Integración de la actividad física y los STEAM-SDG basados en Edupas para concienciar a los estudiantes sobre la sostenibilidad en la formación profesional

Integrating physical activity and Edupas-based STEAM-SDGs for students' sustainability awareness in vocational education

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Abstract

Introduction: Applying STEAM in vocational learning needs to be integrated with Sustainable Development Goals (SDGs) values. Physical activities have been recognized as significant contributors to achieving SDGs because can boost students' awareness and commitment towards sustainable development goals.
Objective: This article aims to measure the impact of integrating physical activities and Edupas-based STEAM-SDGs on students' sustainability awareness.
Methodology: This research uses a mixed-methods approach with concurrent embedded design. The research subjects were 36 students. Data was collected using quantitative and qualitative data throughout the IPAS learning process by applying Edupas-based STEAM-SDGs. Quantitative data was obtained from a questionnaire in Edupas. Qualitative data was collected through observation during the IPAS project learning activities. In addition, it was also collected worksheets and discussions provided in the Edupas LMS. Data analysis was conducted using the stacking technique with the Rasch model.
Results: The results of the mean comparison test between pre-test and post-test data through the t-test obtained a value of t=-3.39, df=66, and prob=0.001.
Discussion: STEAM integration in vocational learning significantly increased students' sustainability awareness. Furthermore, using Edupas LMS encouraged students' active participation in discussions and exploration of ideas, which contributed to improving their skills and understanding of sustainability issues.
Conclusions: Integrating sustainability values in the vocational curriculum is crucial to shaping students' proactive attitudes toward environmental issues.

Keywords

Edupas; STEAM-SDGs; sustainability awareness; physical activities.

Resumen

Introducción: La aplicación de STEAM en el aprendizaje profesional debe integrarse con los valores de los Objetivos de Desarrollo Sostenible (ODS). Se ha reconocido que las actividades físicas contribuyen significativamente a la consecución de los ODS porque pueden impulsar la concienciación y el compromiso de los estudiantes con los objetivos de desarrollo sostenible.
Objetivo: Este artículo tiene como objetivo medir el impacto de la integración de actividades físicas y STEAM-SDGs basado en Edupas en la conciencia de sostenibilidad de los estudiantes.
Metodología: Esta investigación utiliza un enfoque de métodos mixtos con diseño integrado concurrente. Los sujetos de la investigación fueron 36 estudiantes. Los datos se recogieron utilizando datos cuantitativos y cualitativos a lo largo del proceso de aprendizaje de IPAS mediante la aplicación de STEAM-SDG basados en Edupas. Los datos cuantitativos se obtuvieron a partir de un cuestionario en Edupas. Los datos cualitativos se recogieron mediante la observación durante las actividades de aprendizaje del proyecto IPAS. Además, también se recogieron hojas de trabajo y discusiones proporcionadas en el LMS Edupas. El análisis de los datos se realizó mediante la técnica de apilamiento con el modelo de Rasch.
Resultados: Los resultados de la prueba de comparación de medias entre los datos pre-test y post-test a través de la prueba t obtuvieron un valor de t=-3,39, df=66, y prob=0,001.
Discusión: La integración de STEAM en el aprendizaje profesional aumentó significativamente la conciencia de sostenibilidad de los estudiantes. Además, el uso de Edupas LMS fomentó la participación activa de los estudiantes en los debates y la exploración de ideas, lo que contribuyó a mejorar sus habilidades y su comprensión de las cuestiones de sostenibilidad.
Conclusiones: La integración de los valores de sostenibilidad en el currículo de formación profesional es crucial para formar las actitudes proactivas de los estudiantes hacia las cuestiones medioambientales.

Palabras clave

Edupas; STEAM-SDGs; concienciación sobre la sostenibilidad; actividades físicas.

Introduction

Science, Technology, Engineering, Art, and Mathematics (STEAM) approach has been rapidly growing as one learning method that addresses the needs of 21st-century skills. In recent years, STEAM has become a trending pedagogical topic in the education sector in many countries (Zulkarnaen et al., 2023). STEAM is a modern educational philosophy that encourages learners to engage in trial and error, think and analyze new concepts that bring real-world applications, and accept the opinions of others to build education-based knowledge rather than just from exams (Hsiao & Su, 2021; Kummanee et al., 2020). STEAM learning trains students to think about finding solutions to existing problems by creating their ideas with the latest technology (Aerila & Rönkkö, 2023; Khoiri et al., 2023). STEAM education is a complex and contested concept, with the role and status of the arts in STEM subjects being central to promoting transdisciplinary collaboration and addressing social and ecological concerns (Colucci-Gray et al., 2019; Guyotte et al., 2014; Quigley et al., 2017).

During increasingly complex global challenges, this approach is crucial in preparing students, especially at the vocational education level, to contribute effectively to a global society. Applying STEAM not only fosters the development of technical skills needed by the world of work but also builds students' ability to think critically, creatively, and adaptively to technological and artistic developments (Muntamah et al., 2023; Sumida, 2022). Implementing STEAM in project-based learning (PjBL) in vocational schools can connect theory with real applications, increasing students' readiness to face the demands of industry and daily life (Hayat et al., 2023). Implementing Project-Based Learning with the STEAM approach helps students integrate multidisciplinary content and develop skills such as teamwork, collaboration, argumentation, communication, logical reasoning, creativity, and time management in a project (Aguiar et al., 2021; Guyotte et al., 2014; Wibowo et al., 2024).

In vocational schools, the Natural and Social Science Project (IPAS) subject is an ideal place to apply the STEAM approach because this subject integrates natural and social sciences in project-based learning (PjBL). A holistic and multidisciplinary approach to solving complex problems, such as STEAM-based IPAS learning, can develop students' scientific literacy, creativity, and attitude toward the environment (Aguiar et al., 2021; Muntamah et al., 2023). In addition, this approach strengthens the development of soft skills such as cooperation and collaboration, which are very important in the world of work. Applying STEAM in IPAS learning improves students' understanding of the subject matter. It enables them to develop innovative solutions to problems encountered in everyday life, especially those related to industrial and environmental challenges (Hayat et al., 2023; Syaipul Hayat et al., 2024).

Applying STEAM in vocational schools develops practical skills, encourages creativity, and supports problem-solving skills using technology and information. The concept in Thailand has become a policy of "Vocational education creates the nation," which is to provide a quality education that meets international standards with increased competitiveness (Kummanee et al., 2020; Oude Groote Beverborg, 2024). In vocational learning, the application of STEAM is not only about using technology but also helping students enhance their creativity and better prepare for their future careers (Wang & Wang, 2023). The STEAM approach in vocational schools will be more comprehensive if applied by integrating the values of Sustainable Development Goals (SDGs) (Alhazemi, 2024; Manikutty et al., 2023; Ramos-Gavilán et al., 2023). It is considered that in carrying out the project, vocational students can orient their thinking on the sustainability of the earth's living natural resources and the future (Garg & Agarwal, 2024; Syaipul Hayat et al., 2024). One of the goals of the SDGs is to ensure affordable technical and vocational education for all so that more people can be educated with relevant skills for financial success (Nordén, 2024; Rahayu et al., 2021). The increasing application of science and technology impacts various fields, such as disasters or ecological damage, causing financial losses and human casualties. SDGs are a shared responsibility to pay attention to the sustainability of life on earth (Khoiri et al., 2023). SDGs are essential to be integrated with teaching and learning activities in schools, especially in environmental education, such as raising the theme of environmental change in the IPAS project in vocational schools (Rahayu et al., 2021).

One of the main challenges that vocational schools face in implementing STEAM programs is the integration of technological resources (Wang & Wang, 2023). The advent of new technologies can transform the education system, attracting students to learn the content of various disciplines (Hariyono et al., 2024; Thondhlana & Nkosi, 2024). The emergence of new and emerging technologies

has led to the birth of innovative approaches to teaching and learning, such as STEAM, that aim to foster the critical thinking needed for the rapidly changing and complex digital age (Manikutty et al., 2022; Spadoni et al., 2024). Technology such as the Learning Management System (LMS) is essential in supporting STEAM implementation in vocational education. Edupas, an interactive platform for students and teachers, has been shown to support the project-based learning (PjBL) process in IPAS subjects by facilitating more efficient and data-driven project management. This integration makes learning more interactive, inspiring, and relevant to real-world challenges (López & Palacios, 2024; Manikutty et al., 2022). The combination of PjBL and STEAM, supported by a platform called Edupas, has excellent potential to improve the quality of learning in SMK, especially in strengthening competencies, character, and work culture by the profile of Pancasila students. Integrating technology and the STEAM approach in IPAS learning can provide a more comprehensive and practical learning experience and help students develop the skills needed to succeed in the digital and industrial era 4.0 (Hayat et al., 2023).

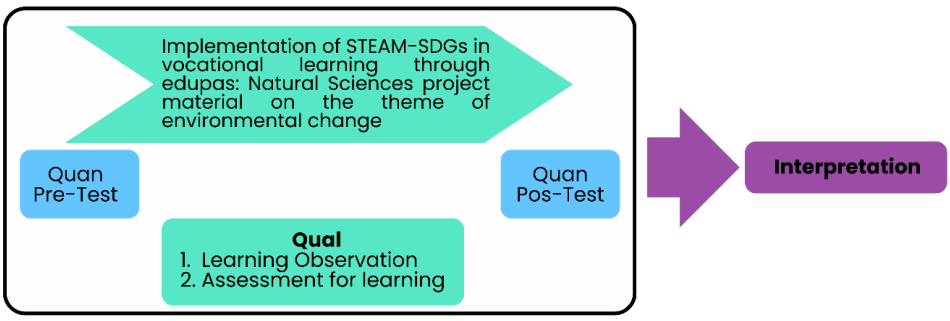
In the STEAM approach, students not only understand phenomena and try to find ways to solve problems from these phenomena, but students are also expected to be able to instill the value of attitudes and skills for sustainable awareness for the next generation (Almusalami et al., 2024; Debrah et al., 2021; Liu et al., 2024). The application of STEAM to Sustainability awareness can facilitate students in understanding a problem from existing phenomena holistically, where students are invited to see phenomena and their solutions by considering various interrelated aspects that affect each other so that from this process, a deeper and more comprehensive understanding of students is created (Salvo et al., 2021; Zakopoulos et al., 2023). The application of STEAM to Sustainability awareness needs to be applied in SMK in order to increase students' self-awareness in carrying out projects to orient further their way of working and thinking towards sustainability to face severe global environmental challenges in the 21st century (Suganya et al., 2024; Zulkarnaen et al., 2023). Sustainability awareness is essential to be applied to learning to understand sustainable awareness, where the impact of activities carried out by students to take action as an effort to protect the surrounding environment (Bambazek & Groher, 2024; Eid et al., 2022; Morales-Baños et al., 2023). Thus, a more balanced life will be created, where the economy, environment, society, and culture support each other (Irawan* et al., 2024).

Based on this explanation, the author assumes that through the SDGs, an integrated STEAM approach through edupas as an LMS in vocational learning can increase Sustainability awareness. The purpose of this study is to measure the impact of the application of STEAM-SDGs in edupas-based vocational learning on student sustainability awareness.

Method

This study uses a mixed-methods approach with concurrent embedded design to explore the impact of implementing STEAM-SDGs in vocational learning through Edupas on students' sustainability awareness. This research combines qualitative data, especially the description of the STEAM-SDGs learning process in the vocational school environment, with quantitative data on students' sustainability awareness in the IPAS project learning.

Figure 1. Research activities with concurrent embedded design



Participants

The population of this study were all grade X students at SMK Negeri 3 Jepara. The research subjects were students of SMK Negeri 3 Jepara class X majoring in Accounting and Institutional Finance (AKL-4), totaling 36 people. The sampling technique was purposive sampling, meaning the determination of samples is based on specific considerations that meet the criteria. Research data were collected using qualitative and quantitative data throughout the IPAS learning process by applying edupas-based STEAM-SDGs.

Data Collection

Qualitative data was collected through observation during the IPAS project learning activities with the theme of Environmental Change. In addition, it was also collected from the assessment of worksheets and discussion forums provided in the edupas LMS. Quantitative data was obtained from the initial and final measurement of students' sustainability awareness through a questionnaire filled in edupas. Data on students' sustainability awareness was collected by conducting a questionnaire consisting of 21 items built from 3 dimensions of sustainability awareness: sustainability practice awareness, behavioral and attitudinal awareness, and emotional awareness. The questionnaire using the Likert scale consists of 4 categories (1: never; 2: sometimes; 3: often; 4: always). The questionnaire was validated by experts and declared valid. The questionnaire about sustainability awareness is presented in Table 1.

Table 1. Sustainability Awareness Questionnaire

No	Statement
1	I read news about environmental changes caused by human activities.
2	I discuss with friends and family the impacts of environmental changes we read about in the news.
3	I pay attention to the importance of sustainability in preserving the environment.
4	I frequently discuss solutions to address environmental changes with my friends.
5	I show concern for the environment by reducing the use of plastic.
6	I remind my friends to keep the environment clean by not littering.
7	I feel happy when I can contribute to environmental conservation efforts.
8	I am accustomed to using public transportation or walking to reduce my carbon footprint.
9	I reduce water usage by fixing leaking taps and not letting water run unnecessarily.
10	I consider environmental impacts in my daily actions, such as using eco-friendly products.
11	I always turn off electronic devices when not in use to save energy.
12	I recycle items that can still be used to reduce waste.
13	I am accustomed to carrying my own water bottle instead of buying bottled water.
14	I feel challenged to find new, more environmentally friendly ways to live my daily life.
15	I use natural resources wisely for daily activities, such as using rainwater to water plants.
16	I believe that reducing single-use plastic can help reduce environmental pollution.
17	By bringing my own shopping bag when shopping, I contribute to reducing plastic bag usage.
18	I am accustomed to choosing products with eco-friendly labels when shopping.
19	I feel wise when I can repurpose used items into something useful.
20	I feel proud when I can plant and take care of trees for environmental greening.
21	By inspecting and fixing minor damages in my house, I feel I contribute to keeping the environment healthy.

Data analysis

The improvement of students' sustainability awareness was assessed using the rubric listed on the instrument, with a range of 4 (very good), 3 (good), 2 (sufficient), and 1 (less). Data analysis was conducted using the stacking technique with the Rasch model.

Results and Discussion

The analysis results of changes in sustainability awareness are used to determine the impact of STEAM-based IPAS Project learning with a learning environment that uses Edupass Learning Management System (LMS) technology. However, to get an overview of learning activities that integrate the Project-based Learning (PjBL) model in the STEAM-based IPAS project, the following are the results of observations during the learning process.

Table 2. STEAM-based IPAS Project Learning Activities with Edupas Learning Management System (LMS)

PjBL Stage	Activities Description	Observed Activities
Bacis question	Teachers present environmental issues through video presentations, then facilitate participants in discussing solutions by asking basic questions.	Most students choose sad emoticons after watching the environmental change video on LMS Edupas. Students were enthusiastic about discussing alternative energy that can be utilized in the context of everyday life.
Project design	Students design projects in groups	Students discuss through an online forum on the Edupas LMS regarding materials that can be used to make prototypes for converting alternative energy by considering the abundance of materials, economy and ease of obtaining them in the surrounding environment.
Project timeline	Students determine the schedule for completing the project.	Students discuss through an online forum on the Edupas LMS the process of implementing alternative energy projects and scheduling completion.
Project monitoring	Students create projects and ensure that their implementation is in accordance with the design and schedule.	Students complete projects and note any obstacles they encounter in completing the project.
Project assessment	Teachers and students assess the project in a measurable way based on predetermined standards.	Students demonstrate prototypes of devices that use alternative energy through a gallery walk and analyze the feasibility of the resulting device through online discussions on the Edupas LMS.
Project evaluation	Reflect on the project implementation process	Each group presents the project results and receives feedback and direction on the strengths and weaknesses of the prototype produced.

Data on students' sustainability awareness was collected by conducting a questionnaire consisting of 21 items built from 3 dimensions of sustainability awareness: sustainability practice awareness, behavioral and attitudinal awareness, and emotional awareness; the results of the t-test analysis using the Rasch Model are presented in Table 3.

Table 3. Results of t-test analysis using Rasch Model with Stacking Technique

Test	mean	SD	Mean diff	t-test	df	prob
Pre-test	.28	1.25	-.90	-3.39	66	.0015
Post-test	1.19	.99				

The average sustainability awareness of students in the pre-test is 0.28 logits with a standard deviation of 1.25 logits. In comparison, the average sustainability awareness of students in the post-test is 1.19 logits with a standard deviation of 0.99 logits. The mean of the person measurement in the pre-test and post-test is greater than the mean of the item measurement (0.00 logit), meaning that, in general, students have good sustainability awareness at the time of the pre-test and post-test. However, in-depth information is known based on the mean comparison test between pre-test and post-test data through the t-test. It is known that the value of t= -3.39, df = 66, and prob = 0.001 < α = 0.05, it can be concluded that there is a significant difference in students' pre-test and post-test scores.

Furthermore, the difference value of the measurement mean= -0.90 (negative value) means that the average pre-test value (0.28 logit) is less than the average post-test value (1.19 logit). Based on this, it can be concluded that the treatment given increases students' sustainability awareness significantly.

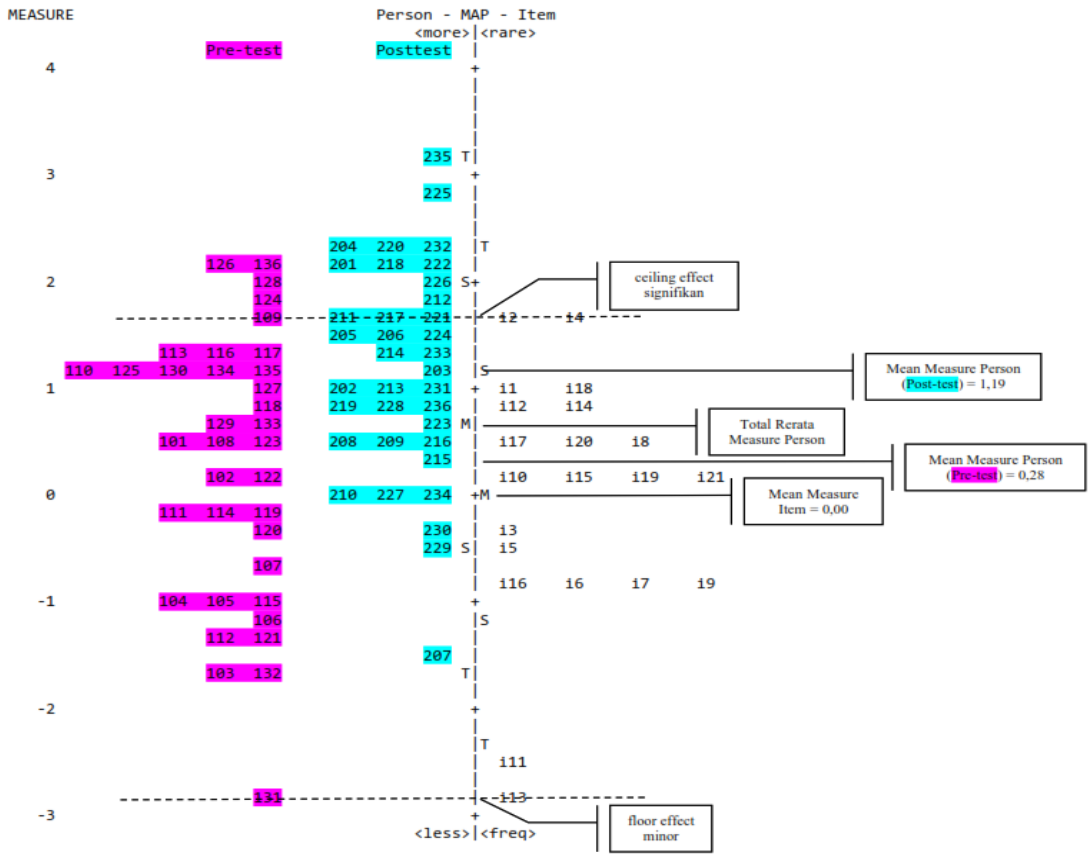
This is corroborated by the visual presentation through the Wright map; it is clear that there has been a shift in students' sustainability awareness from pre-test to post-test. Changes in student responses generally show an increase in students' sustainability awareness. During the pre-test, there was 1 student (-2.88 logit) who had the lowest sustainability awareness, whereas there were 2 students, namely students 26 (2.09 logit) and 36 (2.09 logit) who had the highest sustainability awareness. Student 31 could not answer all items maximally because the minimum item measurement was -2.85 logit. This indicates that a minority (minor) has difficulty with sustainability awareness. In contrast, there are 5 students, namely students 26, 36, 28 (1.97 logits), student 24 (1.84 logits), and student 9 (1.71 logits), who have the opportunity to answer all items maximally because the maximum item measurement is 1.61 logits. This indicates that many students got the best or maximum score, which is significant, meaning that most students have very good sustainability.

At the time of the post-test, there was a change in the responses given by respondents; there was 1 student, namely student 07 (-1.48 logit), who had the lowest sustainability awareness; on the other hand, student 35 (3.09 logit) was the student who had the highest sustainability awareness. However, the posttest results show that some students can easily have sustainability awareness; in other words, the number of students with better sustainability is increasing. There are 12 students with 1.67 logits

to 2.85 logits) who have the opportunity to answer all items maximally; this shows that more and more students have good sustainability awareness. For sustainability awareness, less is 5%, the quite good category is 39%, the good category is 38%, and the very good category is 19%. Ceiling effects are significant because 19% (more than 15%) of people with a maximum score of 4. In contrast, floor effects are minor because 5% (5-10%) of people with a minimum score of 1. So, the research data has significant ceiling effects but minor floor effects.

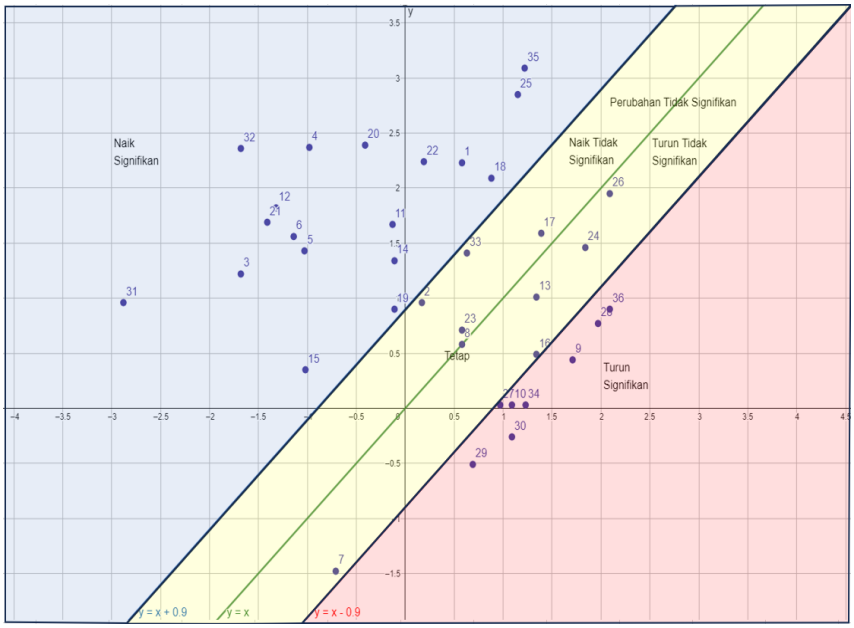
The visual presentation through the Wright map also shows the characteristics of sustainability awareness owned by students. The items of utilizing energy wisely and realizing the importance of responsibility for the environment (-2.85 logit) are characteristics of sustainability awareness possessed by most students. On the other hand, items about discussing issues about the impact of energy use on the environment, society, and the economy and keeping up to date with news about energy availability issues (1.61 logit) are characteristics of sustainability awareness possessed by a small proportion of students. However, overall, in terms of the dimensions of sustainability awareness, both the dimensions of sustainability practice awareness, behavioral and attitude awareness, and emotional awareness, students showed sustainability awareness in these dimensions.

Figure 2. Wright map visualization of sustainability awareness shift



The finding of an increase in the number of students who experienced changes in sustainability awareness that were getting better was supported by the N-gain analysis. There were 22 respondents (61.11%) experiencing an increase, with details of 18 respondents increasing significantly and 4 respondents increasing but not significantly. There was 1 respondent (2.78%) who had permanent sustainability awareness. At the same time, the remaining 13 respondents (36.11%) experienced a decrease in sustainability awareness, with details of 8 respondents dropping significantly and 5 respondents dropping but not significantly. Data visualization is presented in the Figure 3.

Figure 3. N-gain analysis of changes in sustainability awareness



As the findings in the results section show, there is a significant difference in the mean score of the sustainability test before and after the vocational students participated in STEAM-based Project IPAS with a learning environment involving Edupas LMS. This finding is consistent with López and Palacios, who reported that project-based learning proved a practical methodology to increase environmental awareness in participating students in environmental crises (López & Palacios, 2024). A science-based project learning study found that environmental sustainability awareness of elementary school teacher candidates, up to 43.5%, was in the high awareness category (Wibowo et al., 2024). The application of learning environments involving information technology also increases awareness of sustainability. Using technology as a learning pathway fosters students' awareness and deep understanding of sustainability issues while developing the skills and competencies needed to address the problem (Zakopoulos et al., 2023).

This study further supports research on the effectiveness of the STEAM framework for increasing sustainability awareness. Integrating STEAM in project learning with an environment that utilizes technology facilitates the growth of sustainability awareness. Students can express themselves creatively through STEAM, fostering innovative problem-solving skills and developing environmental awareness and proactive attitudes toward sustainability (Hajj-Hassan et al., 2024; Hamid et al., 2017). The findings indicate that student participation in IPAS project learning that integrates STEAM and learning environments using information technology facilitates the development of awareness about sustainability. This awareness grows when students discuss sustainability-oriented environmental problems, design environmentally friendly projects, and decide on the actions that need to be taken when choosing tools and materials for implementing projects. IPAS project activities place students in real-life situations relevant to their daily lives and challenging, requiring them to think about the task or problem solution and the process they can use to achieve the solution. As a result, their awareness of the learning process is likely to increase, and this awareness can be considered a developed skill that can then be transferred to other situations and problems (Sart, 2014).

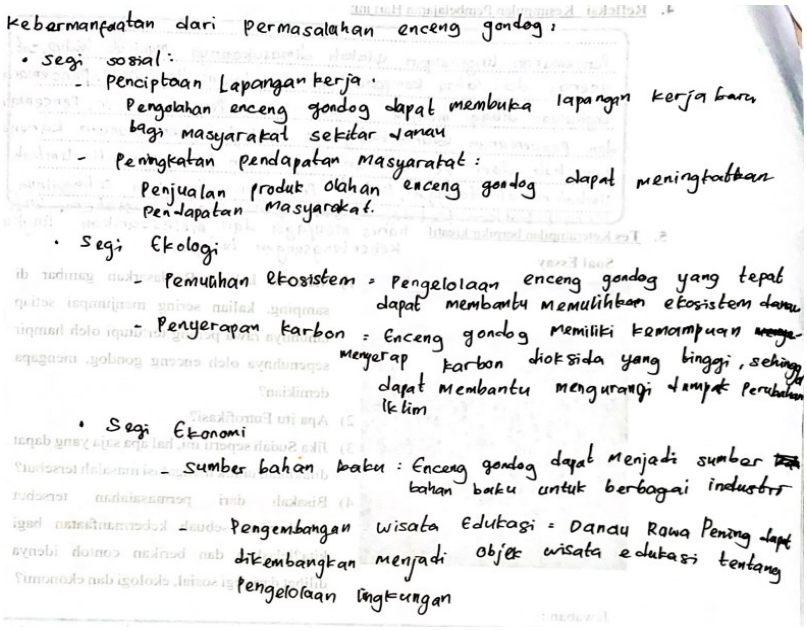
Using Edupas LMS, according to the observation results, allows students to participate more in the discussion. Students have more opportunities to explore ideas, respond, question, oppose, and support or suggest during face-to-face and outside learning. This is consistent with the statement that students can learn about and be aware of the environment at home and school (Ansere et al., 2024; Hajj-Hassan et al., 2024). Student involvement in sustainability-oriented discussions affects students' level of sustainability awareness, increasing students' knowledge of environmental issues and learning more about how to be aware of the environment. Learning that supports self-awareness should include cognitive and non-cognitive processes, and teaching should use practices that touch students'

awareness of their paradigms, such as reflective and social approaches (Jaakkola et al., 2022). Student learning activities are shown in the Figure 4.

Figure 4. Student physical activities in Edupas-based STEAM-SDGs

Students can integrate environmental, social, and economic aspects of sustainability issues through project learning focused on environmental change so that students gain a better understanding and can relate the situation to their daily lives. Meanwhile, talking with students allows them to discuss different opinions and viewpoints. Students can reflect on what is happening in environmental change and make critical decisions about how they will participate in the issues studied in class. When teachers integrate environmental conditions, students gain more knowledge, critically reflect on what is happening, and participate in decision-making to put their knowledge into practice (Gupta et al., 2024; Pauw et al., 2015). School learning can help strengthen links with the environment to achieve sustainability awareness (Debrah et al., 2021).

Figure 5. Artifacts of student answers that integrate environmental, social, and economic aspects



Teachers must develop sustainability awareness on criteria that still need to be added, namely to develop sustainability awareness, such as getting used to discussing the impact of environmental changes on the environment, society, and the economy and keeping up to date with news on environmental issues. Students need to be equipped with environmental literacy skills to act as agents of change in creating a suitable environment (Lipič & Ovsenik, 2020; Sanchez et al., 2024). The importance of students having individual literacy, such as statistical literacy, impacts active

participation, education planning, and awareness of the importance of statistics (Lipič & Ovsenik, 2020). Behavior in terms of environmental practices is a complex task and is influenced by many other factors. Through project learning, students have more practical experiences that can trigger lifestyle changes or desired behaviors among students so that students will have more awareness of sustainability practices (Hamid et al., 2017).

Conclusions

Based on data analysis, integrating physical activities and Edupas-based STEAM-SDGs in vocational learning significantly increases students' sustainability awareness. This shows that integrating sustainability values in the vocational curriculum is crucial to shaping students' proactive attitudes toward environmental issues. Project-based learning that utilizes information technology and the Edupas Learning Management System (LMS) platform encourages active student participation. Students engage in discussions and exploration of ideas, which contribute to improving their skills and understanding of sustainability. The integration of SDGs in vocational learning helps students understand the importance of sustainability and prepares them to face future economic, social, and environmental challenges. Overall, this article emphasizes the importance of STEAM and SDGs integration in vocational education to create a more aware and responsible generation for environmental sustainability.

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