to contribute to environmental preservation, aligning with SDG issues. The experiment involved carbonizing the skin of the jengkol fruit (an Indonesian traditional fruit), and the resultant carbonized materials were utilized for adsorbing curcumin. The study's innovations lie in using biochar as a teaching and learning tool to support SDGs, incorporating additional experimental demonstrations to enhance student comprehension, and focusing on students from Islamic boarding schools as the target group for improvement.

METHOD

Experimental Design

This research uses an experimental research design. Students were divided into two classes: experimental class and control class. Pre-research experiments were carried out in two classes before the research began. The experimental class received learning treatment through an experimental demonstration model assisted by video learning media, while the control class used a conventional learning model. Post-test assessment is carried out to evaluate student learning outcomes. The pre-test and post-test consist of thirteen questions, where students who answer the questions correctly get a score of 1, while students who answer the questions incorrectly get a score of 0. The analysis calculation formula is in equation (1):

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

Research Subjects

The subjects of this research were 45 students who were divided into two groups, namely the experimental class (33 students) and the control class (12 students). From the total number of students, 33 students were females and 12 students were males.

Treatment Procedure

The experimental class and control class were given different treatments, in the experimental class the learning session began with a pre-test. Then students watch a video demonstration of the experiment. Students are directed to observe the tools and materials used and identify the process of making carbon and the results obtained. After that, students were asked to complete the post-test. The end of the session closed with questions and answers as shown in Table 1.

Table 1. 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	Teacher-student

In the control class, the learning session started with a pre-test. After that, the lesson begins with a conventional learning model, where the teacher delivers the material. After the learning session ends, students are asked to complete post-test questions to find out how well

they understand the material after learning. Table 2 shows that the question and answer session was held at the end of the learning session.

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	Teacher
Post-teaching	Post-test	Student
conclusion	Question and answer	Teacher-student

Data Analysis

Analysis of data on increasing student understanding using the N-Gain. The accuracy of each question is assessed through validity and reliability tests. 13 questions were tested on 45 students. To determine the validity of each question, this research uses the product moment correlation formula. Meanwhile, reliability can be assessed using the Kuder Richardson-20 (KR-20) formula. The results of the validation test are shown in Table 3. Most of the questions are valid and can be used, only 3 questions need to be corrected before use. Reliability results are shown in Table 4. r_{count} of 0.55 which indicates the depth level is medium. But all questions are still reliable to use. Then an analysis of the level of difficulty of the pre-test and post-test questions was also carried out using Rovert L. Thorndike and Elizabeth Hagen's level calculations (see Table 5). Table 6 shows the classification of questions based on their level of difficulty.

Statistical analysis is used to test the prerequisites, namely the normality test with the skewness test, to determine whether the research data is normally distributed. A symmetrical skewness curve that resembles a bell is represented by a normal curve. To test differences in student learning outcomes, an independent sample T-test and SPSS version 20 were used. Detailed information regarding the t-test is explained in the literature (Afifah et al., 2022)

Table 3. Validity Test on the Item Questions

Type	Note
Number of questions	13 items
Number of students	45 students
Valid question number	3, 4, 6, 7, 8, 9, 10, 11, 12, 13
Number of valid questions	1, 2, 5

Table 4. Reliability Test on the Item Questions

Type	Note
r_{count}	0.55
Category	The level of reliability on the item questions is medium

Table 5. Difficulty Level of Pre-test Questions

Question	Number of Correct Answers	Total Students	Difficulty Index Value	Question Category
1	21	45	0.467	Difficult
2	16	45	0.356	Difficult
3	25	45	0.556	Difficult
4	29	45	0.644	Medium

Question	Number of Correct Answers	Total Students	Difficulty Index Value	Question Category
5	22	45	0.489	Difficult
6	28	45	0.622	Medium
7	19	45	0.422	Difficult
8	20	45	0.444	Difficult
9	27	45	0.600	Medium
10	21	45	0.467	Difficult
11	21	45	0.467	Difficult
12	20	45	0.444	Difficult
13	29	45	0.422	Difficult

Table 6. Classification and Percentage of Difficulty Level

Category	Question Items	Total (items)	Percentage (%)
Medium	4, 6, 9	3	23
Difficult	1, 2, 3, 5, 7, 8, 10, 11, 12, 13	10	77

RESULTS AND DISCUSSION

Concept of Biochar

The concept of biochar in converting organic components can be simplified using the following reaction (1).

$$(C_xH_yO_z)_n + \text{oxygen} \rightarrow \text{carbon char} + \text{volatiles} + \text{energy} \quad (1)$$

In short, the organic biomass is composed mainly of hydrocarbon components ($(C_6H_{10}O_5)_n$). During the conversion that usually takes the combustion/burning process, carbon is created. The volatiles, which are CO, CO_2, H_2, CH_4, C_xH_y, CH_mO_n, and other compounds in traces are obtained. To be able to make a model for the combustion process, a description of the chemical and physical phenomena involved is required. At a chemical level, the combustion process is a vast series of interlinked reactions. To avoid unnecessary complexity in the model, the reaction during the combustion process may be simply described as a one-step first-order reaction for the formation of the primary product (as carbon material). To produce a good amount of biochar (as product yield), less oxygen component must be done. The formation of biochar also creates energy. Biochar has a large area of porosity, in which this fact is useful when applying it as an adsorbent. Indeed, this information is important for students to understand. Detailed information is explained in our previous studies (Nandiyanto, 2018). The production of carbon biochar as shown in Figure 1.

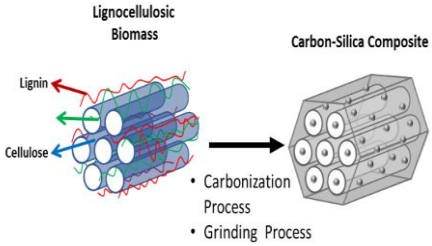

Figure 1. The Production of Carbon Biochar

Bibliometric Analysis for Carbon Biochar

Bibliometric is one of the methods for understanding current research trends. Previous studies on bibliometrics are presented in Table 7.

Table 7. Prior Bibliometric Analysis Research.

No	Title	Topic Discussion	Ref.
1	Dental suction aerosol: Bibliometric analysis.	In this study, the evolution of dental aerosol suction was explained by the distribution of bibliometrics maps and research trends using VOSviewer.	Ramadhan et al., 2022
2	A bibliometric analysis of Covid-19 researches using VOSViewer.	Using bibliometric analysis, this study examines the growth of writing throughout the COVID-19 era.	Hamidah et al., 2022
3	The latest report on the advantages and disadvantages of pure biodiesel (B100) on engine performance: Literature review and bibliometric analysis	This study reviewed the literature on pure biodiesel's advantages and disadvantages for engine performance.	Setiyo et al., 2021
4	Oil palm empty fruit bunch waste pretreatment with benzotriazolium-based ionic liquids for cellulose conversion to glucose: Experiments with computational bibliometric analysis	This study investigated the usage of benzotriazole ionic salt liquid as a solvent for empty palm oil fruit bunches using bibliometric analysis and VOSviewer.	Mudzakir et al., 2022
5	Past, current and future trends of salicylic acid and its derivatives: A bibliometric review of papers from the Scopus database published from 2000 to 2021.	This study's goal was to discuss scientometric studies of SA and its derivatives organizational development and future possibilities.	Ruzmetov et al., 2023
6	Correlation between process engineering and special needs from bibliometric analysis perspectives.	This study included a discussion of the integration of mapping analysis using the VOSviewer application.	Nordin et al., 2022
7	Bibliometric analysis for understanding the correlation between chemistry and special needs education using VOSviewer indexed by Google.	The use of VOSviewer in conjunction with mapping analysis was covered in this work.	Bilad, 2022
8	Nutritional research mapping for endurance sports: A bibliometric analysis.	This study looked into research mapping in the area of nutrition for endurance athletes.	Firdaus et al., 2023
9	Bibliometric and visualized analysis of scientific publications on geotechnics fields.	This study used bibliometric distribution maps from the VOSviewer tool to assess the development of research in geotechnical engineering.	Mulyawati & Ramadhan, 2021
10	What is the correlation between chemical engineering and special needs education from the perspective of bibliometric analysis using VOSviewer indexed by Google Scholar?	In this study, "Special Needs of Chemical Engineering" are analyzed using the VOSviewer tool.	Wirzal & Putra, 2022
11	Counselling guidance in science education: Definition, literature review, and bibliometric analysis.	This study uses a literature review and bibliometric analysis to examine the issue of guidance and counseling in science education.	Solehuddin et al., 2023

No	Title	Topic Discussion	Ref.
12	Phytochemical profile and biological activities of ethylacetate extract of peanut (Arachis hypogaea L.) stems: In-vitro and in-silico studies with bibliometric analysis.	This study examined the chemical composition and pharmacological activity of A.hypogaea stems in vitro and in silico.	Sahidin et al., 2023

Figure 2 shows the simplified bibliometric analysis of carbon biochar using the Scopus database with the keywords of "carbon" and "biochar". Detailed information for the bibliometric is explained in previous literature (Al Husaeni & Nandiyanto, 2022; Azizah et al., 2022b). The results showed that carbon biochar is a very important subject to be learned by students, confirmed by the increasing number of publications year by year exponentially.

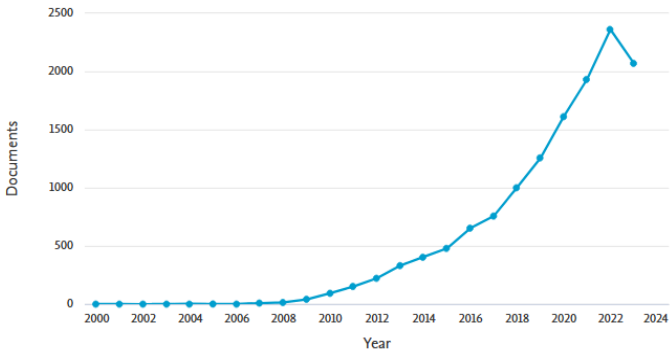

Figure 2. Publication Number of Carbon Biochar

Descriptive Analysis of Control and Experiment Class Learning Outcomes

The initial descriptive analysis compares the post-test answers in the control and experimental classes as shown in Table 8. Table 8 shows the classification of questions based on Bloom's Taxonomy. There is 1 question item (no. 13) with a percentage score that the control class is better than the experimental class. Another question item shows that the post-test score in the experimental class is higher than the control class. This shows that understanding of the concepts in the control class and experimental class is equally good. This increase in scores shows the influence of using the experimental demonstration learning method with videos on students' understanding.

Table 8. 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	The following are included in the human living environment	C1	58%	76%
2	Based on the physical type, hazardous and toxic waste	C1	50%	85%
3	Carbon is also called by the term	C1	58%	88%
4	Wastewater treatment can be done using processing techniques	C2	83%	91%
5	Water phase carbon or charcoal has a term	C1	75%	70%
6	Liquid phase carbon/charcoal has the following uses	C2	67%	91%
7	Carbon works as	C2	58%	79%
8	Adsorption is also called by the term	C1	83%	73%

No	Problems	Bloom Taxonomy	Post-test Control Class Score (%)	Post-test Experiment Class Score (%)
9	The process of processing jengkol skin into carbon is carried out in stages	C3	58%	85%
10	Burning jengkol skin to turn it into carbon	C3	42%	79%
11	Environmental waste that can be converted into carbon is	C1	50%	88%
12	Can carbon from jengkol peel remove odors from water?	C1	75%	88%
13	What is the filter size (mesh) in the carbon method from jengkol skin?	C2	83%	82%

Statistical Analysis of Control and Experiment Class Learning Outcomes

The pre-test and post-test results for the control class and experimental class are presented in Tables 9 and 10. Before analyzing the pre-test and post-test scores for both classes, determine the ideal score that can be achieved is 100 and the minimum score is 70.

Based on Table 10, in the control class of 12 students (men's class), none passed the pre-test. followed by the learning process using conventional methods, then conducting a post-test. As a result, there has been no change in student learning outcomes, getting a minimum score of 70. Meanwhile, in the experimental class (women's class) of 33 students, based on the pre-test, there were no students who passed the test. After the learning process used the experimental video demonstration method, the number of students in the experimental class who passed after the post-test became 33 students (100%). These results show a significant increase in the experimental class. This means that there is a significant influence of the experimental video demonstration method on the learning process.

Table 9. Pre-test and Post-test Score of Control Class

No	Student Code	Pre-test	Post-test	N-Gain	Category
1	C1	53.85	69.23	0.33	Moderate
2	C2	61.54	69.23	0.20	Low
3	C3	53.85	61.54	0.17	Low
4	C4	53.85	69.23	0.33	Moderate
5	C5	53.85	69.23	0.33	Moderate
No	Student Code	Pre-test	Post-test	N-Gain	Category
6	C6	53.85	69.23	0.33	Moderate
7	C7	46.15	61.54	0.29	Low
8	C8	46.15	53.85	0.14	Low
9	C9	61.54	69.23	0.20	Low
10	Q10	53.85	69.23	0.33	Moderate
11	C11	46.15	61.54	0.29	Low
12	C12	46.15	53.85	0.14	Low
Mean score control class		52.56	64.74	0.26	
Standard Deviation		5.29	5.84	0.07	

Table 10. Pre-test and Post-test Score of Experiment Class

No	Student Code	Pre-test	Post-test	N-Gain	Category
1	EX1	61.54	92.31	0.80	High
2	EX2	38.46	76.92	0.63	Moderate
3	EX3	38.46	76.92	0.63	Moderate
4	EX4	38.46	76.92	0.63	Moderate
5	EX5	46.15	92.31	0.86	High
6	EX6	61.54	84.62	0.60	Moderate
7	EX7	38.46	92.31	0.88	High
8	EX8	61.54	92.31	0.80	High
9	EX9	53.85	76.92	0.50	Moderate
10	EX10	61.54	92.31	0.80	High
11	EX11	46.15	84.62	0.71	High
12	EX12	38.46	76.92	0.63	Moderate
13	EX13	46.15	76.92	0.57	Moderate
14	EX14	38.46	84.62	0.75	High
15	EX15	46.15	92.31	0.86	High
16	EX16	30.77	84.62	0.78	High
17	EX17	46.15	84.62	0.71	High
18	EX18	53.85	84.62	0.67	Moderate
19	EX19	46.15	76.92	0.57	Moderate
20	EX20	15.38	84.62	0.82	High
21	EX21	15.38	76.92	0.73	High
22	EX22	69.23	76.92	0.25	Low
23	EX23	61.54	92.31	0.80	High
24	EX24	30.77	76.92	0.67	Moderate
25	EX25	69.23	76.92	0.25	Low
26	EX26	46.15	84.62	0.71	High
27	EX27	53.85	76.92	0.50	Moderate
28	EX28	61.54	76.92	0.40	Moderate
29	EX29	53.85	84.62	0.67	Moderate
30	EX30	46.15	76.92	0.57	Moderate
31	EX31	53.85	76.92	0.50	Moderate
32	EX32	61.54	84.62	0.60	Moderate
33	EX33	53.85	76.92	0.50	Moderate
Mean score control class		48.02	82.52	0.71	
Standard Deviation		13.12	6.07	0.11	

Detailed data on the highest, lowest, minimum, ideal, and average scores as well as standard deviations of pre-test and post-test in the control and experimental classes are presented in Table 11. Further analysis, namely the N-Gain values in both classes, is shown in Table 12.

The N-gain value of learning outcomes in the experimental class is 0.71 (High) higher than the control class 0.26 (Low). Based on the results of the N-Gain value, learning using the experimental demonstration method with videos is effective in increasing understanding of the concept of carbon production for Islamic boarding school students.

Table 11. The Detailed Score 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	12	12	33	33
Highest score	61.54	69.23	69.23	92.31
Lowest score	46.15	61.54	15.38	76.96
Ideal score	100	100	100	100
Average Score	52.56	64.74	48.02	82.52
Standard deviation	5.29	5.84	13.12	6.7

Table 12. Data Related to the Value of N-Gain for Both Classes

Class	N-Gain	Category
Control	0.26	Low
Experiment	0.71	High

Analysis

Before entering the steps for the paired sample t-test. Thus, we have to understadn whether the pre-test and post-test score data are normally distributed or not. The results of the normality test with SPSS are presented in Table 13.

Table 13. Normality Test

Control Class and Experimental Class	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Experimental Class	0.141	33	0.092
Control Class	0.258	12	0.056
a. Lilliefors Significance Correction			

Based on Table 13, all data is normally distributed in both the experimental and control classes. This is based on the results of the Kolmogorov-Smirnov data normality test with sig values of 0.092 > 0.05 and 0.056 > 0.05. Thus, the requirements or assumptions of normality in the t-test have been fulfilled.

Next, statistical analysis was carried out to confirm the results of the analysis of descriptions of learning outcomes in the control class and experimental class. Hypothesis testing using a Paired Sample T-Test at α significant level of 5% to determine whether or not there is an effect of the experimental demonstration method using video on increasing students' learning knowledge in science subjects on biochar material. The research hypothesis is as follows:

1. H0 = There is no effect of using collaborative practicum with experimental demonstrations in increasing Islamic boarding school students' knowledge of biochar production concepts
2. H1 = There is an influence of the use of collaborative practicum with experimental demonstrations in increasing Islamic boarding school students' knowledge of biochar production concepts

Table 14 shows the results of the Paired Sample T-Test. The results show that H0 is rejected and H1 is accepted because the sig value (2-tailed) is 0.000 < 0.05, meaning that there is a significant difference between the gain scores of students in the control class and the experimental class. This means that there is a significant effect of using the experimental

demonstration method using video on increasing student knowledge which has an impact on increasing student learning outcomes

Table 14. Paired Samples Test Results

		Paired Differences					t	Df	Say. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-Test – Post-Test	-3.733	1.993	0.297	-4.332	-3.135	-12.565	44	0.000

Table 14 contains information on the mean paired difference of -3.733. This value shows the difference between the average pre-test learning results and the average post-test learning results. The difference is between -4.332 to -3.135 (95% Confidence Interval of the Difference Lower and Upper).

Correlation between Science and technology in Islamic school

The rapid development of science and technological discoveries has spread results that bring progress, and the benefits are felt for the lives of all mankind. All findings of science and technology (science and technology) on the one hand must be recognized as having significantly influenced and even improved the standard and quality of human life. Whether we admit it or not, various modern tools and facilities are available. For example, Transport and Industry prove to be very beneficial for life. The invention of aircraft technology was made. Thus, someone could travel around the world in a short time. The existence of television allows giving information about important events in distant places without having to leave the house. The invention of mobile phones (cellphones) makes us able to connect with anyone, anywhere and anytime. Advances in computers created Internet networks that allowed people to access information easily, quickly, and accurately (Maslaha & Suryani, 2018).

Modern society has managed to develop advanced science and technology to overcome various problems in its life. Islam's view of science and technology is that Islam has never restrained its people from being advanced and modern. Islam strongly supports its people to conduct research in any field, including science and technology. The Quran is an inspiration, meaning that in the Quran there are many texts (verses) that encourage humans to see, look, think, and observe the phenomena of God's created universe that are interesting to investigate, research, and develop. The Qur'an is a holy book that has a significant role in the advancement of science and technology. The evidence is:

1. The first revelation revealed by Allah Almighty is the command to read/study and use reason, not the command to pray, fast, or dhikrulah.
2. That Allah Almighty appointed Prophet Adam (AS) as His caliph because one of them is the mastery of science (note QS. Al Baqarah verses 31-33).
3. Man has the highest degree in the side of Allah SWT, is a man who has faith and knowledge (QS 58/11). Because faith brings man to heights in the Hereafter (*fil akhirati hasanah*), and science brings man to heights in the world (*fid dunya hasanah*).

Islamic educational institutions as a place for the development of Islamic teachings have an important role as the center of Islamic civilization in the past. That is why many moslem scholars are available (Ragadhita & Nandiyanto, 2022). From this Islamic school were born Muslim scholars, freedom fighters, various arts, renewal figures and polite and commendable Islamic cultures. Scientific culture should have been built in the Islamic school environment

because this culture has led the West to become the center of civilization today. The topic of building a scientific culture in the Islamic school environment is one of the reconstruction efforts to become the center of Islamic civilization in the future. In addition, interaction with the development of time also needs to be done. Islamic schools must more or less accommodate science and technology in everyday life, as a development of knowledge (Rosyidin, 2021).

Synergistic integration between science and technology in Islamic schools will consistently produce reliable resources in applying their knowledge strengthened by a strong spirituality in facing life. This concept is a new breakthrough in the world of Islamic schools, where usually students only focus on religious science without being associated with modern science. Muslims believe that all science in general comes from the Creator, Allah Almighty. The sources and laws of Allah cannot contradict the Quran, especially the kauniyyah (nature/science) verses (Iqbal, 2023). Thus, the Quran gives a lot of encouragement to humans to study and understand the universe through a scientific approach. This is in line with man's efforts to understand and appreciate the wonders of God's creation through scientific exploration in various disciplines.

In addition, in history it has been mentioned that Muslim scientists at that time had been pioneers for the advancement of Islamic civilization in all fields of science about eight centuries before the time of Galileo Galilei (1564-1642) and Copernicus (1473-1543) (Ni'mah, 2023; Ragadhita & Nandiyanto, 2022). This at least shows that the basic principles of science have been compiled by scientists long before the philosophy of science was formulated as a scientific discipline (Yahya, 2015). Islamic civilization had achieved spectacular glory and progress in the sciences at the beginning of the early period of its history. This progress was achieved precisely at a time when Europe was still in the dark ages.

Islamic boarding school is an Islamic faith-based institution and is the oldest educational institution in Indonesia. He has contributed greatly to the spread of Islam, until the independence of this nation. As time goes by, the world changes. Indeed, Islamic school must be able to run to take over the process, of developing science, not only religious science. Islamic schools here play an important role in maintaining the knowledge of Allah, especially religion and science, which is actually one. The goal is clear, to form character and creed as a strong foundation and experience in the provision of reaching the future, not only for students, but for the development of world science. Previous studies on science and technology in Islamic Boarding Schools is presented in Table 15.

Table 15. Science and Technology in Islamic Boaring Schools Research.

No	Title	Topic Discussion	Ref.
1	The response of Islamic education to the advancement of science in the covid-19 pandemic era in the Islamic Boarding Schools.	In this study, pesantren responded to the COVID-19 pandemic by applying technology in learning during the pandemic through online learning.	Mansir, 2021
2	The role of islamic boarding schools in moral education in the technological era.	In this study, technology became one of the inhibiting factors in moral cultivation in pesantren.	Mukti et al., 2022
3	The development of educational technology in the realm of Islamic boarding school learning	This research examines the problems of madrasah and pesantren in facing technological developments in the era of the industrial revolution 4.0.	Salsabila et al., 2022
4	Challenges and learning strategies of Islamic education in Islamic	Research that discusses the challenges of pesantren in the use of technology in learning. The use of mobile phones as a tool	Lundeto et al., 2021

No	Title	Topic Discussion	Ref.
	boarding schools in the industrial revolution era 4.0	that supports the learning process is a recommendation in this study.	
5	Challenges of online boarding schools in the digital era	The development of science and technology has an impact on learning in pesantren, so that online pesantren emerge. Study of the challenges of the emergence of online pesantren that provide learning as in pesantren in general.	Kardi et al., 2023
6	Digital learning transformation at Islamic boarding schools: digital-based learning patterns in Salaf and modern Islamic boarding schools in Jember.	In this study, there are two pesantren that have different forms, where one pesantren has formal education and one pesantren does not. The results showed that pesantren that have formal education have started using technology in their learning while others have not used technology.	Suharto and Fatmawati, 2022
7	The innovation of traditional education system in islamic boarding schools based on modernization	In this study, changing the maindset in the management of traditional pesantren into modern pesantren is important in order to adapt to the times marked by science and technology.	Machmud, 2022
8	Integration of STEM Approach in teaching science to Indonesian Islamic boarding school students (Malaysian pre-service teachers' experience)	In this study, it was found that STEM approaches can be integrated in science learning in Islamic subjects in Islamic boarding schools.	Suprapto et al., 2022
9	Implementation of Life Skills Education at Darul Fallah Agricultural Boarding School Bogor	The research illustrates the implementation of life skills education in Darul Fallah agricultural boarding schools, namely through revamping the education system that applies an integrative curriculum between the Ministry of Agriculture, Ministry of Education, local skills (agricultural materials, animal husbandry, fisheries, appropriate technology and others) and the pesantren curriculum, with a learning system that combines theory and practice.	Ramdhani, 2015

Discussion of Statistical Analysis

The research results show that the experimental demonstration method using video can increase Islamic boarding school students' knowledge (Prastica et al., 2021). The use of video has been a well-known media for increasing student comprehension (Winarni & Rasiban, 2021; Onasanya et al., 2022; Millatina et al., 2022; Anggraeni & Maryanti, 2021; Fadillah & Maryanti, 2021; Maulid & Sakti, 2022). This result is proven by the difference in N-Gain values between the control class and the experimental class. The test results showed that the N-gain value for the experimental class is higher than the control class. The N-gain value for the experimental class is in the moderate category while the control class is in the low category. The results of statistical tests also show that there are significant differences. The results of this research illustrate that the use of experimental demonstration methods with videos helps students to better understand the learning material.

Experimental demonstrations can attract students' attention and students' focus on the series of experiments contained in the video has an impact on increasing students' interest in learning (Sari et al., 2022). Thus, student learning outcomes will increase. This is in line with research conducted by Nandiyanto et al. (2022) regarding the use of demonstration experiments

via video showing an increase in student learning outcomes. A complete video display, coupled with audio, makes learning more interesting. Therefore, the score increases in the post-test compared to the pre-test. Through videos, students gain the same understanding (Nurdin et al., 2019). Learning using experimental demonstrations can build students' abilities, interests and talents, creativity, and learning outcomes (Nurdin, 2022).

The experimental demonstration learning method has several advantages compared to conventional learning. Through experiments, students are trained to think critically, creatively, and effectively and help each other to solve problems (Sulistyanti et al., 2019). The learning experience becomes more real. Thus, students can develop their abilities in solving problems. Students are trained to improve critical thinking and students can be more independent (student center) (Patmasari et al., 2023). The experimental demonstration method is a suitable method for learning science and technology (Sunami & Aslam, 2021). This is what shows that the experimental demonstration method has advantages over conventional methods. This can be used as a basis for teachers to develop learning media and learning methods to improve student learning outcomes. Another aspect that can be done is to use the experimental demonstration method with learning videos.

Based on the results of the above research, students in Islamic schools can increase their knowledge in the field of science very well if it is given the right method of learning. The concept of learning through demonstration can be a new breakthrough in the world of Islamic schools in increasing students' understanding of the field of science. There is no way to run. Islamic schools must be able to run to take over the process, especially in developing knowledge.

CONCLUSION

Based on the research results, the experimental demonstration method using learning videos is effective in increasing knowledge of learning material. The difference in scores between the control class and the experimental class shows that Islamic boarding school students easily understand carbon material after learning using the experimental demonstration method. The use of the experimental demonstration method can provide a different learning experience thereby influencing learning outcomes in science subjects. The results of this research will provide useful insights for further empirical research and it can also provide benefits for Islamic boarding school graduates to be better prepared to face the SDGs and competition in the industrial world.

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BIBLIOGRAPHY

Abdussemiu, A. (2022). Problems of teaching practical biology in senior secondary schools. *ASEAN Journal of Science and Engineering Education*, *2*(3), 199-206. https://doi.org/10.17509/ajsee.v2i3.44721

Abosede, P.J., Onasanya, S.A., and Ngozi, O.C. (2024). Students self-assessment of demonstration-based flipped classroom on senior secondary school students' performance in physics. *Indonesian Journal of Teaching in Science*, *4*(1), 27-40. https://doi.org/10.17509/ijotis.v4i1.60876

Afifah, S., Mudzakir, A., & 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. https://doi.org/10.17509/ijotis.v2i1.45895

Akinoso, S.O. (2023). Motivation and ICT in secondary school mathematics using unified theory of acceptance and use of technology model. *Indonesian Journal of Educational Research and Technology*, *3*(1), 79-90. https://doi.org/10.17509/ijert.v3i1.47183

Al Husaeni, D.F., and Nandiyanto, A.B.D. (2023b). Bibliometric using VoSviewer with publish or perish (using google scholar data): From step-by-step processing for users to the practical examples in the analysis of digital learning articles in pre and post covid-19 pandemic. *ASEAN Journal of Science and Engineering*, *2*(1), 19-46. https://doi.org/10.17509/ajse.v2i1.37368

Ala, N.A., Onojah, A.O., Ishyaku, A.M., and Adamu, S.B. (2022). Development of an animation *package* in biology for teaching vertebrate, anatomy, and physiology. *ASEAN Journal for Science Education*, *1*(2), 117-130. Retrieved from https://ejournal.bumipublikasinusantara.id/index.php/ajsed/article/view/173

Alhassan, N., Alhassan, A., and Chioma, A.F. (2024). Examining the role of biology teachers' beliefs, motivations, and self-reported practices in constructing curves for biology class. *Indonesian Journal of Teaching in Science*, *4*(1), 11-26. https://doi.org/10.17509/ijotis.v4i1.60689

Ana, A. (2020). Trends in expert system development: A practicum content analysis in vocational education for over growth pandemic learning problems. *Indonesian Journal of Science and Technology*, *5*(2), 246-260. https://doi.org/10.17509/ijost.v5i2.24616

Anggraeni, R., & Maryanti, R. (2021). Implementation of video learning media in islamic religious education subjects. *Indonesian Journal of Multidiciplinary Research*, *1*(2), 257-266. https://doi.org/10.17509/ijomr.v1i2.37609

Azizah, E.V., Nandiyanto, A.B.D., Kurniawan, T., and Bilad, M.R. (2022a). The effectiveness of using a virtual laboratory in distance learning on the measurement materials of the natural sciences of physics for junior high school students. *ASEAN Journal of Science and Engineering Education*, *2*(3), 207-214. https://doi.org/10.17509/ajsee.v2i3.38599

Azizah, S. N., Nandiyanto, A. B. D., Wulandary, V., & Irawan, A. R. (2022b). Implementation of video learning media in Islamic religious education subjects for elementary school students. *Indonesian Journal of Multidiciplinary Research*, *2*(1), 91-96. https://doi.org/10.17509/ijomr.v2i1.38635

Babalola, E.O. (2022). Design and development of 3-dimensional model of human circulatory system to teach a concept of biology in senior secondary schools. *Indonesian Journal of Teaching in Science*, *2*(1), 17-28. https://doi.org/10.17509/ijotis.v2i1.39006

Babalola, E.O., Ayoola, D.A., and Omolafe, E.V. (2023). Analysis of experts' opinion on the human excretory system model for teaching biology in Nigeria. *ASEAN Journal of Science and Engineering Education*, *3*(1), 19-26. https://doi.org/10.17509/ajsee.v3i1.45457

Barke, H.D., and Buechter, J. (2023). Laboratory jargon and misconceptions in chemistry an empirical study. *ASEAN Journal of Science and Engineering Education, 3*(1), 65-70. https://doi.org/10.17509/ajsee.v3i1.48210

Bilad, M. R. (2022). Bibliometric analysis for understanding the correlation between chemistry and special needs education using Vosviewer indexed by google. *ASEAN Journal of Community and Special Needs Education*, *1*(2), 61-68. Retrieved from https://ejournal.bumipublikasinusantara.id/index.php/ajcsne/article/view/61

Duda, H. J., Susilo, H., & Newcombe, P. (2019). Enhancing different ethnicity science process skills: Problem-based learning through practicum and authentic assessment. *International Journal of Instruction*, *12*(1), 1207-1222. Retrieved from https://www.e-iji.net/dosyalar/iji_2019_1_48.pdf

Fadillah, I. N., & 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. https://doi.org/10.17509/ijomr.v1i2.37853

Firdaus, I. R., Febrianty, M. F., Awwaludin, P. N., Ilsya, M. N. F., Nurcahya, Y., & Sultoni, K. (2023). Nutritional research mapping for endurance sports: A bibliometric analysis. *ASEAN Journal of Physical Education and Sport Science*, *2*(1), 23-38. Retrieved from https://ejournal.bumipublikasinusantara.id/index.php/ajopess/article/view/198

Francis, T.T., and Baba, S.J. (2023). Effect of concept mapping teaching approach on students' academic *performance* in chemistry in senior secondary schools. *Indonesian Journal of Educational Research and Technology*, *3*(1), 69-78. https://doi.org/10.17509/ijert.v3i1.46145

Glorifica, I. (2021). Media analysis of biology teaching book grade xii: A study based on science literation category. *Indonesian Journal of Educational Research and Technology, 1*(1), 17-22. https://doi.org/10.17509/ijert.v1i1.32659

Hamidah, I., Sriyono, S., & Hudha, M. N. (2020). A bibliometric analysis of Covid-19 research using VOSviewer. Indonesian Journal of Science and Technology, 34-41. https://doi.org/10.17509/ijost.v5i2.24522

Hashim, S., Masek, A., Mahthir, B.N.S.M., Rashid, A.H.A., and Nincarean, D. (2021). Association of interest, attitude and learning habit in mathematics learning towards enhancing students' achievement. *Indonesian Journal of Science and Technology*, *6*(1), 113-122. https://doi.org/10.17509/ijost.v6i1.31526

Hofifah, S.N., and Sumiati, S. (2023). The effectiveness of the practicum video guide on distance learning in improving biology learning outcomes in enzyme content. *Indonesian Journal of Teaching in Science*, *3*(2), 201-212. https://doi.org/10.17509/ijotis.v3i2.62905

Husnah, A.U., Hidayat, M.A., and Jannah, M. (2021). The journey of a math: As a mathematics learning innovation. *Indonesian Journal of Multidiciplinary Research, 1*(1), 129-136. https://doi.org/10.17509/ijomr.v1i1.33814

Ibrahim, A.O. (2023). Impact of blended learning method on secondary school physics students' achievement and retention in Lokoja, Nigeria. *ASEAN Journal for Science Education*, *2*(2), 57-66. Retrieved from https://ejournal. bumipublikasinusantara.id/ index.php/ajsed/article/view/205

Iqbal, L. M. (2023). Pesantren dan pembaharuan: arah dan implikasi. *JISIP (Jurnal Ilmu Sosial dan Pendidikan)*, *7*(2), 1652-1661. http://dx.doi.org/10.58258/jisip.v7i2.4990

Kardi, K., Basri, H., Suhartini, A., & Meliani, F. (2023). Challenges of online boarding schools in the digital era. *At-Tadzkir: Islamic Education Journal*, *2*(1), 37-51. https://doi.org/10.59373/attadzkir.v2i1.11

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. https://doi.org/10.17509/ijomr.v1i2.38546

Lestari, D.A., Suwarma, I.R., and Suhendi, E. (2024). Feasibility analysis of the development of STEM-based physics e-book with self-regulated learning on global warming topics. *Indonesian Journal of Teaching in Science*, *4*(1), 1-10. https://doi.org/10.17509/ijotis.v4i1.60110

Lundeto, A., Talibo, I., & Nento, S. (2021). Challenges and learning strategies of islamic education in islamic boarding schools in the industrial revolution era 4.0. *Al-Ishlah: Jurnal Pendidikan*, *13*(3), 2231-2240. https://doi.org/10.35445/alishlah.v13i3.1153

Machmud, M. C. (2020). The innovation of traditional education system in Islamic boarding schools based on modernization. *Ilomata International Journal of Social Science*, *1*(3), 131-140. https://doi.org/10.52728/ijss.v1i3.112

Mansir, F. (2021). The response of islamic education to the advancement of science in the covid-19 pandemic era in the islamic boarding schools. *AULADUNA: Jurnal Pendidikan Dasar Islam*, *8*(1), 20-27. https://doi.org/10.24252/auladuna.v8i1a2.2021

Marasabessy, R. (2021). Study of mathematical reasoning ability for mathematics learning in schools: A literature review. *Indonesian Journal of Teaching in Scienc*e, *1*(2), 79-90. https://doi.org/10.17509/ijotis.v1i2.37950

Mardani, D. M. S., Sadyana, I. W., & Suputra, P. H. (2020). Interactive learning medium development for learning hiragana and katakana. *JAPANEDU: Jurnal Pendidikan dan Pengajaran Bahasa Jepang*, *5*(1), 23-30. https://doi.org/10.17509/japanedu.v5i1.19342

Maryanti, R., Rahayu, N. I., Muktiarni, M., Al Husaeni, D. F., Hufad, A., Sunardi, S., & Nandiyanto, A. B. D. (2022). Sustainable development goals (SDGs) in science education: Definition, literature review, and bibliometric analysis. *Journal of Engineering Science and Technology*, *17*, 161-181. Retrieved from https://jestec.taylors.edu.my/ Special%20Issue%20ICMScE2022/ICMScE2022_20.pdf

Maryati, W.E., Retnowati, E., and Thoe, N, K. (2022). Learning mathematics formulas by listening and reading worked examples. *Indonesian Journal of Teaching in Science*, *2*(1), 61-74. https://doi.org/10.17509/ijotis.v2i1.45801

Maslaha, A., & Suryani, Y. J. (2018). Urgensi iptek dalam pengembangan pendidikan islam. *Tarbiyah Wa Ta'lim: Jurnal Penelitian Pendidikan dan Pembelajaran*, *5*(2), 47-55. https://doi.org/10.21093/twt.v5i2.2254

Maulid, M. N., & Sakti, A. W. (2022). The effectiveness of learning videos as a source of digital literacy on poster learning in elementary schools. *Indonesian Journal of Multidiciplinary Research*, *2*(1), 51-56. https://doi.org/10.17509/ijomr.v2i1.38623

Millatina, S. N., Maryanti, R., & Wulandary, V. (2022). Strengthening literacy of cultural arts and crafts in the material of sculpture for 6th-grade elementary school students through learning video media. *Indonesian Journal of Educational Research and Technology*, *2*(3), 189-194. https://doi.org/10.17509/ijert.v2i3.38675

Mudzakir, A., Rizky, K. M., Munawaroh, H. S. H., & Puspitasari, D. (2022). Oil palm empty fruit bunch waste pretreatment with benzotriazolium-based ionic liquids for cellulose conversion to glucose: Experiments with computational bibliometric analysis. Indonesian Journal of Science and Technology, *7*(2), 291-310. https://doi.org/10.17509/ijost.v7i2.50800

Mukti, H. A., Irpani, A., & Tabroni, I. (2022). The role of Islamic boarding schools in moral education in the technological era. *L'Geneus: The Journal Language Generations of Intellectual Society*, *11*(2), 35-40. https://doi.org/10.35335/geneus.v11i2.3093

Mulyawati, I. B., & Ramadhan, D. F. (2021). Bibliometric and visualized analysis of scientific publications on geotechnics fields. ASEAN Journal of Science and Engineering Education, *1*(1), 37-46. https://doi.org/10.17509/ajsee.v1i1.32405

Nandiyanto, A. B. D., Asyahidda, F. N., Danuwijaya, A. A., Abdullah, A. G., Amelia, N., Hudha, M. N., & Aziz, M. (2018). Teaching "nanotechnology" for elementary students with deaf and hard of hearing. *Journal of Engineering Science and Technology*, *13*(5), 1352-1363. Retrieved from https://jestec.taylors.edu.my/ Vol%2013%20issue%205%20 May%202018/13_5_16.pdf

Nandiyanto, A. B. D. (2018). Cost analysis and economic evaluation for the fabrication of activated carbon and silica particles from rice straw waste. *Journal of Engineering Science and Technology*, *13*(6), 1523-1539. Retrieved from https://jestec.taylors.edu.my/ Vol%2013%20issue%206%20June%202018/13_6_10.pdf

Nandiyanto, A. B. D., Fiandini, M., Fadiah, D. A., Muktakin, P. A., Ragadhita, R., Nugraha, W. C., Kurniawan, T., Bilad, M.R., Yunas, J., & Al Obaidi, A. S. M. (2023). Sustainable biochar carbon microparticles based on mangosteen peel as biosorbent for dye removal: Theoretical review, modelling, and adsorption isotherm characteristics. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, *105*(1), 41-58.

Nandiyanto, A. B. D., Fiandini, M., Hofifah, S. N., Ragadhita, R., Al Husaeni, D. F., Al Husaeni, D. N., Maryanti, R., & Masek, A. (2022). Collaborative practicum with experimental demonstration for teaching the concept of production of bioplastic to vocational students to support the sustainability development goals. *Journal of Technical Education and Training*, *14*(2), 1-13. https://doi.org/10.37934/arfmts.105.1.4158

Ni'mah, Z. A. (2023). Telaah Argumentasi Kajian Integrasi Ilmu dan Agama. *Jurnal Pendidikan dan Pemikiran*, *3*(1), 41-55. Retrieved from https://ejournal-revorma.sch.id/index.php/mansa/article/view/51

Nordin, N. A. H. M. (2022). Correlation between process engineering and special needs from bibliometric analysis perspectives. ASEAN Journal of Community and Special Needs Education, *1*(1), 9-16. Retrieved from https://ejournal.bumipublikasinusantara.id/index.php/ajcsne/article/view/3

Nurdin, E., Ma'aruf, A., Amir, Z., Risnawati, R., Noviarni, N., & Azmi, M. P. (2019). Pemanfaatan video pembelajaran berbasis Geogebra untuk meningkatkan kemampuan pemahaman konsep matematis siswa SMK. *Jurnal Riset Pendidikan Matematika*, *6*(1), 87-98. http://dx.doi.org/10.21831/jrpm.v6i1.18421

Nurdin, N. (2022). Pengaruh Penggunaan Video Pembelajaran terhadap Minat Belajar Siswa pada Materi Mendongeng di Masa Pandemi Covid 19. Murhum: *Jurnal Pendidikan Anak Usia Dini, 3*(1), 43-52. https://doi.org/10.37985/murhum.v3i1.75

Nurwanda, Y., Milama, B., & Yunita, L. (2020). Beban Kognitif Siswa pada Pembelajaran Kimia di Pondok Pesantren. *Jurnal Inovasi Pendidikan Kimia*, *14*(2), 2629-2641. https://doi.org/10.15294/jipk.v14i2.21813

Obafemi, K.E., Saadu, U.T., Adesokan, A., Yahaya, O., Sulaimon, J.T., Obafemi, T.O., and Yakubu, F.M. (2023). Self-efficacy as a correlate of pupils' academic achievement in mathematics. *Indonesian Journal of Teaching in Science*, *3*(2), 113-120. https://doi.org/10.17509/ijotis.v3i2.59775

Ogunjimi, M.O., and Gbadeyanka, T.A. (2023). Effect of guided inquiry and explicit-instructional strategies on lower basic students' academic performance in mathematics. *Indonesian Journal of Teaching in Science*, *3*(1), 23-32. https://doi.org/10.17509/ijotis.v3i1.54191

Olumorin, C.O., Babalola, E.O., and Ayoola, D.A. (2022). Design and development of human excretory system model to teach a biology concept in Ilorin, Nigeria. *Indonesian Journal of Teaching in Science*, *2*(2), 107-116. https://doi.org/10.17509/ijotis.v2i2.45782

Omolafe.E.V. (2021). Primary educators' experts' validation of the developed mathematics mobile application to enhance the teaching of mathematics in Nigeria primary schools. *ASEAN Journal of Science and Engineering Education, 2(1),* 157-166. http://dx.doi.org/10.17509/ajsee.v1i3.38505

Onasanya, T. O., Aladesusi, G. A., Taiwo, S. A., Onasanya, S. A., & Adeoye, J. T. (2022) Effect of technology-enabled video instruction on senior secondary school students' performance in selected technical drawing concept in Ilorin. *Indonesian Journal of Educational Research and Technology*, *2*(2), 141-148. http://dx.doi.org/10.17509/ijert.v2i2.43559

Patmasari, L., Hidayati, D., Ndari, W., & Sardi, C. (2023). Digitalisasi Pembelajaran yang Berpusat pada Siswa di SMK Pusat Keunggulan. *Jurnal Ilmiah Mandala Education, 9*(1), 1-7. http://dx.doi.org/10.58258/jime.v9i1.3729

Pinassang, J. L., Nurrahman, D. I., Shevriyanto, B., Utami, G. I., & Rosetia, A. (2022). Using biochar as a sustainable green indoor playground building material in Batam. *Journal of Architectural Design and Development (JAD)*, *3*(1), 38-44. http://dx.doi.org/10.37253/jad.v3i1.6737

Prastica, Y., Hidayat, M. T., & Ghufron, S. (2021). The influence of the use of learning video media on learning outcomes in mathematics subjects for elementary school students. *BASICEDU Journal: Journal of Elementary Education*, *5*(5), 3260-3269. https://doi.org/10.31004/basicedu.v5i5.1327

Putri, S.R., Hofifah, S.N., Girsang, G.C.S., and Nandiyanto, A.B.D. (2022). How to identify misconception using certainty of response index (CRI): A study case of mathematical *chemistry* subject by experimental demonstration of adsorption. *Indonesian Journal of Multidiciplinary Research, 2(*1), 143-158. http://dx.doi.org/10.17509/ijomr.v2i1.38738

Putri, W. A., Astalini, A., & Darmaji (2022). Analisis Kegiatan Praktikum untuk Dapat Meningkatkan Keterampilan Proses Sains dan Kemampuan Berpikir Kritis. *Edukatif : Jurnal Ilmu Pendidikan*, *4*(3), 3361-3368. https://doi.org/10.31004/edukatif.v4i3.2638

Radiamoda, A.A. (2024). Difficulties encountered by the students in learning mathematics. *Indonesian Journal of Educational Research and Technology*, *4*(1), 63-70. https://doi.org/10.17509/ijert.v4i1.60048

Ragadhita, R., & Nandiyanto, A. B. D. (2021). How to calculate adsorption isotherms of particles using two-parameter monolayer adsorption models and equations. *Indonesian Journal of Science and Technology*, *6*(1), 205-234. https://doi.org/10.17509/ijost.v6i1.32354

Ragadhita, R., & Nandiyanto, A. B. D. (2022). Correlation of Science in Al–Quran Perspective. *ASEAN Journal of Religion, Education, and Society*, *1*(1), 25-30. Retrieved from https://ejournal.bumipublikasinusantara.id/index.php/ajores/article/view/177

Rahayu, W. P., Harisma, I. W., Syamsuddin, Y., Sofyana, S., & Mulyati, S. (2021). Ekstraksi Pektin dari Kulit Jeruk dan Kulit Pisang sebagai Biosorben pada Proses Adsorpsi Logam Berat Fe. *Journal Serambi Engineering*, 6(2), 1899-1907. https://doi.org/10.32672/jse.v6i2.2891

Ramadhan, D. F., Fabian, A. M., & Saputra, H. M. (2022). Dental suction aerosol: Bibliometric analysis. ASEAN Journal of Science and Engineering, *2*(3), 295-302. https://doi.org/10.17509/ajse.v2i3.50658

Ramdhani, M. R. (2015). Implementasi pendidikan life skill di Pesantren pertanian darul fallah Bogor. *Tadbir Muwahhid*, *4*(2), 53-64. https://doi.org/10.30997/jtm.v4i2.339

Rini, E. F. S., & Aldila, F. T. (2023). Practicum activity: analysis of science process skills and students' critical thinking skills. *Integrated Science Education Journal*, *4*(2), 54-61. https://doi.org/10.37251/isej.v4i2.322

Rosyidin, M. A. (2021). Interaksi pesantren dengan sains dan teknologi. *TA'DIBUNA: Jurnal Pendidikan Agama Islam*, *4*(1), 53-73. http://dx.doi.org/10.30659/jpai.4.1.53-73

Ruzmetov, A., & Ibragimov, A. (2023). Past, current and future trends of salicylic acid and its derivatives: A bibliometric review of papers from the Scopus database published from 2000 to 2021. *ASEAN Journal for Science and Engineering in Materials*, *2*(1), 53-68. Retrieved from https://ejournal.bumipublikasinusantara.id/index.php/ajsem/article/view/225

Sahidin, I., Nohong, N., Manggau, M. A., Arfan, A., Wahyuni, W., Meylani, I., Malaka, M.H., Rahmatika, N.S., Yodha, A.W.M., Masrika, N.U.E., Kamaluddin, A., Sundowo, A., Fajriah, S., Asasutjarit, R., Fristiohady, A., Maryanti, R., Rahayu, N.I., & M. Muktiarni (2023). Phytochemical profile and biological activities of ethylacetate extract of peanut (Arachis hypogaea L.) stems: In-vitro and in-silico studies with bibliometric analysis. Indonesian Journal of Science and Technology, *8*(2), 217-242. https://doi.org/10.17509/ijost.v8i2.54822

Salsabila, U. H., Nuri, N. S., Fiddini, P. F., Sholikhah, D. A., & Rahmah, A.R.N.K. (2022). The development of educational technology in the realm of Islamic boarding school learning. *MA'ALIM: Jurnal Pendidikan Islam*, *3*(01), 10-20. https://doi.org/10.21154/maalim.v3i1.3413

Sari, W. N., Gustanu, P., Suprayitno, M., Etriya, R., & Aprilia, C. A. (2022). Penerapan Video Pembelajaran IPA dalam Meningkatkan Motivasi Belajar Siswa pada Pembelajaran Online Kelas V SD N Pulorejo 02. *JIIP – Jurnal Ilmiah Ilmu Pendidikan*, *5*(8), 2795-2800. https://doi.org/10.54371/jiip.v5i8.744

Setiyo, M., Yuvenda, D., & Samuel, O. D. (2021). The concise latest report on the advantages and disadvantages of pure biodiesel (B100) on engine performance: Literature review and bibliometric analysis. *Indonesian Journal of Science and Technology*, *6*(3), 469-490. https://doi.org/10.17509/ijost.v6i3.38430

Shofa, M. I., Redhana, I. W., & Juniartina, P. P. (2020). Analisis Kebutuhan Pengembangan Media Pembelajaran IPA Berbasis Argument Mapping. *Jurnal Pendidikan dan Pembelajaran Sains Indonesia (JPPSI)*, *3*(1), 31-40. https://doi.org/10.23887/jppsi.v3i1.24620

Solehuddin, M., Muktiarni, M., Rahayu, N. I., & Maryanti, R. (2023). Counseling guidance in science education: Definition, literature review, and bibliometric analysis. *Journal of Engineering Science and Technology*, *18*, 1-13. Retrieved from https://jestec.taylors.edu.my/Special%20Issue%20ISCoE%202022_1/ISCoE%201_01.pdf

Sombria, K.J.F., Celestial, D.L., Jalagat, C.G.M., and Valdez, A.G. (2023). Online learning through google classroom: effects on students critical thinking skills in chemistry. *ASEAN Journal of Science and Engineering Education*, *3*(2), 193-210. https://doi.org/10.17509/ajsee.v3i2.49794

Suharto, B., & Fatmawati, E. (2022). Digital learning transformation at Islamic boarding schools: digital-based learning patterns in salaf and modern Islamic boarding schools in jember. *Journal of Positive School Psychology*, *6*(2), 5319-5329. Retrieved from https://www.journalppw.com/index.php/jpsp/article/view/3279

Sulistyanti, L., Siahaan, J., & Junaidi, E. (2019). Pengaruh Model Pembelajaran Two Stay Two Stray (TSTS) Dipadukan dengan Metode Demonstrasi Terhadap Hasil Belajar Kimia. (CEP) *Chemistry Education Practice, 2*(1), 17-23. https://doi.org/10.29303/cep.v2i1.1137

Sunami, M. A., & Aslam, A. (2021). Pengaruh Penggunaan Media Pembelajaran Video Animasi Berbasis Zoom Meeting terhadap Minat dan Hasil Belajar IPA Siswa Sekolah Dasar. *Basicedu Journal, 5*(4), 1940-1945. https://doi.org/10.31004/basicedu.v5i4.1129

Suprapto, P. K., Norawi, M., Hernawati, D., & Meylani, V. (2020). Integration of STEM approach in teaching science to Indonesian Islamic boarding school students (Malaysian pre-service teachers' experience). *International Journal of Innovation, Creativity and Change*, *10*(11), 515-530. Retrieved from https://www.ijicc.net/images/vol10iss11/ 101136_ Suprapto_2020_E_R.pdf

Suryaningsih, Y. (2017). Pembelajaran Berbasis Praktikum Sebagai Sarana Siswa untuk Berlatih Menerapkan Keterampilan Proses Sains dalam Materi Biologi. *Bio Education*, *2*(2), 49-57. http://dx.doi.org/10.31949/be.v2i2.759

Susilowati, N.I., Liliawati, W., and Rusdiana, D. (2023). Science process skills test instruments in the new Indonesian curriculum (merdeka): Physics subject in renewable energy topic. *Indonesian Journal of Teaching in Science*, *3*(2), 121-132. https://doi.org/10.17509/ijotis.v3i2.60112

Swafiyah, B., Muhammad, B.A., and Yamusa, A.Z. (2023). Effect of conceptual change instructional strategy on chemistry students' performance in acids and bases concepts. *ASEAN Journal for Science Education*, *2*(1), 47-54. Retrieved from https://ejournal.bumipublikasinusantara.id/index.php/ajsed/article/view/172

Tipmontiane, K., and Williams, P.J. (2022). The integration of the engineering design process in biology-related STEM activity: A review of Thai secondary education. *ASEAN Journal of Science and Engineering Education,* *2*(1)*,* 1-10. https://doi.org/10.17509/ajsee.v2i1.35097

Vijayarani, S., Sivamathi, C., and Prassanalakshmi, R. (2023). Frequent items mining on data streams using matrix and scan reduced indexing algorithms. *ASEAN Journal of Science and Engineering*, *3*(2), 123-138. https://doi.org/10.17509/ajse.v3i2.45345

Wastriami, W., & Mudinillah, A. (2022). Manfaat Media Pembelajaran Berbasis Aplikasi Kinemaster Terhadap Hasil Belajar IPA Siswa SDN 25 Tambangan. *TARQIYATUNA: Journal of Islamic Religious Education and Madrasah Ibtidaiyah*, *1*(1), 30-43. https://doi.org/10.36769/tarqiyatuna.v1i1.195

Winarni, R. S., & Rasiban, L. M. (2021). Perception of Japanese students in using online video as a learning media. *Indonesian Journal of Educational Research and Technology*, *1*(1), 15-16. https://doi.org/10.17509/ijert.v1i1.32652

Wirzal, M. D. H., & Putra, Z. A. (2022). What is the correlation between chemical engineering and special needs education from the perspective of bibliometric analysis using vosviewer indexed by Google Scholar. *Indonesian Journal of Community and Special Needs Education*, *2*(2), 103-110. https://doi.org/10.17509/ijcsne.v2i2.44581

Wirzal, M.D.H., and Halim, N.S.A. (2022). Short play approach for analytical chemistry class. *ASEAN Journal of Science and Engineering Education,* *2*(2), 163-168. https://doi.org/10.17509/ajsee.v2i2.42762

Ajidirman, Wiskandar, W., & Zurhalena, Z. (2023). Pemberdayaan Kelompok Tani Makmur Melalui Pembuatan Biochar Limbah Kelapa Sawit Areal Replanting untuk Meningkatkan Kesuburan Tanah. *Lumbung Ngabdi: Jurnal Pengabdian Masyarakat* I.*1*(1), 19-24. https://doi.org/10.51806/ngabdi.v1i1.13

Yahya, F. A. (2015). Problem manajemen pesantren, sekolah dan madrasah: Problem mutu dan kualitas input-proses-output. *el-Tarbawi*, *8*(1), 93-109. https://doi.org/10.20885/ tarbawi.vol8.iss1.art6