

# Promoting Creative Thinking and Communication Skills Through Project-Based Science Learning on Nutritional Exploration of Traditional Indonesian Foods

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**ABSTRACT** This study investigated the effect of a Project-Based Learning (PBL) model incorporating ethnoscience content, specifically the traditional food Legomoro, on students' creative thinking and communication skills. Using a quantitative quasi-experimental design with an unequal control group, this study was conducted on eighth-grade students at a junior high school in Magelang City. Two classes participated: Class VIII A (experimental, 31 students) and Class VIII B (control, 31 students), selected through purposive sampling. Data were collected through tests and observation sheets, including pre- and post-tests for creative thinking, as well as observation and self-assessment for communication skills and for the implementation of learning. Data were analyzed using descriptive statistics, inferential statistics, and MANOVA with SPSS 26.0. The results showed significant differences between experimental classes and demonstrated a strong influence of ethnoscience-loaded PjBL on students' creative thinking and communication skills regarding the traditional food 'Legomoro.' This study emphasizes the importance of selecting the appropriate learning model, offering educators valuable insights to enhance their teaching practices by incorporating local cultural contexts and fostering 21<sup>st</sup>-century skills.

**Keywords:** Creative thinking skill, Communication skill, Project-based learning, Nutritional exploration

## 1. INTRODUCTION

Indonesia has participated in PISA since 2001. The PISA 2022 survey focused on math, reading, science literacy, and creative thinking as small assessment areas. According to PISA 2022 results, Indonesia ranks 69<sup>th</sup> out of 80 participating countries. The results show that the average scores in 2022 decreased compared to 2018 in math, reading, and science. According to PISA 2022 results, Indonesia's science literacy remains relatively low. Science literacy skills must be instilled early in their application.

Suparya et al. (2022) Explained that, about 21<sup>st</sup>-century abilities, the focus of education in Indonesia is to improve student learning outcomes and master the 4C skills that are the demands of the 21<sup>st</sup> century. One of the abilities that is particularly important to note, enabling students to apply science appropriately, is science literacy. Science literacy skills are among the primary needs of students in the 21<sup>st</sup> century. Sanjiartha et al. (2024) Explained that science literacy is closely related to 21<sup>st</sup>-century learning because both emphasize the importance of mastering high-level

thinking skills such as critical, creative, collaborative, and communicative thinking.

21<sup>st</sup>-century skills play a vital role in preparing superior and competent human resources to meet the challenges of scientific and technological development. Arsanti et al. (2021) Explained that, according to Trilling and Fadel, 21<sup>st</sup>-century abilities comprise three main types: (1) life and career skills, (2) learning and innovation skills, and (3) information, media, and technology skills. Four competencies must be possessed. The Ministry of Education and Culture promotes these competencies under the 4C framework: the ability to think creatively, think critically, solve problems, communicate effectively, and collaborate effectively. 4C competencies are essential for the younger generation to master because they help students navigate future challenges.

The 21<sup>st</sup>-century learning paradigm has undergone changes characterized by a shift in focus to the learning process. 21<sup>st</sup>-century learning is oriented towards a

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scientific approach to learning. According to Hamzah et al. (2023), several 21st-century learning models exist, including Project-based Learning (PBL). The Project-based Learning model is considered effective in developing these four skills because it emphasizes learner-centered learning activities through real projects. This aligns with the statement by Simeru et al. (2023) that the Project-Based Learning model affects student learning and is related to 21<sup>st</sup>-century skills. Therefore, this Project-Based Learning model can develop students' 21st-century skills. However, many previous studies have not integrated the ethnoscience approach into PjBL to strengthen local context and increase learner involvement in the learning process. Ethnoscience, a science grounded in local culture, can enrich the learning experience, make it more relevant to everyday life, and thereby be more effective in shaping 21<sup>st</sup>-century competencies.

One of the 21<sup>st</sup>-century skills students must master is creative thinking. According to Salsabila et al. (2023) Creative thinking is a mental activity that involves generating new ideas and offering various possible answers to a given question. Vari (2022) States that students' creative thinking skills can be observed from the number of responses they provide to a problem; the more responses given, the higher the level of student creativity. Individuals with creative thinking skills have several advantages, as explained by Fuadiyah et al. (2024). Students who possess the ability to think creatively can create innovative products, develop compelling works, and solve complex problems using their skills.

However, although many studies demonstrate that the Project-Based Learning model can enhance creative thinking skills, most are conducted in the context of general learning and have not incorporated the ethnoscience approach. Emda (2023) Noted that the ethnoscience approach not only enables learners to imitate and accept the information conveyed but also encourages them to build meaning and understanding and develop the knowledge gained. In addition, previous research has not thoroughly examined creative thinking skills in the context of learning that combines PBL and ethnoscience. Therefore, further research is needed that combines PjBL with an ethnoscience approach to help learners fully develop their creativity and make it relevant to their environment.

The ability to think creatively is not only about knowledge but also about creativity. Creative thinking skills are cognitive processes that can produce a variety of diverse and innovative perspectives, both by developing existing ideas and creating new ones. (Thammaariyasakun et al., 2025). Students are expected to have creative thinking skills, 'Adiilah and Haryanti (2023) Explain that students who can think creatively tend to have a higher mindset and power of capture compared to students who do not have

it. With creative thinking skills, learners will be better able to find new ideas and solve problems effectively.

According to Samaniego et al. (2024) Creative thinking ability is generally associated with four primary skills: originality, fluency, flexibility, and elaboration. Each of these aspects plays a crucial role in uncovering and assessing creativity. Originality reflects the ability to generate unique and innovative ideas. Fluency indicates the ability to create numerous ideas within a given time frame. Meanwhile, flexibility refers to the ability to shift viewpoints and adapt to different approaches. Elaboration refers to the skill of developing ideas in detail and depth.

In addition to creative thinking skills, practical communication skills are essential for students in 21<sup>st</sup>-century learning. Pratiwi et al. (2022) Explained that science communication encompasses various activities, including sharing research results, assisting with research, teaching, compiling results, and conveying emotions. Based on research conducted by Ariyani et al. (2019) The science learning process remains passive and centered on educators, resulting in less developed science communication skills among students. In addition, according to Raharjo et al. (2022) Low science communication among students is attributed to suboptimal interactions among educators and students, as well as between students and their peers.

Communication skills encompass various aspects, including behavior, language proficiency, and the ability to conduct conversations and deliver presentations. (Safitri et al., 2022). Students with strong communication skills will be more actively engaged in their learning. Students not only take notes and listen but also broaden their horizons and contribute to interactive discussions between students and teachers. Additionally, Fitriah et al. (2020) Noted that practical communication skills enable learners to comprehend the information and messages conveyed by the teacher. This is particularly important in the learning process because it facilitates students' understanding and application of the material taught. Budiono and Abdurrohman (2020) Explained several aspects of communication skills, including the ability to express ideas and thoughts effectively, listen attentively, convey information clearly, and use language effectively.

Students' low science communication skills result in their inability to convey their ideas effectively. Learners are less active in responding to the teacher's questions, and some feel embarrassed to ask, which hinders communication between the teacher and learners. The Project-based learning model was chosen as a means for students to solve problems using knowledge through collaborative work, including communication activities (Fauzizah et al., 2023). Lidi et al. (2022) noted that the learning process should connect science with students' local knowledge, grounded in natural phenomena that can be scientifically verified. The integration of ethnoscience

into the Project-based learning model can be an effective solution to improve students' communication skills. Sulistyowati et al. (2020) reported that the ethnoscience-based Project-Based Learning model significantly influenced students' learning activities. This ethnoscience-based project-based learning encourages students to discuss with one another, share local knowledge, and present project results both orally and in writing, thereby naturally training and improving their science communication skills.

One potential learning model applied in science learning is the Project-based learning model. The PjBL approach is rooted in Dewey's insight that students develop a deeper understanding of learning materials by solving problems in authentic tasks that emulate what experts do in the real world. (Chang et al., 2024). Simeru et al. (2023) Explained that the Project-based Learning model impacts student learning and is closely related to 21<sup>st</sup>-century skills, making it a suitable approach for developing these skills in students. The Project-based learning model has several advantages, including the ability to increase students' motivation to learn by encouraging them to think more creatively, improve their problem-solving skills, and enhance their collaboration and communication through project activities. (Nugraha et al., 2023).

According to Ariyani et al. (2019) The Project-based learning (PBL) model positively influences students' science communication skills and significantly enhances their creative thinking skills. In addition, research conducted by Nugroho et al. (2019) Indicates that the Project-based Learning (PBL) learning model yields significant results in enhancing students' creative thinking and communication skills. Most research on the application of Project-based Learning (PBL) in Indonesia has focused on developing 21<sup>st</sup>-century skills, such as collaboration, creativity, and problem-solving; few have explored the potential of ethnoscience as a learning resource. Fadilah et al. (2025) Explained that integrating ethnoscience into project-based learning is not only to improve students' learning outcomes but also to introduce local cultural values as part of strengthening cultural literacy.

Science learning that supports local cultural values is essential to implement in the education process. (Wilujeng et al., 2024). One cultural element that can be integrated into science learning is ethnoscience. According to Lidi et al. (2022) Ethnoscience is a learning approach that utilizes local knowledge as a source or learning object, which can be integrated into learning presented in a contextualized manner. Pertiwi and Firdausi (2019) Stated that the local culture or ethnoscience approach is essential to apply in learning, making the learning process more meaningful for students and potentially improving their academic results. This research is one of the first studies to explicitly use the Project-Based Learning (PBL) model to teach ethnoscience about Legomoro traditional food, while simultaneously

measuring two aspects of 21<sup>st</sup>-century skills: creative thinking and communication. This approach is still rarely used, thus making a new contribution to integrating local culture with the development of 21<sup>st</sup>-century skills. Through science learning integrated with local culture, students are expected to explore the values of knowledge in local culture and relate them to science. The ethnoscience introduced in this research is a traditional food in Yogyakarta.

Based on the identified problems, project-based learning integrated with ethnoscience is necessary for classroom instruction. This project-based learning is expected to improve students' creative and communication skills through meaningful learning experiences. Research by Andriani et al. (2023) Showed that PjBL learning has a superior effect on students' communication and creative thinking skills. However, the research did not integrate ethnoscience into the PjBL learning model. Therefore, the researcher used the study as a reference for the author to determine whether applying the PjBL model, which incorporates ethnoscience, also influences students' communication and creative thinking skills.

This study aims to determine significant differences in students' creative thinking and communication skills between learning using the Project-Based Learning model with ethnoscience content on Legomoro traditional food and direct instruction on the nutrient content of food. In addition, this study aims to determine the effect of Project-Based Learning with ethnoscience content on students' creative thinking and communication skills related to nutrients in traditional Legomoro food.

The first hypothesis is that there are differences in students' creative thinking and communication skills between the Project-Based Learning model with ethnoscience content on Legomoro traditional food in the experimental class and the direct instruction model in the control class. The second hypothesis is that learning using the Project-Based Learning model with ethnoscience content on Legomoro traditional food affects students' creative thinking and communication skills in the context of food's nutrient content.

## 2. METHOD

### 2.1 Research Design

The study employed a quasi-experimental design. The design used is a Non-equivalent Control Group Design because neither the experimental group nor the control group is randomly selected. The research implementation process is illustrated in Figure 1.

The research design employed was a Non-Equivalent Control Group Design, as shown in Table 1. The sample selection was based on the science teacher's recommendations, with consideration of students' learning outcomes and characteristics. Before treatment, both classes were given a pre-test to measure initial ability. The

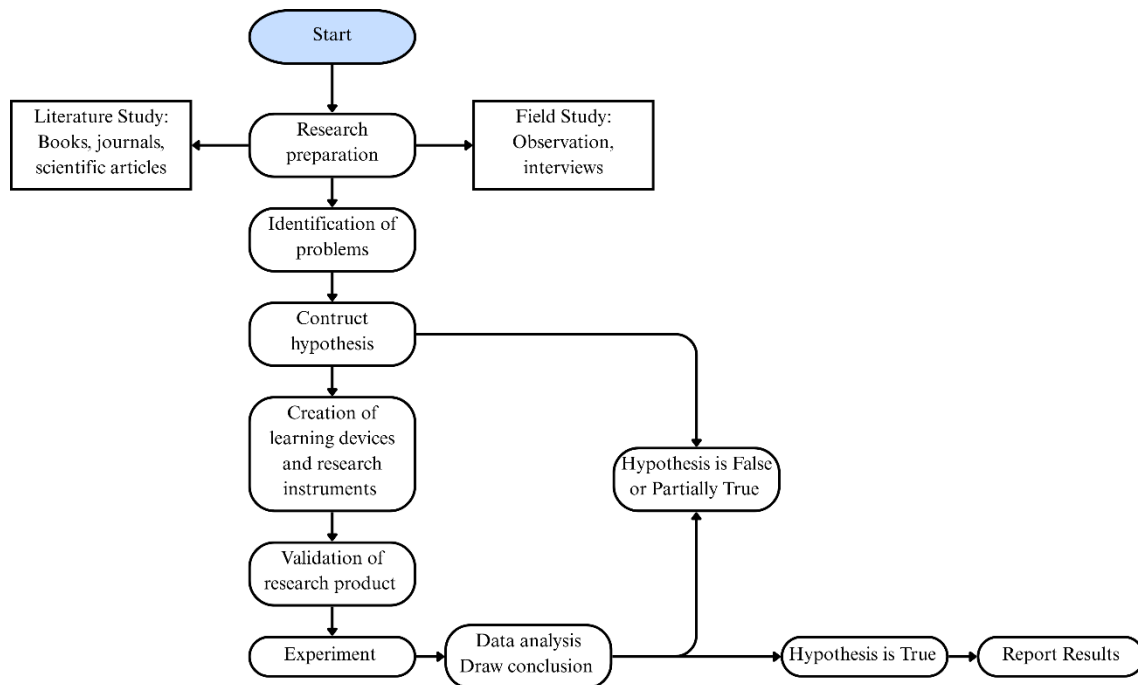


Figure 1 Research flowchart

Table 1 Non-equivalent control group research design

| Group      | Pre-test | Treatment | Post-test |
|------------|----------|-----------|-----------|
| Experiment | P1       | O1        | P2        |
| Control    | P1       | O2        | P2        |

experimental class then received instruction using the Project-Based Learning model with ethnosience content on Legomoro traditional food, while the control class used the direct instruction model. After that, both groups were given a post-test to determine the effect and any differences in results between the two learning models.

2.2 Research Participants

The research participants were 62 eighth-grade students, divided into 31 from the experimental class and 31 from the control class. The participants were selected from a population of 246 grade VIII students from public junior high schools in Magelang City, Indonesia, using a purposive sampling technique. Sampling was conducted under specific conditions and criteria set by the researcher, based on consideration of the science teacher's observations of students' activities during the learning process, the academic results of each class, and the number of students in each class. The samples in this study were classified as Class VIII A for the experimental class and Class VIII B for the control class.

2.3 Measures

Data collection techniques to determine the impact of applying PjBL with ethnosience content from Legomoro traditional food on students' creative thinking and communication skills include tests and observations. The instruments used in this study include:

Pre-test and Post-test

Data collection techniques, including tests, were employed using pre-test and post-test description questions to measure students' creative thinking skills. Creative thinking skills were assessed using 10 validated description questions covering three core competencies: (1) Fluency, (2) Flexibility, (3) Originality, and (4) Elaboration. The test designs for the pre-test and post-test are presented in Table 2.

Table 2 Aspects and indicators of creative thinking skills through tests

| Aspect                   | Indicator   | Number of Items |
|--------------------------|-------------|-----------------|
| Creative Thinking Skills | Fluency     | 3               |
|                          | Flexibility | 2               |
|                          | Originality | 2               |
|                          | Elaboration | 3               |

A pre-test was conducted to measure students' creative thinking ability before they received treatment using the Project-Based Learning model with ethnosience of Legomoro traditional food. The Post-test was conducted to measure students' creative thinking ability after receiving treatment using the Project-Based Learning model with ethnosience of Legomoro traditional food.

Communication Skills Observation Sheet

The observation technique was used to collect data on students' communication skills, with an observation sheet that assessed both oral and written communication. The observation sheet consists of statement items on aspects of

**Table 3** Aspects and indicators of communication skills assessed through observation

| Aspect                | Indicator                                      | Number of Items |
|-----------------------|--|-----------------|
| Oral Communication    | Able to express ideas and thoughts effectively | 4               |
|                       | Able to listen effectively                     | 4               |
|                       | Able to convey information well                | 4               |
|                       | Use good and effective language                | 4               |
|                       | Able to express ideas and thoughts effectively | 4               |
| Written Communication | Able to listen effectively                     | 4               |
|                       | Able to convey information well                | 4               |
|                       | Use good and effective language                | 4               |

students' communication skills. The indicators of communication skills assessed are presented in Table 3.

#### 2.4 Procedure

The learning process in this study spanned five meetings. The first activity carried out was administering a pre-test, followed by the core activities of Project-based learning with ethnoscience content, and concluded with administering a post-test. Details of the learning stages and activities at each meeting are presented in Table 4.

**Table 5** Learning phases and activities

| Phase & Step   | Activity Description  | Time (Duration) |
|--|---|-----------------|
| Pre-Test   | Assess students' initial creative thinking and communication skills. Students observe the case presented in the worksheet, determine fundamental questions, and create an innovative design of Legomoro traditional food. | 80 minutes      |
| Session 1: Case Study and Exploration of Legomoro        | Students present the results of the Legomoro innovation project design and make a plan for implementing project activities.   | 80 minutes      |
| Session 2: Presents                                      | Students test the nutritional content of Legomoro food, present the project and test results, and evaluate the project implementation. Assessing students' final creative thinking and communication skills.              | 80 minutes      |
| Session 3: Experimentation, Presentation, and Evaluation |   | 80 minutes      |
| Post-Test  |   | 80 minutes      |

The results showed that the creative thinking and communication skills of students who used Project-Based Learning with ethnoscience content on Legomoro traditional food increased significantly compared to the control class that used direct instruction.

#### 2.5 Content Validity

Content validity is used to assess the suitability of an instrument relative to the theory developed by experts. The tested instruments include teaching modules, LKPD, handouts, questions assessing creative thinking, observation sheets for communication skills, and self-assessment questionnaires for oral communication skills. The validation process was conducted by expert lecturers, who evaluated the instrument using the prepared validation sheet. Based on the assessment results, the lecturer determines whether the instrument can be used without revision, needs improvement, or requires a complete overhaul. The results of the overall validation assessment score for science learning device products, as evaluated by experts, are presented in Table 5.

**Table 4** Assessment results of each product

| Products              | Learning Expert Assessment |      | Average | Category  |
|-----------------------|----------------------------|------|---------|-----------|
|                       | 1                          | 2    |         |           |
| Teaching Module       | 3.69                       | 3.88 | 3.79    | Very good |
| LKPD                  | 3.82                       | 3.54 | 3.68    | Very good |
| Handout               | 3.85                       | 3.85 | 3.85    | Very good |
| Assessment Instrument | 3.81                       | 3.92 | 3.87    | Very good |

Based on Table 5, the results of the assessment on each product of the Project-Based Learning-based science learning tool with ethnoscience content, specifically Legomoro traditional food, are declared feasible because they meet the requirements, with an average score obtained in the excellent category so that the Project Based Learning-based science learning tool with ethnoscience content of Legomoro traditional food is suitable for use in learning to determine the effect on students' creative thinking and communication skills.

#### 2.6 Empirical Validity

##### Empirical Test

Empirical validation was conducted by administering the Creative Thinking Ability Questionnaire and the Oral Communication Ability Self-Assessment Questionnaire to class IX students who had received nutrition content material in food. In this research, validity and reliability testing were conducted using the QUEST program. Several criteria are used to determine whether the instrument is valid or not using the QUEST program. According to Setyawarno (2017), the assessment of the suitability of each item with the model in the QUEST program is based on the values of Infit MNSQ, Outfit M, and difficulty index or threshold. Good items must meet the requirements of item

**Table 6** Item quality criteria according to item response theory

| Fit with Rasch Model     |               | Index of Difficulty (b) | Criteria    |
|--------------------------|---------------|-------------------------|-------------|
| Infit MNSQ               | Outfit T      |                         |             |
| $0.77 \leq x \leq 1.33$  | $T \leq 2.00$ | $-2 \leq b \leq 2$      | Good        |
| $0.77 \leq x \leq 1.33$  | $T \leq 2.00$ | $b > 2$ or $b < -2$     | Good enough |
| $x < 0.77$ or $x > 1.33$ | $T > 2.00$    | $b > 2$ or $b < -2$     | Not good    |

response theory. Item quality is determined by the fit of the item with the Rasch model and the threshold. Item quality criteria, as presented according to the item response theory approach by Setyawarno (2017), are listed in Table 6.

Based on the analysis of the quality of 20 items related to creative thinking ability, one question falls into the poor category. The number of items was reduced to 10, representing each indicator of creative thinking ability, with consideration of a threshold value reflecting the difficulty of each item.

Based on the analysis of the quality of 16 oral communication questionnaire items, five items fall into the 'good enough' category. After determining the items' validity, their reliability is interpreted.

### Reliability Test

The test used is Cronbach's alpha, also known as the alpha coefficient. The alpha coefficient ranges from 0 (no reliability) to 1 (perfect reliability). The value of the correlation coefficient of reliability, as presented by Isma et al. (2023), is shown in Table 7.

**Table 7** Reliability correlation coefficient values

| Reliable Index       | Result Qualification |
|----------------------|----------------------|
| $R < 0.20$           | Very low             |
| $0.20 \leq R < 0.40$ | Low                  |
| $0.40 \leq R < 0.70$ | Medium               |
| $0.70 \leq R < 0.90$ | High                 |
| $0.90 \leq R < 1.00$ | Very high            |

The results of testing the reliability of the science literacy questions instrument and the questionnaire assessing students' oral communication skills are presented in Table 8.

**Table 8** Reliability analysis results of the creative thinking ability questionnaire and the oral communication questionnaire

| Test Instrument                    | Reliability of Estimated Value | Category |
|------------------------------------|--------------------------------|----------|
| Creative thinking skills questions | 0.82                           | High     |
| Oral communication questionnaire   | 0.71                           | High     |

Based on the test validity analysis results for the creative thinking ability variable, which included 20 items, one question falls into an unfavorable category. The number of items is reduced to 10, each representing an indicator of creative thinking ability, with the threshold value reflecting

the level of difficulty of the items. A reliability test is a method used to determine whether research questions are reliable. A reliability test was conducted using the QUEST program. The reliability of the estimated value for creative thinking ability questions is 0.82, which is categorized as high. The reliability of the estimated value for the self-assessment questionnaire of students' oral communication skills is 0.71, which falls within a high category. It can be concluded that the instrument for assessing creative thinking ability and the self-assessment questionnaire for oral communication ability are reliable and effective, making them suitable for use as research tools.

The data analysis methods employed include descriptive and inferential statistical analyses, including prerequisite tests, MANOVA tests, and effect size calculations. Data analysis of the implementation of teaching modules in learning can be observed from the scores recorded when observers complete the learning implementation observation sheet during learning activities. Descriptive statistics were used to assess improvements in students' creative thinking and communication skills, as measured by gain scores. Inferential statistical analysis was employed to evaluate the effectiveness of implementing Project-Based Learning with ethnoscience content developed in this study.

Before conducting the MANOVA test, the data were first converted to interval data, and then prerequisite tests were conducted. Prerequisite tests include the Shapiro-Wilk normality test and Levene's Test for homogeneity, both of which are performed in SPSS 26.0. The prerequisite test assumptions of normality and homogeneity hold if the asymptotic normality holds. Sig (2-tailed)  $\frac{1}{2} \alpha$  with the value of  $\alpha$  is 0.05. After the data are normally distributed, the MANOVA test is used to determine differences in improvement between the two paired samples. The effect size in this study was measured using Partial Eta Squared. Effect sizes reported as  $\eta^2$  or  $\omega^2$  in the behavioral sciences can be interpreted as follows: 0.01 indicates a small effect, 0.06 a medium effect, and 0.14 or higher a significant impact (Richardson, 2011).

### 3. RESULT AND DISCUSSION

The effect of the project-based science learning model with ethnoscience content on Legomoro traditional food was assessed in terms of improvements in students' creative thinking and communication skills. The data were obtained from learning outcomes in two classes: the experimental class, which used the Project Learning-based science



**Figure 2** Legomoro traditional food ingredients

learning model with ethnoscience content on Legomoro traditional food, and the control class, which used the direct instruction model. In the experimental class, students were divided into eight groups, and each group made traditional Legomoro food. The following are group activities to make traditional Legomoro food.

The basic ingredients for Legomoro are glutinous rice, chicken, and coconut milk (Figure 2). The basic ingredients were chosen because they are readily available to the learners. After each group made Legomoro traditional food, the next activity was to test the nutrient content of Legomoro food. The following is a group activity to test the nutrient content of Legomoro traditional food.

### 3.1 The Effect of the Project-Based Learning Model with Ethnoscience of Legomoro Traditional Food on Creative Thinking Ability

After learning was conducted in experimental and control classes using different models, the project-based learning model was found to have a significant effect on creative thinking skills. Project-based learning offers an engaging and hands-on learning experience. Kusadi et al. (2020) Noted that the Project-based learning model can direct students to solve problems directly through project work, which indirectly involves students being active and trained to think and act creatively.

Based on the analysis results, students' creative thinking skills in the experimental class increased, as indicated by higher average scores from the pre-test to the post-test. The average pre-test score in the experimental class was 48.79, while the post-test score increased to 74.44. This indicates that the Project-Based Learning-based science learning model, incorporating ethnoscience content related to Legomoro traditional food, can enhance students' creative thinking skills.

The next step is to conduct prerequisite tests, consisting of normality and homogeneity tests, before proceeding to the hypothesis testing stage. The univariate normality test assesses whether the data for each dependent variable are normally distributed. This test uses the Shapiro-Wilk test, paying attention to the Asymptotic Distribution. Sig. (2-tailed). If the value is

greater than the significance level of 0.05, then the data is considered normally distributed. The results of this normality test were obtained using SPSS version 26.0

**Table 9** Univariate normality test results

| Creative Thinking Ability |               | Communication Skills |               |
|---------------------------|---------------|----------------------|---------------|
| Experiment Class          | Control Class | Experiment Class     | Control Class |
| 0.11                      | 0.58          | 0.08                 | 0.23          |

software and are presented in Table 9.

Based on the results of the univariate normality test on the gain score of each variable in the table above, the Asymp. Sig. (2-tailed) For the creative thinking and communication ability variables, the p-values exceeded the 0.05 significance level. This indicates that both variables are normally distributed.

After conducting a normality test, the prerequisite test is the homogeneity-of-variance test. The variance homogeneity test determines whether the dependent

**Table 11** Univariate normality test results

| Variables                 | Sig. Value. |
|---------------------------|-------------|
| Creative Thinking Ability | 0.49        |
| Communication Skills      | 0.19        |

variable has constant variance. This test uses the Levene test, focusing on the p-value (also referred to as Sig.). If the Sig. The value is greater than the 0.05 significance level, indicating that the variances across the dependent variables are homogeneous. The test results are shown in Table 10.

Based on the results of the variance homogeneity test on the gain score of each variable in Table 10, the significance value (Sig.) is greater than 0.05 for all variables. This indicates that the data on each variable has homogeneous or equal variance.

After the prerequisite test is fulfilled, the next step is to conduct a MANOVA test to test the research hypothesis (Table 11). The MANOVA test aims to determine whether the Project-Based Learning model, incorporating ethnoscience content, has a significant effect on improving creative thinking and communication skills compared to the direct instruction learning approach. This test was

**Table 10** Results of the MANOVA test

| Effect             | Value | F        | Hypothesis df | Error df | Sig.  | Partial Eta Square |
|--------------------|-------|----------|---------------|----------|-------|--------------------|
| Pillai's Trace     | 0.871 | 198.785b | 2.000         | 59.000   | 0.000 | 0.871              |
| Wilk's Lambda      | 0.129 | 198.785b | 2.000         | 59.000   | 0.000 | 0.871              |
| Hotelling's Trace  | 6.738 | 198.785b | 2.000         | 59.000   | 0.000 | 0.871              |
| Roy's Largest Root | 6.738 | 198.785b | 2.000         | 59.000   | 0.000 | 0.871              |

**Table 12** Test of Between – Subject’s Effects Result

| Source    | Dependent Variable | Type III Sum of Squares | df | Mean Square | F       | Sig.  |
|-----------|--------------------|-------------------------|----|-------------|---------|-------|
| Intercept | Creative Thinking  | 10.950                  | 1  | 10.950      | 351.414 | 0.000 |
|           | Communication      | 3.867                   | 1  | 3.867       | 135.983 | 0.000 |

conducted using SPSS with  $\alpha = 0.05$ . The MANOVA test conditions are as follows: if Sig < 0.05, then H0 is rejected, or H1 is accepted.

Based on the four analyses, it is clear that the independent variables have a strong influence on the dependent variable. All studies show a p-value of 0.000, which is smaller than the significance threshold of 0.05. This indicates a significant difference in students' creative thinking and communication skills through learning with the Project-Based Learning model, incorporating ethnoscience content on traditional Legomoro food and its nutritional content. Based on the Partial Eta Square value of 0.871 at the intercept, which is close to 1, indicating a significant effect, the Project-Based Learning model with Legomoro ethnoscience content has a substantial impact on students' creative thinking and communication skills. The MANOVA test also provides results in the form of a test of a between-subjects effect, which aims to show that the project-based science learning model developed can improve the two dependent variables measured. The results of the between-subjects test are presented in Table 12.

Based on the results of the between-subjects effect test above, it can be seen that the Sig. The gain score for creative thinking and communication skills, as obtained from the intercept statistics, was 0.000. The significance level is set at 0.05. The results obtained are smaller than the Sig. 0.05, then H1 in this study is accepted, which means that there is a significant effect on the creative thinking and communication skills of groups of students who take part in learning using the Project-based learning model with ethnoscience content on nutrient content material compared to groups of students who do not take part in learning using the model.

The Test of Between-Subjects Effects also produced a Partial Eta Square value to observe its effect. The size of

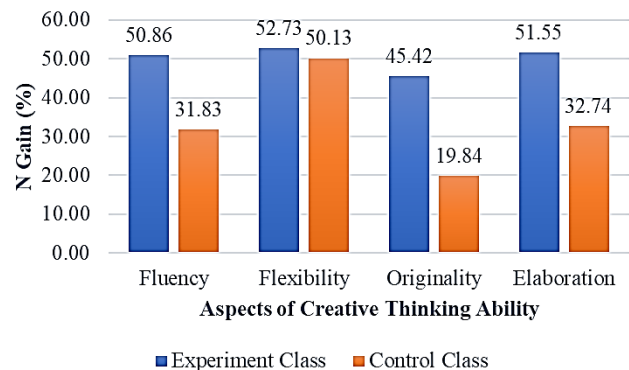
**Table 14** Partial eta square value results on the test of between-subject effects

| Source    | Dependent Variable | Partial Eta Square | Category     |
|-----------|--------------------|--------------------|--------------|
| Intercept | Creative Thinking  | 0.854              | Large Effect |
|           | Communication      | 0.694              | Large Effect |

the influence on each dependent variable is also evident from the Partial Eta Square value in the intercept statistics from the Test of Between-Subjects' Effects results. The Partial Eta Square results from the Test of Between-Subjects' Effect results are presented in Table 13.

Based on Table 13, the Partial Eta Square indicates that creative thinking and communication skills fall into the large effect category. This classification is based on Richardson (2011). Effect sizes, represented by  $\eta^2$  or  $\omega^2$  in behavioral sciences, can be interpreted as follows: a value of 0.01 indicates a small effect, 0.06 denotes a medium effect, and 0.14 or above signifies a significant impact.

Based on the gain score calculation for students' creative thinking skills, it is evident that the increase in the experimental class is greater than that in the control class. The experimental class achieved a gain score of 0.51, and the control class achieved a score of 0.33, both falling within the medium category (Table 14). However, the experimental class's gain score showed greater improvement. The average gain score for each aspect of students' creative thinking skills is shown in Figure 3.



**Figure 3** Assessment results for each aspect of creative thinking ability

**Table 13** Results of the creative thinking skills of the experimental and control classes

| Indicator        | Experiment    |            | Control       |            |
|------------------|---------------|------------|---------------|------------|
|                  | Pre Score     | Post Score | Pre Score     | Post Score |
| Fluency          | 57.80         | 79.84      | 52.15         | 70.16      |
| Flexibility      | 51.61         | 76.61      | 37.50         | 68.95      |
| Originality      | 37.10         | 65.73      | 47.58         | 59.27      |
| Elaboration      | 45.70         | 73.66      | 44.58         | 62.10      |
| <b>Sum</b>       | 1512.50       | 2307.50    | 1460.00       | 2030.00    |
| <b>Min Score</b> | 35.00         | 57.50      | 15.00         | 45.00      |
| <b>Max Score</b> | 62.50         | 92.50      | 70.00         | 80.00      |
| <b>Average</b>   | 48.79         | 74.44      | 47.10         | 65.48      |
| <b>SD</b>        | 7.54          | 10.44      | 12.20         | 9.70       |
| <b>N-Gain</b>    | <b>0.51</b>   |            | <b>0.33</b>   |            |
| <b>Category</b>  | <b>Medium</b> |            | <b>Medium</b> |            |

Based on the graph above, the experimental class outperforms the control class across all aspects of creative thinking, particularly fluency, flexibility, originality, and elaboration. In the element of fluent thinking, the experimental class scored 51.49, higher than the control class's 31.83. The experimental class demonstrated superior flexible thinking ability, scoring 52.73 compared to 50.13 in the control class, although the difference was not substantial. The most significant difference was observed in the ability to think creatively, with the experimental class scoring 45.42, significantly higher than the control class, which scored 19.84. Meanwhile, in terms of detailing ability, the experimental class scored 51.55, higher than the control class, which scored 30.78.

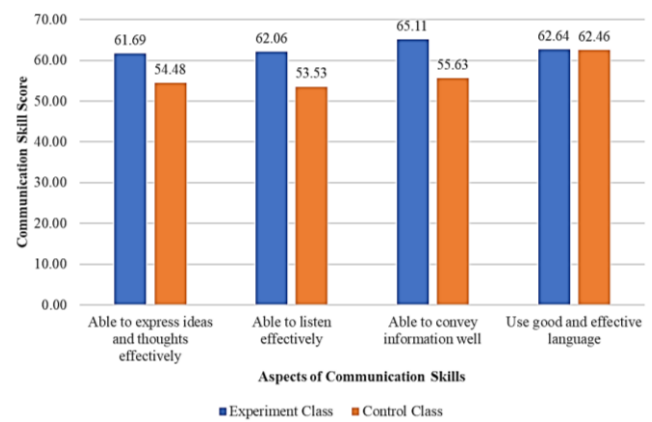
Based on the research, ethnoscience-based project-based learning tools have been found to effectively improve students' creative thinking skills compared to those in groups that do not use these tools. This is because the Project-based learning model is a learning approach with a scientific foundation, designed to provide active, creative learning experiences. In this approach, students are directly involved in designing and creating products, formulating problems, and ultimately producing tangible outcomes. The results of the research show that the n-gain value in the experimental class falls in the medium range, indicating that the application of Project-based learning tools for science learning with ethnoscience content is effective. According to research by Azizah and Wulandari (2024), students' creative thinking ability increases in the medium category when the Project-based learning model grounded in local wisdom is applied.

### 3.2 The Effect of the Project-Based Learning Model with Ethnoscience of Legomoro Traditional Food on Communication Skills

Based on the analysis results, the experimental class's communication skills are higher, specifically with moderate criteria, compared to the control class, which has lower criteria. The results of the observation sheet on communication skills yielded an average of 70.77 for the experimental class and 63.22 for the control class. Based on the average values of the two classes, the experimental class, which used the Project-based learning model with ethnoscience content, showed a larger increase than the control class, which did not use the learning model. This indicates that applying the Project-based learning model with ethnoscience content improves students' communication skills regarding nutritional content in food.

Based on the gain scores for aspects of the student's communication skills, it is evident that each aspect increased more in the experimental class than in the control class. The gain score value in the experimental class was 0.35 with a medium category, while the gain score value in the control class was 0.15 with a low category.

Based on Figure 4, the comparison of communication skills between the experimental and control classes can be



**Figure 4** Assessment results of each aspect of communication skills

**Table 15** Results of communication skill of experimental and control classes

| Indicator                                      | Experiment    |            | Control     |            |
|--|---------------|------------|-------------|------------|
|  | Pre Score     | Post Score | Pre Score   | Post Score |
| Able to express ideas and thoughts effectively | 56.35         | 77.42      | 46.09       | 53.20      |
| Able to listen effectively                     | 53.20         | 59.61      | 56.02       | 59.61      |
| Able to convey information well                | 53.28         | 68.65      | 52.60       | 62.54      |
| Use good and effective language                | 60.24         | 77.42      | 60.24       | 67.52      |
| <b>Sum</b>                                     | 1728.80       | 2194.02    | 1733.88     | 1959.19    |
| <b>Min Score</b>                               | 25.00         | 44.59      | 38.86       | 48.46      |
| <b>Max Score</b>                               | 76.97         | 86.42      | 72.74       | 80.79      |
| <b>Average</b>                                 | 55.77         | 70.77      | 55.93       | 63.22      |
| <b>SD</b>                                      | 11.19         | 11.35      | 9.18        | 10.96      |
| <b>N-Gain</b>                                  | <b>0.35</b>   |            | <b>0.15</b> |            |
| <b>Category</b>                                | <b>Medium</b> |            | <b>Low</b>  |            |

seen from four main aspects (Table 15). In terms of the ability to express ideas and thoughts effectively, the experimental class achieved a higher score of 61.69 compared to the control class, which scored 54.48. The second aspect is the ability to listen effectively; the experimental class received a higher score (62.06) than the control class (53.53). The third aspect is the ability to convey information effectively; the experimental class shows a higher value than the control class, at 65.11, while the control class has a value of 55.63. The fourth aspect is the ability to use good and effective language; the experimental class scored 62.64, slightly higher than the control class, which scored 62.46.

Based on Table 16, the results of the self-assessment questionnaire on students' oral communication skills are compared between the experimental and control classes. In the experimental class, there was a significant increase in self-assessment of oral communication skills from the initial questionnaire to the final questionnaire. The initial

**Table 16** Average assessment results of the oral communication self-assessment questionnaire

| Indicator | Experiment |            | Control   |            |
|-----------|------------|------------|-----------|------------|
|           | Pre Score  | Post Score | Pre Score | Post Score |
| Sum       | 1949.22    | 2221.29    | 1835.71   | 1993.61    |
| Min Score | 52.38      | 53.02      | 43.86     | 56.20      |
| Max Score | 69.74      | 96.46      | 80.99     | 72.00      |
| Average   | 62.88      | 71.65      | 59.22     | 64.31      |
| SD        | 4.72       | 11.11      | 6.78      | 3.68       |
| N-Gain    | 0.22       |            | 0.09      |            |
| Category  | Low        |            | Low       |            |

questionnaire results for the experimental class showed an average score of 62.88, while the final questionnaire score increased to 71.65. In the control class, students' self-assessment scores on oral communication skills were lower than in the experimental class. The initial questionnaire results showed an average value of 59.22, while the final questionnaire results were 64.31.

Based on the research conducted, the ethnoscience-based project-based learning tools developed can improve students' communication skills compared to those in groups that do not use these science learning tools. According to Andriani et al. (2023) The Project-based learning model can improve communication skills because, in the process, students are trained to ask questions and express opinions when presenting projects they have worked on. The results of the research carried out show that the n gain value in the experimental class indicates that the application of Project-based science learning tools with ethnoscience content falls into the low category. This finding aligns with research conducted by Khoiri and Putri (2020), which indicates that the Project-based learning model has a positive impact on students' communication skills.

### 3.3 The Effect of the Project-Based Learning Model with Ethnoscience of Legomoro Traditional Food on Creative Thinking and Communication Skills

The project-based science learning model helps improve students' creative thinking skills by encouraging them to explore ideas, solve problems, and connect science concepts with local culture, such as analyzing the nutrient content of traditional Legomoro food. Tama et al. (2019) Explained that creative thinking skills can be developed by familiarizing learners with effective learning patterns in class, such as conveying ideas, asking questions, and offering new ideas in problem-solving.

The Project-Based Learning approach, combined with ethnoscience content and Ethno-STEM learning, shares similarities in integrating local culture into science learning to contextualize material and strengthen 21<sup>st</sup>-century skills. The Project-Based Learning model is recognized for its advantages in enhancing students' problem-solving skills

and motivating them to generate ideas actively and effectively. (Nugraha et al., 2023). In the context of ethnoscience, Project-Based Learning emphasizes involving students in project-based experiences rooted in the local potential around them, such as the exploration of traditional Legomoro food, which is used as a learning medium in this study.

Meanwhile, the Ethno-STEM approach, as demonstrated by the research of Karim et al. (2022) It places greater emphasis on explicitly integrating cultural elements into the four main STEM disciplines (Science, Technology, Engineering, and Mathematics). Ethnoscience-based Project-Based Learning emphasizes the investigation and creation of projects grounded in real-life experiences relevant to students' daily lives. In contrast, Ethno-STEM excels at building a structured, multidisciplinary conceptual understanding by explicitly integrating local culture and STEM components.

The project-based Learning science learning model, incorporating ethnoscience content related to Legomoro traditional food, can also support students' communication skills. This learning model encourages learners to discuss, collaborate, and present projects. According to Dewi (2023) Learners' communication skills can be trained through learner-centered learning activities, thus encouraging active involvement and effective interaction. Group discussions, presentations, and reflections help learners to practice speaking, listening, and expressing their opinions clearly.

Creative thinking and communication skills are essential for equipping students to meet the challenges of the 21<sup>st</sup> century. Septikasari and Frandy (2018) Explain that 21<sup>st</sup>-century skills are the abilities needed by the younger generation to compete in the global era. The importance of creative thinking skills and communication skills is highly relevant to the Merdeka curriculum implemented in Indonesian education. Creative thinking skills encourage learners to generate new ideas through their thinking process. (Aulia, 2023). Meanwhile, communication skills enable the expression of ideas, thoughts, and feelings. (Marzuqi, 2019). Therefore, the education and learning process is critical in ensuring that students possess 21<sup>st</sup>-century skills, especially learning and innovation skills. (Umam & Jiddiyah, 2020).

Although the results showed a significant improvement in students' communication skills after applying the ethnoscience-based Project-Based Learning (PjBL) model, the N-Gain in communication skills obtained was still in the low category compared to the improvement in creative thinking skills. First, communication skills require time and continuous practice, so the three meetings in this study may not have been sufficient to foster significant practical changes. Second, in its implementation, the focus of learning is stronger on project completion and testing the nutritional content of traditional foods, rather than

providing space for intensive exploration of communication between students. Third, local cultural factors and learning habits that remain dominated by passive approaches may also affect students' willingness to express opinions and discuss openly during the learning process.

This research aligns with Wanggi et al. (2023), which states that applying the Project-Based Learning model, integrated with ethnoscience, affects students' creative thinking skills. In addition, Sulistyowati et al. (2020) Stated in their research that the ethnoscience-based Project-Based Learning model had a significant influence on students' learning activities. Emda (2023) Noted that the ethnoscience approach not only enables learners to imitate and accept the information conveyed but also encourages them to build meaning and understanding and develop the knowledge gained. Fadilah et al. (2025) Explained that integrating ethnoscience into project-based learning is not only to improve students' learning outcomes but also to introduce local cultural values as part of strengthening cultural literacy.

Andriani et al. (2023) Explained that the application of the Project-Based Learning model provides a meaningful learning experience for students, as the activity is entirely centered on them. Additionally, the Project-Based Learning model can create a new learning atmosphere in the classroom, encouraging students to become more active. This suggests that the Project-Based Learning model can facilitate students' creative thinking and communication skills, as it is student-centered and provides opportunities for students to play a more active role in learning. The results of this study indicate that the project-based learning model, incorporating ethnoscience content on Legomoro traditional food, can facilitate students' improvement in creative thinking and communication skills.

Although the ethnoscience-based PjBL model in this study was developed to address local educational needs in Indonesia, similar approaches are also part of a global trend. In South Africa, for example, the integration of Indigenous Knowledge into Technology Education, as outlined in the Indigenous Knowledge Systems policy, exemplifies holistic, culture-based, and inclusive learning. Seleke et al. (2025) emphasize that this effort is not merely an academic reform but a cultural transformation that strengthens the connection between education, identity, and cultural heritage. This demonstrates that the PjBL-ethnoscience approach in Indonesia is not only locally relevant but also aligns with the global direction of education toward greater inclusivity and sustainability.

#### 4. CONCLUSION

Based on the analysis and discussion results, there are significant differences in the creative thinking and communication skills of students who use science learning

tools based on Project-based learning with ethnoscience content compared to those who do not. These results are also supported by the findings of Partial Eta Square statistics, which show that the developed ethnoscience-based project-based learning science learning tools have a significant effect on the variables of creative thinking ability and communication ability. The use of a project-based Learning model with ethnoscience content on Legomoro traditional food in science learning materials, focusing on the nutrient content in food, is efficacious in improving students' creative thinking and communication skills.

The results of this study serve as input for teachers and prospective teachers to make self-improvements in the learning process, including the use of appropriate learning models to enhance students' creative thinking and communication skills. The results of this study serve as input for teachers and prospective teachers to make self-improvements in the learning process, including the use of appropriate learning models to enhance students' creative thinking and communication skills. Communication skills are closely linked to learners' creative thinking skills, as they often involve group discussions when working on a project. Through communication, learners can exchange ideas, convey them effectively, and develop problem-solving solutions together. Learning that focuses on learners' creative thinking problems has a positive impact on communication skills.

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