BIOEDUSCIENCE
ISSN: 2614-1558
http://journal.uhamka.ac.id/index.php/bioeduscience

Implications of STEAM Model Learning Through Ecoprint LKPD on Students' Creativity and Entrepreneurial Competence

Vira Safitri Aulia[1], Setiono[1*], Jujun Ratnasari[1] and Herni Fitriani[2]

[1] Faculty of Teacher Training and Education, Biology Education, Muhammadiyah University of Sukabumi Jl. R. Syamsudin, S.H. No. 50, Cikole District, Sukabumi City, West Java 43113
[2] State Senior High School 2 Sukabumi City, Jl. Karamat No. 93 Sukabumi, West Java, Indonesia
* Correspondence: setionoase@gmail.com

Abstract

Background: Innovation in learning methods is essential to improve students' creativity and entrepreneurial competence. The STEAM learning model with ecoprint-based Student Worksheets (LKPD) is one method that can be used. This study aims to determine the effect of the STEAM learning model through eco print-based Student Worksheets (LKPD) on students' creativity and entrepreneurial competence with students whose learning uses conventional learning models (discovery learning). **Method:** This study used a quasi-experimental method with a Non-equivalent control group design. The research sample selection technique used purposive sampling of class X students at a high school in Sukabumi City for the 2023/2024 academic year. **Results:** The study showed that students' creativity in the experimental class obtained an average value of 82±0.24 percent and entrepreneurial competence of 86±0.38 percent, both in the outstanding category. The hypothesis test results obtained a significance value of Sig (2-tailed) 0.000 for both variables, so H0 was rejected and H1 was accepted. **Conclusion:** This study implies that using the STEAM model through Ecoprint-based LKPD can be an alternative effective learning model in improving students' creativity and entrepreneurial competence. The implications of this study indicate the need for broader development of the Ecoprint project-based STEAM model to support practical and innovative learning.

Keywords: Entrepreneurship Competence; Creativity; STEAM.

Article history
Received: 01 Aug 2023
Accepted: 05 May 2024
Published: 30 Mar 2025

Publisher's Note:
BIOEDUSCIENCE stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Citation: Aulia, V.S., Setiono, Ratnasari, J. & Fitriani, H. (2025). Implications of STEAM Model Learning Through Ecoprint LKPD on Students' Creativity and Entrepreneurial Competence. *BIOEDUSCIENCE, 9*(1), 95-109. doi: 10.22236/jbes/15986

Introduction

Skills are the key to unlocking lifelong learning and creative work (Battelle for Kids, 2022). The skills approach manages teaching and learning activities, emphasizing students' active and creative involvement in acquiring knowledge. Many experts view this approach as the most appropriate way to implement learning in schools, especially amid increasingly rapid technological developments (Nasihudin & Hariyadin, 2021).

According to Fullan (2018), 21st-century skills consist of six main elements known as 6C: critical thinking, collaboration, communication, creativity, character, and citizenship. One aspect, namely creativity, has played a significant role in various fields, especially in education and technology. The development of the 21st century has significantly influenced society and students, and society is increasingly aware of the importance of an innovative, creative, and well-educated young generation. Especially from a young age, they are trained to solve problems by thinking creatively and understanding the concept of problems individually and in groups (Tanjung et al., 2021).

According to the 2023 Global Innovation Index (GII) data, Indonesia is ranked 61st out

of 132 countries in global innovation with a score of 30.3 (World Intellectual Property Organization [WIPO], 2023). However, Indonesia's position is still lagging behind that of other countries in the Asian region, especially in terms of creativity and innovation. Countries like Singapore, South Korea, and China have more advanced innovation ecosystems supported by strong education and research policies. This shows that education in Indonesia still has significant challenges in producing creative and innovative individuals. Creativity is a person's ability to use their thinking to create new ideas, possibilities, and discoveries based on originality. A creative mentality is overcoming existing problems (Yunesti, 2023). Student creativity involves skills that are part of student quality (Rusmana, 2020).

In line with this, creativity is an essential skill from the birth of innovation that produces various global opportunities, one of which is giving birth to new entrepreneurs and strengthening the world economy. Increasing a country's competitiveness and encouraging economic growth can be done strategically through entrepreneurship. A country's entrepreneurship ratio is considered advanced if it has a minimum of 4 percent (Ministry of Cooperatives and SMEs, 2023). However, Indonesia's entrepreneurship ratio is currently only 3.47 percent, far below that of other countries in the ASEAN region. The government targets to reach 3.95 percent by 2024 by producing new competent entrepreneurs (Ministry of Cooperatives and SMEs, 2024).

Based on the results of initial observations at one of the high schools in Sukabumi City through teacher interviews, students' entrepreneurial competencies in biology learning have not been seen in practice. In addition, this competency is not explicit. So it is considered essential to be trained to students. However, because this observation was only carried out in one school, the results cannot yet represent the conditions of student entrepreneurship more broadly. A creativity test was conducted on 55 respondents to support this finding and identify entrepreneurship-related skills. Creativity was measured using Torrance's (2018) indicators, including flexibility, fluency, elaboration, and originality. The analysis showed that students' verbal creativity levels were still low, with 85.5 percent in the sufficient category and 14.5 percent in the low category.

Meanwhile, 63.4 percent of students were classified as low in the figural creativity test. These findings indicate that low creativity can contribute to students' lack of entrepreneurial competence. Creativity is essential to entrepreneurship because it involves thinking innovatively and finding solutions in various situations. Therefore, a learning model is needed that develops knowledge and equips students with practical skills that can improve students' creativity and entrepreneurial competence. One innovation in learning that can provide students with 21st-century skills and competencies is integrating various disciplines through the science, technology, engineering, and mathematics (STEM) model.

This model is designed to provide a more contextual and applicable learning experience so that students can develop 21st-century skills such as critical thinking, problem-solving, and creativity (Bybee, 2013). STEM is recommended in learning because it integrates various disciplines and improves students' skills (Barokah S.L, 2024). Currently, STEM has developed with the integration of art. The experience of STEM projects in the expanded learning program allows students to think critically and creatively in designing products to solve problems arising in learning (Setiono & Windyariani, 2023). Art allows them to express their ideas visually and emotionally, which is essential to developing creativity. Students can develop holistic and innovative thinking methods if they interact with fields such as art, science, mathematics, and technology (Istim et al., 2022).

Implementing the STEAM learning model applied using eco print-based Student Worksheets (LKPD) can emphasize direct learning experiences integrating science and art using natural materials (Azizah et al., 2022). Using Ecoprint LKPD in STEAM learning allows students to explore scientific and technical concepts through creative and project-based activities. Ecoprint techniques can be a contextual learning tool and help students hone their skills and competencies to collaborate, in addition to assisting students in understanding learning concepts, especially in biodiversity material. Based on previous research shows that

Ecoprint LKPD helps students with abstract concepts and emphasizes the discovery of ideas by combining various technological applications related to the material in the right way, teaching students to make simple tools related to the material (Irdalisa et al., 2023).

Studies examining Ecoprint LKPD's effect in STEAM learning's context on students' creativity and entrepreneurial competence are still limited. This study explores further how the STEAM learning model through Ecoprint LKPD can affect students' creativity and entrepreneurial competence. In addition, this study identifies the level of creativity and entrepreneurial competence based on established indicators. It evaluates the differences in learning outcomes between students using the STEAM learning model through LKPD Ecoprint in the experimental and control classes. Furthermore, this study also examines students' responses to implementing the learning model. The results of this study are expected to be a reference for educators in implementing effective, innovative learning strategies to develop students' creativity and entrepreneurial competence.

Method

This study uses a quantitative approach with a quasi-experimental design. This design was chosen because this study aims to test variables against other variables in the control and experimental classes. The quasi-experimental method is a research method used to determine the effect of the independent variable, namely using the STEAM learning model through the Ecoprint LKPD as the independent variable used, on the dependent variable with the aspects to be measured, creativity and entrepreneurial competence as the dependent variable. The experimental group will receive the STEAM learning model treatment through the Ecoprint LKPD, while the control group will receive conventional learning treatment. Quasi-experimental design research has a control group, but it cannot fully function to control external variables that affect the implementation of the experiment (Sugiyono, 2018). The research design used in this study is a non-experimental control group design. The control group and the experimental group are not selected randomly but based on the equality of student characteristics, which are then chosen from both classes as a whole to be given a Pretest (initial knowledge) and Post-test (final assessment) after treatment. The following is the implementation of the Non-Equivalent Control Group Design experiment presented as follows:

Table 1. Non-Equivalent Control Group Research Design, Sugiyono (2011)

Class	*Pretest*	Perlakuan	*Postest*
Experiment	$O_{1:}$	$X_{1:}$	$O_{2:}$
Control	$O_{3:}$	$X_{2:}$	$O_{4:}$

Information:
O_1: Pretest experimental group
X_1: Treatment of experimental group using STEAM model
O_3: Pretest control group
O_2: Posttest experimental group
X_2: Treatment of experimental group with conventional learning
O_4: Pretest Control Group

Sample or Participant

The sample used in this study were students of class X at SMAN 2 Kota Sukabumi in the 2023/2024 academic year, namely classes XK and XH, each consisting of 37 participants.

Instrument

The instrument used as a data collection tool in this study was a test to measure verbal and non-verbal (figural) creativity using descriptive questions for the pretest and post-test and an entrepreneurial competency questionnaire using a Likert scale. The form of the instrument consists of:

1) Figural Creativity Test consisting of 3 questions in the form of pictures using the Torancce (1977) indicators, namely (1) Picture Construction with the Originality indicator with the sub-indicator Abstractness for titles (Abstract title) Elaboration (Elaboration) Checklist of creative Strengths (List of creative strengths). (2) Picture Completion with indicators, namely Fluency (Fluency), Originality (Authenticity), Abstractness of titles (Abstractness of titles), Elaboration (Elaboration) Resistance to premature closure (Resistance) namely Checklist of creative strengths (List of creative strengths) (3) Line and Circles (repeated images) namely Fluency (Fluency) Originality (Authenticity) Elaboration (Elaboration) Checklist of creative strength. The instrument's development refers to the journal (Rofi'ah et al., 2021).
2) The Verbal Creativity Test is a descriptive test comprising six questions using the Torance (2018) indicators: fluency, flexibility, and originality. The development of the instrument refers to research conducted by (Fauziah et al., 2021) with sub-indicators, namely (1) Ask and guess, (2) Guessing causes and guessing consequences (Guessing causes and guessing consequences) (3) Unusual use activity (Unusual use activity) (4) Product improvement activity (Product improvement activity) (5) suppose activity (For example activity) with sub-indicators Elaboration & Synthesis.
3) Entrepreneurial competency questionnaire consisting of 34 statements (positive and negative, each composed of 17 statements) referring to five indicators according to (Irwanda et al., 2022), namely innovation and creativity, risk-taking, self-confidence, leadership, opportunity identification/future orientation using a Likert scale according to Sugiyono (2018). The student response questionnaire to the STEAM model through the Ecoprint LKPD uses a Likert scale.

Data collection

Data collection techniques are carried out by providing a pretest before the learning process and conducting a post-test at the end of learning using a creativity test and a student response questionnaire to the learning model before and after the learning process is completed based on the research instruments that have been created, including figural and verbal creativity tests using indicators according to Torance (2018) and an entrepreneurial competency questionnaire with indicators according to (Irwanda et al., 2022). Creativity test measurement activities are carried out during the research with the first step, providing pretest questions before learning begins. After completing the learning, students are asked to fill in the post-test questions.

Procedure

The research implementation procedure is carried out in schools in four stages: preparation, treatment, control, and evaluation.

Data analysis

Data were analyzed using the normality test, homogeneity test, N-Gain test, and independent sample T-test. This study analyzed data with various statistical tests adjusted to the data type. The normality test was applied to test whether the pretest and post-test data were normally distributed before further analysis. Furthermore, the homogeneity test was used to ensure equality of variance between the control and experimental groups as a prerequisite before testing with the Independent Sample T-Test, which aims to determine significant differences between the two groups. Improvement in learning outcomes was analyzed using the N-Gain test, which measures the effectiveness of treatment on changes in pretest and post-test scores.

Meanwhile, data from student response questionnaires using a Likert scale with four alternative answers were analyzed descriptively. Thus, the analysis techniques used in this study were adjusted to the characteristics of each data set to obtain valid and reliable results. Analysis techniques and student response questionnaires were analyzed using a Likert scale

with four alternative answers: strongly agree, agree, disagree, and strongly disagree (Sugiyono, 2017).

Result

Based on the research results, data was obtained from students who used the STEAM learning model (experimental class) and those who implemented conventional learning (control class). The following are the results of the pretest and post-test data in the experimental class and control class:

Table 1. Recapitulation of the Results of the Average Value of Creativity and Entrepreneurial Competence of Students in the Experimental Class and Control Class

Data	Class	Average Value			Category *N-Gain*
		Pretest	***Postest***	***N-Gain***	
Creativity	**Exsperiment**	53,04±0,67	82,50±0,24	0,63±0,01	Medium
	Control	51,48±0,55	75,37±0,52	0,49±0,05	Medium
Entrepreneurship Competence	**Experiment**	64,01±0,32	85,70±0,38	0,62±0,09	Medium
	Control	61,09±0,53	76,94±0,59	0,41±0,03	Medium

Results of the Creativity and Entrepreneurship Competence Statistical Test of Students

The pretest and post-test data of creativity and entrepreneurial competence were then analyzed using prerequisite tests such as normality, homogeneity, and hypothesis tests. The normality and homogeneity tests of the pretest and post-test in the experimental and control classes of creativity and entrepreneurial competence showed that the data were normally distributed and homogeneous with a sig value of >0.05. Furthermore, the post-test hypothesis test in the experimental and control classes was carried out using the t-test (Independent sample T-test), which showed that using the STEAM learning model through LKPD Ecoprint had implications for students' creativity and entrepreneurial competence.

Table 1 shows the average results of students' creativity and entrepreneurial competence scores in the experimental and control classes. It is known that the initial average based on the pretest of both groups showed that the initial condition values of students were not significantly different. The post-test value increased in the experimental class compared to the control class. The data in the table above shows that the experimental class showed a higher N-Gain value than the control class, even though both showed an increase.

Table 2. Average Percentage Value of Students' Verbal Creativity Indicator

Creativity Indicator	***Pretest***		***Postest***	
	E	**C**	**E**	**C**
Fluency	53,15	53,15	82,43	74,1
Flexibility	52,70	52,47	82,09	72,97
Originality	52,70	52,81	81,87	73,2
Average	**52,85**	**52,81**	**82,13**	**73,42**

Note: E: Experiment, C: Control

Table 2. shows an increase in the pretest and post-test values of verbal creativity implemented in the experimental and control classes. The pretest was conducted before the treatment was given or the learning process began. All indicators of verbal creativity for both classes showed a significant increase in the post-test score. Compared to the control class, all indicators of verbal creativity in the experimental class showed a higher growth. This indicates that the experimental class's overall treatment significantly impacts creativity and entrepreneurial ability.

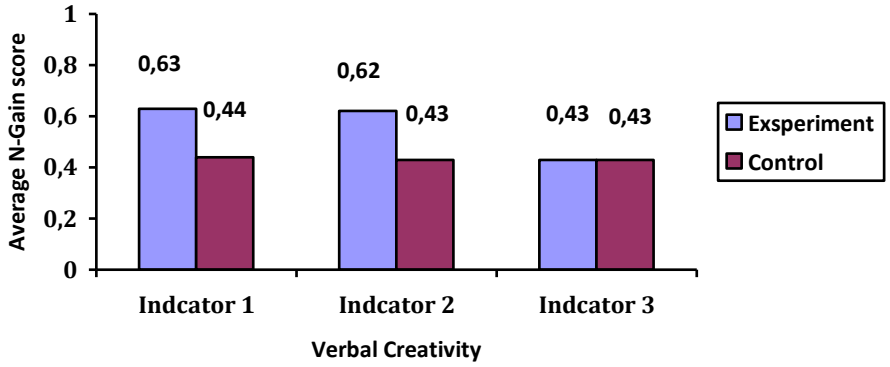

Figure 1. Results of N-Gain Verbal Creativity of Experimental Class and Control Class

Figure 1. The results of the N-Gain score are compared with three indicators of verbal creativity: indicator 1 fluency, indicator 2 flexibility, and indicator 3 originality, with the results of the experimental class being higher than the control class. All indicators of verbal creativity in the experimental and control classes are in the medium category. There is a slight difference in the range of values in the range. According to Hake (1999), there are three ranges of N-Gain. ≤ 0.3 is considered a low criterion; 0.3 ≤ 0.7 is considered a medium criterion, and a value of ≥ 0.7 is regarded as a high criterion. The results above show increased pretest and post-test values implemented in the experimental and control classes.

Table 3. Average Percentage Value of Students Figural Creativity Indicator

Creativity Indicator	*Pretest*		*Postest*	
	E	C	E	C
Fluency	54,95	51,35	83,33	78,60
Elaboration	52,93	45,72	78,83	76,35
Originality	51,80	53,38	86,49	77,03
Average	**53,23**	**50,15**	**82,88**	**77,33**

Note: E: Experiment, C: Control

Table 3. Shows an increase in the pretest and post-test scores for each figural creativity indicator carried out in the experimental and control classes.

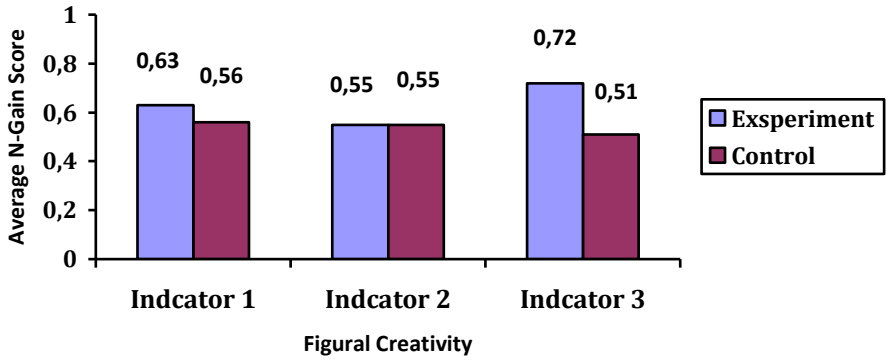

Figure 2. Results of N-Gain Figural Creativity of Experimental Class and Control Class

Figure 2. shows the results of the N-Gain score of figural creativity per indicator. Based on the N-Gain score data above, it is known that the N-Gain score for each indicator is different. The score per indicator in the experimental class is higher than in the control class. Indicator 1 Fluency shows the medium category in the experimental and control classes. Indicator 2 Elaboration shows the same score in the medium category. Indicator 3 Originality in the

experimental class is in the high category. At the same time, the control class is in the medium category.

Table 4. Average Value of Students Entrepreneurship Competence Indicators

Entrepreneurship Competency Indicators	*Pretest*		*Post-test*	
	E	C	E	C
Innovation and Creativity	63,73	61,58	87,78	77,26
Risk Taking	64,58	63,51	83,49	77,51
Self-Confidence	63,92	61,08	82,03	76,08
Leadership	66,35	63,24	84,19	77,16
Identification Opportunities/Future-Oriented	61,76	55,54	88,92	76,35
Average	**64,01**	**61,09**	**85,70**	**76,94**

Note: E: Experiment, C: Control

Table 4. shows that both classes showed significant improvement in all indicators of entrepreneurial competence from the pretest to the post-test. The experimental class consistently showed higher post-test scores than the control group in all indicators. The experimental group showed higher improvement in all indicators, indicating that the experimental class was more effective in improving entrepreneurial competence. The data above shows that the experimental group outperformed the control group in all indicators of entrepreneurial competence measured after being given the treatment.

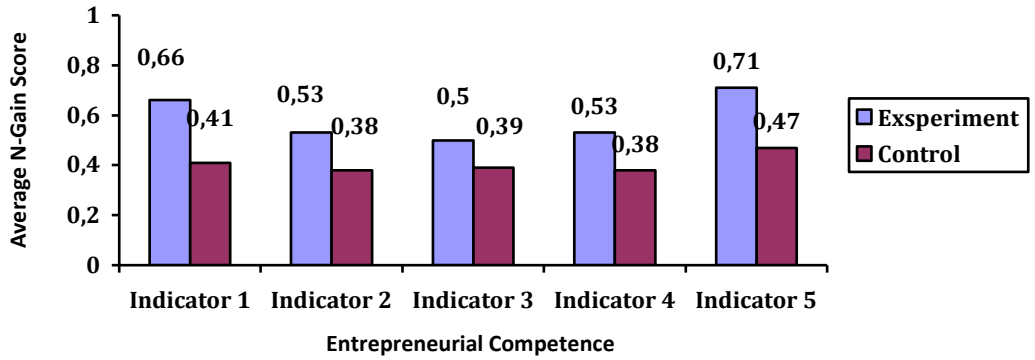

Figure 3. N-Gain Results of Entrepreneurial Competence of Experimental and Control Classes

Figure 3. shows the results of the N-Gain score of entrepreneurial competence per indicator. It is known that the experimental class is higher than the control class. Indicator 1, the experimental class's innovation and creativity, has a higher N-Gain score than the control class. Indicator 2, namely the risk-taking of the experimental class, is higher than the control class. Indicator 3, namely self-confidence, is higher than that of the control class, even though both are in the medium category. Indicator 4, namely leadership, is in the medium category. Indicator 5, namely identification of opportunities/future orientation, is higher in the experimental class than the control class and is in the high category of 0.71, while the control class is in the medium category.

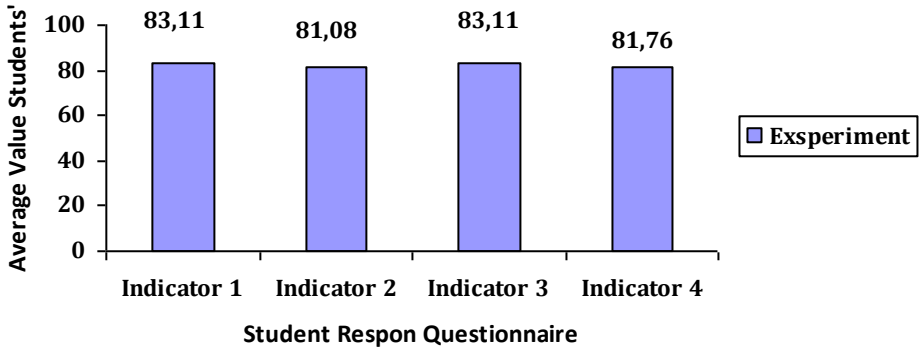

Figure 4. Student Responses to STEAM Model Learning through Ecoprint LKPD

Figure 4. Based on the results of the student response questionnaire in STEAM model learning through Ecoprint LKPD on students' creativity and entrepreneurial competence, it is in the excellent category because the four indicators have a value with an overall average of 82.26 percent. So it can be stated that STEAM model learning through Ecoprint LKPD gets an excellent response, and students feel helped by the STEAM learning model in Biology learning.

Discussion

Implications of STEAM Model Learning through Ecoprint LKPD on Students' Creativity and Entrepreneurial Competence

Based on the research that has been conducted, it is known from the overall average data analysis results that the learning outcomes of students in the experimental and control classes are very different. The stages of data analysis above have gone through statistical and parametric analysis tests, namely normality, homogeneity, and hypothesis testing (Independent sample T-test). Based on the results of the hypothesis test analysis, a significance value of Sig (2-tailed) of 0.000 was obtained for both variables so that H0 was rejected and H1 was accepted, which means that there are implications for learning the science, technology, engineering, arts, and mathematics (STEAM) model on students' creativity and entrepreneurial competence. This study shows that Ecoprint LKPD can improve students' creativity and entrepreneurial abilities by implementing the STEAM learning model. This indicates that more contextual and applicable learning can be achieved through a project-based approach combining science, technology, engineering, arts, and mathematics. Increasing students' creativity improves their ability to develop initiative and problem-solving skills. In addition, increasing entrepreneurial competency improves their ability to generate creative ideas. In addition, this model can inspire educators to build more interactive, exploratory, and experience-based learning strategies to improve students' skills in facing the 21st century.

The results above indicate that the learning model improves the overall learning quality and increases the learning process's effectiveness. The creativity and entrepreneurial competency of students in the experimental class experienced a higher increase than those in the control class. This is because the STEAM learning model can increase students' creativity in solving problems in the surrounding environment, so students must be more active and innovative in their learning activities. It can help students understand biodiversity material and increase their knowledge when designing an experiment through LKPD Ecoprint. In addition to developing students' cognitive aspects, STEAM learning can also build their creativity, which helps them face challenges in the future (Arsy & Syamsulrizal, 2021). Applying the STEAM approach in entrepreneurship learning supports achieving entrepreneurship learning goals and can foster students' entrepreneurial spirit (Kartika & Rokhmaniyah, 2019).

Student Creativity per Indicator in Experimental and Control Classes

At the learning stage, students are guided by the teacher to carry out learning activities in groups according to the steps available in the Student Worksheet (LKPD) using the STEAM model in the experimental class and the Discovery learning steps in the control class on biodiversity material through an Ecoprint making project that emphasizes direct practice. Fatmala & Hartati's (2020) research shows that Ecoprint activities significantly increase creativity. These results are reinforced by Azizah's study (2021). Ecoprint combines elements of art and creativity in STEAM learning, successfully increasing creativity and environmental awareness. Students not only gain an understanding of science concepts but also have the opportunity to demonstrate their creative abilities and critical thinking by designing their prints. Both of these abilities are very important in a changing world. Compared to previous studies, this study focuses more on developing STEAM-based LKPD, which is systematically designed to improve students' creativity and entrepreneurial competence.

The potential for student creativity is measured through the Torrance Test of Creative Thinking (TTCT) test approach, which is a test that measures a person's ability to solve problems creatively. TTCT consists of two parts, namely Verbal and Figural (Croopley, 2000). The test is used to determine talented students, both verbally and figuratively. TTCT-V (Torrance Test of Creative Thinking Verbal) assesses three aspects of creative thinking, including 1) Fluency, where children can provide many ideas with words; 2) Flexibility, namely children can provide various ideas, shift from one approach to another, or use various strategies; 3) Originality, namely the child's ability to produce unusual ideas (Torrance, 2018). Figural creativity has three leading indicators: 1) Fluency creates one idea and produces many ideas with various responses. (Abstractness of title) The ability to produce an abstract image. 2) Elaboration is refining the ability to detail, assess, develop, and enrich a concept. and 3) Originality as the ability to create unique and original ideas (Carter, 2000).

Based on the results of the verbal and figural creativity tests that have been carried out in the experimental and control classes per indicator can be seen in Table 3, and Table 4 shows that the average value of the Flexibility, Fluency, Originality, and Elaboration indicators in the experimental and control classes as a whole shows a significant increase. Before the treatment, the average Pretest results of both classes showed the same ability ≤60, which is sufficient. After being given treatment, both classes experienced an increase in Post-test scores. The overall average Post-test score in the experimental class was in the excellent category of≥82. In contrast, in the control class it had an average score of 60≤X≤80, which was included in the good category. The study results showed a significant increase in the verbal and figural creativity indicators after STEAM-based learning through LKPD Ecoprint. Before the treatment, the average pretest results of both classes were in the sufficient category (≤60). However, after being given treatment, the experimental class experienced a significant increase, with an average post-test reaching an excellent category (≥82), while the control class only reached a good category (60≤X≤80). This finding indicates that using STEAM-based LKPD through the Ecoprint project effectively improves student creativity compared to conventional learning models such as Discovery Learning. The results of this study suggest that integrating STEAM model learning through Ecoprint LKPD as a project-based approach helps improve students' verbal and figural creativity.

The results of the N-Gain score per verbal creativity indicator can be seen in Figure 1. Figural creativity can be seen in Figure 2. shows that the N-Gain score of the first indicator, namely the fluency of verbal and figural creativity in the experimental and control classes, shows that the N-Gain score is in the moderate category, namely 0.30≤0.70. Although in the same category, the experimental class has an N-Gain score with a higher range, almost approaching 0.70 compared to the control class. According to Torrance (2000), fluency is the ability to generate an idea and create various answers. The results of the N-Gain score analysis of the verbal and figural creativity fluency indicators show that students in the

experimental class can provide more ideas through words. At the same time, the results of figural creativity show that students in the experimental class can generate various ideas and have creative and varied concepts compared to students in the control class. This happens because the experimental class uses the STEAM model with the Engineering Design Process (EDP) steps, according to Carparo & Morgan (2013); Windyariani et al. (2023) as characteristics of the design or engineering process. Before developing a product in the early stages, students carry out problem identification activities with limitations regarding the biodiversity problems presented. (Identity and Problem Constraint) After that, research is carried out to obtain as much information as possible to find solutions and information regarding using biodiversity as an appropriate product. This shows that design learning was carried out in the experimental class, which was not done in conventional learning (discovery learning) in the control class. STEAM learning can provide opportunities for students to learn to carry out the design process and make products with good creativity and problem-solving skills (Ayuningsih et al., 2022).

Similar to verbal creativity, the second indicator, namely flexibility, can be seen in Figure 1 that the flexibility indicator in the experimental and control classes is in the moderate category, 0.30≤0.70. Both classes have a significant increase in value, and this occurs because, in the initial steps of learning in the experimental and control classes, both identified the problems presented in learning, so both classes experienced a significant increase. However, in its implementation in the experimental class, the EDP step involves students in creative activities. Creativity is essential in the EDP process; creativity influences the development of products (Setiono, 2023). Students develop ideas (Ideate) for products and develop them (build). At the same time, this is not the case in the control class after students search for information on the internet and classify plants. Immediately make Ecoprint products so that the difference in scores in the experimental class has a higher range of score differences approaching 0.70 when compared to the control class. These results show that students' ability to express ideas in words in the experimental class flexibly is better than in the control class. The STEAM learning approach effectively improves students' ability to convey innovative ideas. The STEAM model encourages students to collaborate on team projects, allowing them to exchange ideas and work together to find creative solutions (Nur & Nugraha, 2023).

The results of the figural creativity N-Gain score can be seen in Figure 2. It shows that the second indicator, namely elaboration in the experimental and control classes, has an N-Gain score of 0.30≥0.70, both of which are in the same category, namely moderate. According to Guilford Pratitis & Pandin (2002), elaboration is the ability to detail in detail assess, develop, and enrich an idea. This happens because both classes carry out the same experimental activity, namely making Ecoprint. Working on a project is challenging and directs students to design, solve problems, make decisions, and carry out investigative activities. This activity will train students to produce many unique ideas or ideas and elaborate on them (Setiono et al., 2024).

This will contribute to student creativity. After the learning series, students make presentations and ask questions. It is known from the results of the N-Gain score analysis that students have been able to collect literature information on the internet regarding biodiversity and plants that can be used as Ecoprints. In the process of making Ecoprints, not all plants can be used. Good plants have high color pigments and humidity (Dewi et al., 2023). After the product is made, students present it, and the question and answer session occurs actively. According to other studies, Ecoprint activities provide learning centered on fun and engaging collaborative activities and can help their development (Susanti et al., 2021).

The results of the N-Gain score for the third indicator of verbal creativity, namely originality, can be seen in Figure 1, showing that the experimental and control classes have scores that are not much different and are included in the moderate category. This indicates that students in both classes can demonstrate the ability to produce original and unique ideas through their ideas. The results of figural creativity show differences in the

experimental class with an N-Gain score of ≥70, which is in the high category compared to the control class. Implementation in the experimental class has an advanced stage in its learning, namely developing products. Data from the identification results in the LKPD are then experimented with and analyzed by making Ecoprints to determine whether the plants they have identified can produce colors and arrange them aesthetically. Art allows them to express their ideas visually and emotionally, which is essential to developing creativity. Children who play with science, mathematics, technology, and art elements can develop holistic and innovative ways of thinking (Istim et al., 2022). This stage trains students to work together and be responsible for their group assignments. After the product is made, students make improvements to whether the product produced is good or needs to be improved again. The next step is to test the product (Test and refine) to improve it; the last step is communicating (Communicate). The results of figural creativity in Figure 2. show that the experimental class is in the high category compared to the control class. Creativity is an individual's capacity to use their thoughts to generate new ideas, possibilities, and discoveries based on originality (Yunesti, 2023).

Thus, the STEAM learning process for creativity per the indicator described above proves that the STEAM learning model is an alternative learning model that can help student-centered learning, prioritize real experiences, and influence student creativity with Ecoprint LKPD and literature research process, implementation of STEAM learning makes students more creative, independent, and able to work together. According to the statement (Agustina & Mugara, 2020), STEAM learning can improve student competencies such as creativity, adaptation, critical thinking, initiative, responsibility, and self-confidence. Research (Laskyana et al., 2022) found that the STEAM approach provides results that students can achieve: better understanding of concepts, better thinking skills, increased learning motivation, and increased awareness of concepts.

Student Entrepreneurship Competence per Indicator in Experimental and Control Classes

Based on the research that has been carried out, the results obtained from data processing on student entrepreneurship competencies show that learning in the Pretest value can be seen in Table 3. Showing that student entrepreneurship competencies in the experimental and control classes are at the same ability in sufficient criteria. After being given treatment, both classes experienced a significant increase in post-test scores. The experimental class had post-test results in excellent criteria ≥82, while the control class had an N-Gain score of 60≤X≤80 in the good category. Entrepreneurship competency was assessed using a Likert scale instrument with Indicators according to Irwanda (2022) to determine student entrepreneurship competencies in the experimental and control classes.

At this learning stage, students in the experimental class learn through direct activities and simulations of real-world situations using the STEAM model, which emphasizes direct practice. In the experimental class, students are taught to implement products into the real world; namely, students are trained to market and try to sell their products through the marketplace. The results show a high influence on opportunity identification and future orientation, ≥0.70. In the high category. While in the control class, using conventional learning methods (discovery learning).

The results of the N-Gain score on indicator 1, namely innovation and creativity, can be seen in Figure 3. The N-Gain score is in the moderate category. However, the score results in the experimental class are higher. This is because in learning in the experimental and control classes, the same product is made, namely Ecoprint. However, the experimental class uses the STEAM model in the learning steps. According to their findings, students are challenged to use local plants and design them into a product. At this stage, students are trained to create activities to make products by innovating, which makes students in the experimental class more honed. This aligns with previous research proving that the influence of innovation and creativity on entrepreneurship is interrelated. Creativity is related to discovering new ideas about a product; innovation is how to implement that creativity (Wiyono, 2020).

The results of the N-Gain score on the second indicator, namely risk-taking, can be seen in Figure 3. A higher N-Gain score in the experimental class indicates that students believe and dare to take risks, which is crucial to achieving their goals. At this stage, STEAM learning trains students to explore, experiment, and dare to decide on group ideas and implement real products. A person with an innovative nature can also see business opportunities and dare to take realistic and measurable risks to make these opportunities real (Wulandari & Deliabilda, 2020).

The results of the N-Gain score on the third indicator, namely self-confidence, can be seen in Figure 3, which shows that it is in the moderate category. However, in the experimental class, the N-Gain score has a higher range compared to the control class. At the STEAM learning stage, working together and solving problems with their groups and then presenting their work with each of their uniqueness makes students actively involved and confident in showing the products they have made. Self-confidence can help someone solve problems. When someone can overcome their anxiety about the failure they will do, they become confident (Sari et al., 2024).

The results of the N-Gain score on the fourth indicator, namely leadership, can be seen in Figure 3, which shows that it is in the moderate category. The experimental class has a higher N-Gain score compared to the control class. This is because, in the experimental class, students are trained to organize the tasks they create to implement products that have sales value so that students have a sense of responsibility for the tasks given and foster an entrepreneurial spirit. In line with this, leadership is the main capital needed to have an entrepreneurial character. Developing leadership in entrepreneurship is a very valuable investment in the long term (Sewang, 2023). In line with Magdalena's research (2025), the STEAM differentiated learning model shows that learning activities foster leadership.

The results of the N-Gain score on the fifth indicator, namely opportunity identification/future orientation, can be seen in Figure 3. Identifying opportunities/future orientation in the experimental class shows an N-Gain score of ≥0.70, which means it is in the high category. Learning in the experimental class trains communication and reflection. Students in the experimental class can see opportunities and business ideas on the internet implemented through their products and try to sell them through the marketplace, thereby fostering motivation towards entrepreneurship. This is in line with other studies that show that future-oriented people have goals they want to achieve. An entrepreneur with a perspective, vision for the future, and goals to be achieved is defined as a future-oriented person. This is because businesses are established for the long term, not just temporarily (Utari & Yusrik, 2021).

The results of this study show that the STEAM model of learning entrepreneurship is effective and has a positive and significant impact on students' entrepreneurial competence. The assessment results show a significant difference in competence between the two groups. Students in the experimental class were more creative, risk-taking, and adept at solving problems than students in the control class. Strong entrepreneurial skills will encourage their desire to become young entrepreneurs and be able to start new businesses. These entrepreneurial skills have qualities such as being innovative and creative, daring to take risks, being confident, having a leadership spirit, and being able to identify opportunities (Irwanda et al., 2022).

Student Response Questionnaire on STEAM Model Learning through Ecoprint LKPD

Based on the results of the student response questionnaire in the experimental class using the STEAM model. It is known that the average result is 82.26 percent in the excellent category. These indicators include 1) STEAM model learning is more meaningful for learning Biology, 2) Biology learning using the STEAM model enables students to carry out experimental activities, and 3) The STEAM learning model makes it easier to solve problems in Biology lessons and find new ideas. So, based on the results above, it can be stated that students can participate in learning enthusiastically by doing product experiments with a creative and innovative approach so that STEAM model learning through Ecoprint LKPD

makes it easier for students to understand biodiversity subjects. STEAM model learning encourages students to use technology, solve problems and analyze, and involve creative, collaborative learning strategies (Hayati et al., 2023).

Conclusions

Learning outcomes using the STEAM model through Ecoprint LKPD in the experimental class showed higher creativity and entrepreneurial competence than the control class using the discovery learning model. The STEAM learning model can improve students' creativity and entrepreneurial competence. The ability of creativity and entrepreneurial competence specifically can be seen from the percentage of N-Gain values for each indicator, which is more significant in flexibility, fluency, originality, and elaboration, as well as in entrepreneurial competence. Using the STEAM model through Ecoprint LKPD provides a more contextual and applicable learning experience, allowing students to develop critical thinking skills, problem-solving, and adaptability in situations that demand innovation. Thus, this learning model is relevant in improving cognitive learning outcomes and equips students with the skills needed in entrepreneurship. Therefore, integrating the STEAM model in learning, primarily through environmental-based projects such as Ecoprint, can be an effective strategy to create a more holistic and long-term impactful learning experience for students.

Acknowledgments

Thanks are conveyed to all parties involved in this research, namely the supervising lecturer and the research location that helped and supported the author in completing this research.

Declaration statement

The authors report no potential conflict of interest.

References

Agustina, D., Mugara, R., & Rohmalina. (2020). Pembelajaran STEAM pada pembuatan instalasi penjernihan air menggunakan botol plastik air mineral untuk mengembangkan kreativitas anak usia dini. *CERIA (Cerdas Energik Responsif Inovatif Adaptif)*, 3(4), 323–328. https://doi.org/10.31004/ceria.v3i4.4374

Arsy, I., & Syamsulrizal, S. (2021). Pengaruh Pembelajaran Steam (Science, Technology, Engineering, Arts, And Mathematics) Terhadap Kreativitas Peserta Didik. *Biolearning Journal*, *8*(1), 24–26. https://doi.org/10.36232/jurnalbiolearning.v8i1.1019

Ayuningsih, F., Malikah, S., Nugroho, M. R., Winarti, W., Murtiyasa, B., & Sumardi, S. (2022). Pembelajaran Matematika Polinomial Berbasis STEAM PjBL Menumbuhkan Kreativitas Peserta Didik. *Jurnal Basicedu*, *6*(5), 8175–8187. https://doi.org/10.31004/basicedu.v6i5.3660

Azizah, N., Romli, A. A., Zafirah, Ardana, M. F., & Iftikhariyah, E. H. (2024). Implementasi Pembelajaran Berbasis STEAM melalui Pelatihan Pembuatan Ecoprint untuk Mengembangkan Kreativitas Siswa pada Abad 21. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 9(2). https://doi.org/10.23969/jp.v9i2.14413

Barokah, S. L. (2024). Penerapan STEM dalam pembelajaran untuk meningkatkan keterampilan siswa. *Jurnal Pendidikan Sains*, *5*(3), 45-56. https://doi.org/10.34007/jonas.v5i3.703

Battelle For Kids. (2022). Framework For 21st Century Learning Definitions.

Bybee, R. W. (2013). *The case for STEM education: Challenges and opportunities*. NSTA Press.

Dewi, I. Y., Lutfi, A., Astuti, S. H., Pramudita, W. P., Azzahra, S. A. F., Putri, O. M., Hartati, T., Zulfi, R., Said, S. R., Sunarno, T., Husen, K., Hastuningsih, E., & Firdaus, N. (2023). Pembuatan Batik Memanfaatkan Bahan Alami dengan Teknik Ecoprint Pounding dalam Melatih Kreativitas Peserta Didik di SMA Negeri 1 Cikeusal, Banten. Jurnal Pengabdian Kampus, 10(2), 183-190.

Fatmala, Y., & Hartati, S. (2020). Pengaruh membatik ecoprint terhadap perkembangan kreativitas seni anak di taman kanak-kanak. *Jurnal Pendidikan Tambusai*, *4*(2), 1143–1155. https://doi.org/10.31004/jptam.v4i2.577

Fauziah, L., Rizkiyah, F., Miarsyah, M., & Ristanto, H. (2021). Pengembangan TTCT-V (*Torrance Test of Creative Thinking Verbal*) berbasis lingkungan untuk tingkat SMA. *Bio-Lectura*, *8*(1), 1–11. https://doi.org/10.31849/bl.v8i1.4534

Fullan, M. (2018). Deep Learning: Engage the World Change the World. Corwin Press

Hadiyati, E., & Fatkhurahman, F. (2021). Dampak kepercayaan diri mahasiswa berwirausaha melalui kemandirian dan lingkungan keluarga. *INOBIS: Jurnal Inovasi Bisnis dan Manajemen Indonesia, 5*(1), 84–95. https://doi.org/10.31842/jurnal-inobis.v5i1.230

Hayati, R., Prima, W., Wulandari, S., Yunita, A. P., Mulyati, A., & Azmi, K. (2023). Model Pembelajaran STEAM (Science, Techonology, Engineering, Art, and Math) dalam Pembelajaran Matematika Sekolah Dasar: Pembelajaran Berdiferensiasi. *EDUKATIF : Jurnal Ilmu Pendidikan*, *5*(6), 2591–2603. https://doi.org/10.31004/edukatif.v5i6.5723

Irwanda, M., Machmud, A., & Supardi, E. (2022). Pengukuran Efektivitas Pembelajaran Kewirausahaan dalam Mengembangkan Keterampilan Wirausaha di Unversitas Pendidikan Indonesia Bandung. *Edumaspul: Jurnal Pendidikan*, *6*(1), 770–778. https://doi.org/10.33487/edumaspul.v6i1.2784

Istim, N., Hendratno, H., & Setyowati, S. (2022). Pengaruh Penggunaan Media Pembelajaran Loose Part Bahan Plastik terhadap Perkembangan Bahasa dan Fisik Motorik pada Anak Usia 5-6 Tahun. *Jurnal Basicedu*, *6*(5), 8572–8584. https://doi.org/10.31004/basicedu.v6i5.3793

Kartika, W. I., & Rokhmaniyah, R. (2019). Analysis of the Implementation of the STEAM Approach in Entrepreneurship Learning To Support Planning for the Implementation of Entrepreneurship Curriculum in Elementary Schools. *Social, Humanities, and Educational Studies (SHEs): Conference Series*, *2*(1), 219. https://doi.org/10.20961/shes.v2i1.37649

Kementerian Koperasi dan Usaha Kecil dan Menengah Republik Indonesia. (2024). *Target rasio kewirausahaan 3,95% pada 2024*. Kementerian Koperasi dan UKM. https://www.kemenkopukm.go.id

Laskyana, B., Triatna, C., & Nurdin. (2022). Kajian pedagogik dalam implementasi STEAM pada pembelajaran jarak jauh di era pandemi. *SAP (Susunan Artikel Pendidikan)*, 7(1), 50–58. https://doi.org/10.30998/sap.v7i1.12972

Nasihudin Nasihudin, and Hariyadin Hariyadin. "Pengembangan Keterampilan Dalam Pembelajaran." *Jurnal Pendidikan Indonesia*, vol. 2, no. 4, 25 Apr. 2021, pp. 733–743. https://doi.org/10.36418/japendi.v2i4.150.

Nur, N., & Nugraha, M. S. (2023). Implementasi model pembelajaran STEAM dalam meningkatkan kreativitas peserta didik di RA Al-Manshuriyah Kota Sukabumi. *Jurnal Arjuna: Publikasi Ilmu Pendidikan, Bahasa dan Matematika*, 1(5), 73–93. https://doi.org/10.61132/arjuna.v1i5.158

Rofi'ah, U. A., Khotimah, N., & Lestari, P. I. (2021). Pengukuran kreatifitas anak usia dini menurut E.P. Torrance. *Alzam: Journal of Islamic Early Childhood Education*, *3*(1), 40–55. https://doi.org/10.35878/alzam.v3i1.526

Rusmana, D. (2020). Pengaruh Keterampilan Digital Abad 21 pada Pendidikan Kewirausahaan untuk Meningkatkan Kompetensi Kewirausahaan Peserta Didik SMK. *Jurnal Ekonomi Pendidikan Dan Kewirausahaan*, *8*(1), 17. https://doi.org/10.26740/jepk.v8n1.p17-32

Saptutyningsih, E., & Wardani, D. T. K. (2019). Pemanfaatan Bahan Alami untuk Pengembangan Produk Ecoprint di Dukuh IV Cerme, Panjatan, Kabupaten Kulonprogo. *Warta LPM*, *21*(2), 18–26. https://doi.org/10.23917/warta.v21i2.6761

Sari, S. A., Sinaga, M. A., Fawas, R. A., & Keling, M. (2024). Pengaruh karakteristik kewirausahawan terhadap keberhasilan sebuah usaha. Maeswara: Jurnal Riset Ilmu Manajemen dan Kewirausahaan, 2(1), 74-80. https://doi.org/10.61132/maeswara.v2i1.594

Setiono, S., & Windyariani, S. (2023). *Development of Online STEM Learning Program for the Preparation of Prospective 21st Century Biology Teacher*, 21(3). https://doi.org/10.19184/bioedu.v21i3.40383

Setiono, S., Windyariani, S., & Agustiani, N. (2024). Creativity profile of biology teacher candidates: An exploratory study. *Biosfer*, *17*(1), 215–222. https://doi.org/10.21009/biosferjpb.38636

Sewang, S. (2023). Mengembangkan Jiwa Kepemimpinan dalam Berwirausaha di Era Globalisasi. *KREATIF: Jurnal Pengabdian Masyarakat Nusantara*, 4(3), 01–06. https://doi.org/10.55606/kreatif.v4i3.3762

Sugiyono. (2018). Metode Penelitian Kuantitatif. Alfabeta

Susanti, S. M., Henny, H., & Marwah, M. (2021). Inovasi Pembelajaran Anak Usia Dini Berbasis Kearifan Lokal melalui kegiatan Eco print di masa pandemic covid-19. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *5*(2), 1987–1996. https://doi.org/10.31004/obsesi.v5i2.775

Susanto, N. C. A., Latief, M., Puspitasari, R. D., Bemis, R., & Heriyanti, H. (2021). Pengenalan ecoprint guna meningkatkan keterampilan siswa dalam pemanfaatan bahan alam. *Jurnal Inovasi Hasil Pengabdian Masyarakat (JIPEMAS)*, *4*(1), 111. https://doi.org/10.33474/jipemas.v4i1.8974

Tanjung, H. S., Jerba, H., & Nababan, S. A. (2021). Analisis kemampuan berfikir kreatif siswa melalui pendekatan pembelajaran science, technology, engineering and mathematics (STEM) di SMA Negeri 1 Meureubo. *Genta Mulia*, *13*(2). https://doi.org/10.61290/gm.v13i2.120

Utari, D., & Yusrik, M. (2021). Pengaruh Jiwa Kewirausahaan Terhadap Keberhasilan Usaha Cafe di Kota Palembang. *Jembatan (Jurnal Ekonomi, Manajemen, Bisnis, Auditing, dan Akuntansi)*, *6*(1), 13–25. https://doi.org/10.54077/jembatan.v6i1.52

Wahyuni, M. M. S., Nisa, A. F., & Zulfiati, H. M. (2025). Proyek Berdiferensiasi STEAM dalam Menumbuhkan Jiwa Kepemimpinan dan Sikap Peduli Lingkungan Siswa Sekolah Dasar. *Ideguru: Jurnal Karya Ilmiah Guru*, *10*(2), 1094-1103. https://doi.org/10.51169/ideguru.v10i2.1793

Wiyono, H. D. (2020). Kreativitas dan Inovasi dalam Berwirausaha. *Jurnal USAHA*, *1*(2), 19–25. https://doi.org/10.30998/juuk.v1i2.503

World Intellectual Property Organization. (2023). Global Innovation Index 2023: Innovation in the Face of Uncertainty. WIPO. Retrieved from https://www.wipo.int/global_innovation_index/en/

Wulandari, A., & Deliabilda, S. A. (2020). Keberanian Mengambil Risiko Bisnis pada Mahasiswa Ekonomi dan Bisnis. *Jurnal Pengembangan Wiraswasta*, *22*(3), 217. https://doi.org/10.33370/jpw.v22i3.494

Yunesti, D. (2023). Peningkatan Kreativitas Anak Usia Dini Melalui Metode Percobaan Sains Sederhana dengan Kegiatan Ecoprint. *Jurnal Pendidikan Islam Anak Usia Dini, 2,* 25– 32.