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Application of Project-Based Worksheets in the Production of Dried Noodles with the Addition of Natural Dyes to Develop Creative Thinking Skills

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Abstract
Project-based worksheets are used to develop students' creative thinking skills, especially in the context of chemical additives using natural ingredients. Creative thinking is crucial for students as it enhances problem-solving abilities and the capacity to produce works or products. This study aims to describe student activities and analyze their creative thinking skills in applying project-based worksheets to the production of dried noodles with the addition of natural dyes. The research method employed is pre-experimental, utilizing a one-shot case study design. The participants in this study were 15 students from Grades 10th and 11th who were actively involved in the Youth Scientific Club (KIR) extracurricular activities. The instruments used included observation sheets, learning descriptions, project-based worksheets, and assessment sheets (performance, product, packaging, poster, and presentation). The results of this study indicate that the implementation of project-based worksheets was executed very well, with an average percentage of 88.88%. Students' creative thinking skills at each stage were rated as highly creative, with an average score of 95.27, placing them at level 4. Based on the research findings, the implementation of project-based worksheets demonstrated students' creative thinking skills at a very good level.

Keywords:
Project-based worksheets, creative thinking skills, dried noodles, natural dyes

INTRODUCTION

Chemistry has abstract concepts, which is one of the main reasons students find it difficult to understand the subject matter (Agustin et al., 2018). Difficulty in understanding chemistry material is caused by its theoretical nature and the lack of practical work involved (Rohayah, 2023). Practical work plays an important role in clarifying chemical concepts (Tukan et al., 2020). Based on a preliminary study at SMA Negeri 16 Bandung, it was found that practical activities in the Youth Scientific Club (KIR) extracurricular program were not supported by adequate teaching materials. In fact, the use of worksheets is considered effective in practical learning (Rahmatullah & Fadilah, 2017).

The application of project-based worksheets in practical work is highly appropriate because it provides students with the opportunity to design their own experiments and produce a product, thereby developing their creative thinking skills (Wardani et al., 2021). In the context of chemistry learning, the topic of food additives is relevant to daily life because it is directly related to food products, such as the production of dried noodles (Emilia et al., 2020). Dried noodle products commonly sold in the market generally use synthetic dyes such as tartrazine CI No. 19140, which is known to pose risks to human health (Faridah et al., 2019). In addition to dyes, dried noodles also contain sodium salt, which functions as a flavor enhancer (Wicaksono et al., 2022). High sodium salt content can increase the potential for health problems. Therefore, innovation is needed in the development of dried noodles through the use of safer natural dyes derived from vegetables, as well as the use of natural flavor enhancers made from mackerel fish protein (Ntau et al., 2022).

Project-based learning has been proven effective in improving students' creative thinking skills. Apipah et al. (2019) stated that project-based learning was carried out well at

every phase and resulted in a significant improvement in students' creative thinking skills. In line with this, Noviyana (2017) concluded that the use of project-based worksheets had a positive effect on the development of creative thinking skills.

Although various previous studies have discussed the use of project-based worksheets in developing creative thinking skills, their application is still limited to certain materials and food products. The application of project-based worksheets in the production of dried noodles with the addition of natural dyes is still rarely found. In addition, most studies utilizing natural ingredients as additives in dried noodles have focused only on product quality, rather than on the development of students' creative thinking skills in chemistry learning.

Based on the above, there is a research gap in the form of a lack of connection between project-based learning, the production of dried noodles with natural dyes, and the development of students' creative thinking skills. Therefore, this study aims to analyze students' creative thinking skills in the application of project-based worksheets through the activity of producing dried noodles with the addition of natural dyes within the context of chemistry learning.

METHOD

This study used a pre-experimental method with a one-shot case study design, which involves administering treatment only once, followed by an observation process (Arikunto, 2007). The research subjects consisted of 15 students from Grades 10 and 11 who participated in the Youth Scientific Club (KIR) extracurricular activities.

The research instruments used were a learning description, a student activity observation sheet, project-based worksheets, and an assessment rubric covering the assessment of the worksheet, performance, product, packaging, poster, and presentation. The research instruments were first validated by two Chemistry Education lecturers from UIN Sunan Gunung Djati Bandung and one KIR supervising teacher from SMA Negeri 16 Bandung. The validation results showed an average calculated r-value of 0.93, exceeding the critical r-value of 0.3, so the instrument was declared valid and suitable for use in the study (Sugiyono & Wibowo, 2004). After validation, the instrument was administered to the students. The worksheet contained several questions aligned with the indicators of creative thinking skills.

Data processing was carried out using an observation sheet aimed at describing student activities during the implementation of the project-based worksheets. The collected data were then converted into percentages based on a score range of 1 to 4.

Data analysis was carried out by assessing the project-based worksheets, converting the scores from the worksheet answers into grades. The worksheet was developed as an instrument to measure students' creative thinking skills, containing learning stages aligned with the project-based learning model and the indicators of creative thinking skills. In addition, assessments of performance, product, packaging, poster, and presentation were conducted during the project work process. The scores obtained from each instrument were converted into grades and used as supporting data to provide a more comprehensive picture of students' creative thinking skills. The formula used to determine the percentage score of creative thinking is as follows.

$$(\%)\ \text{score} = (\text{Total score obtained} / \text{Total maximum score}) \times 100\%$$

In the final stage of the analysis, the scores from the worksheet, performance, product, packaging, poster, and presentation assessments were averaged to determine the category of students' creative thinking skills. The categories are presented in Table 1 below.

Table 1. Level Criteria and Predicate of Creative Thinking Ability Based on Score

Score	Category
90–100	Level 4 (Highly creative)
80–89	Level 3 (Creative)
65–79	Level 2 (Moderately creative)

55–64	Level 1 (Less creative)
<55	Level 0 (Not creative)

Source: Arfiyani (2018)

RESULTS AND DISCUSSION

The following is an explanation of the research results obtained from the application of project-based worksheets in the production of dried noodles with the addition of natural dyes to develop creative thinking skills.

Description of Student Activities in the Implementation of Project-Based Worksheets in the Production of Dried Noodles with Natural Dye Addition

Student activity during the implementation of the worksheets was assessed based on the prepared observation sheet, in order to obtain a picture of student activity in the implementation of the project-based worksheets. The implementation of the project-based worksheets was carried out in two face-to-face meetings. The first meeting consisted of five project stages: analyzing the problem, designing the project, conducting research on the production of dried noodles with the addition of natural dyes, developing a draft/prototype of the product by testing the dried noodles with natural dyes that had been produced, and assessing and comparing the product by evaluating the resulting noodle product and comparing it with commercial noodles. The second meeting consisted of one project stage: evaluation and publication of the product in the form of a product presentation and a poster report. The recapitulation of student activities across all stages can be seen in Table 2.

Table 2. Student Activities and Their Categories

Group	Stage 1 (%)	Stage 2 (%)	Stage 3 (%)	Stage 4 (%)	Stage 5 (%)	Stage 6 (%)	Average	Category
1	85.41	66.66	95.83	87.5	86.11	100	86.9	Very good
2	89.5	85.41	91.67	79.16	86.11	100	88.64	Very good
3	87.5	97.91	95.83	79.16	86.11	100	91.1	Very good
Average	87.5	83.33	94.44	81.94	86.11	100	88.88	Very good

Notes: 1. Analyzing the problem; 2. Designing the project; 3. Conducting the experiment; 4. Developing a draft/prototype of the product; 5. Assessing and comparing the product; 6. Finalization and publication of the product.

The average percentage of student activity was 88.88%, categorized as very good. This indicates that student activity in project-based learning was carried out almost perfectly. This is in line with the findings of Sari et al. (2019), who stated that the project-based learning model emphasizes learning through student activities by applying research, analysis, creation, and presentation skills. In addition, these findings are supported by Addiin et al. (2014), who explained that the project-based learning model encourages student activity through product creation as a solution to a problem.

The highest percentage of student activity implementation occurred at the finalization and publication of the product stage, reaching 100%, categorized as very good. This was because each group was enthusiastic about presenting their project results, and other groups were equally enthusiastic in providing feedback. This is in line with the study by Sumarni (2015), which found that project-based learning can increase student engagement and confidence in communication. In addition, project-based learning provides opportunities for students to engage in closure, question-and-answer sessions, and reflection (Grant, 2002). Meanwhile, the lowest percentage of student activity implementation was found at the stage of developing a draft/prototype of the product, with a value of 81.94%, still categorized as very good. Although all groups were able to answer correctly, some provided incomplete answers and did not include citations from relevant journal or book references. This is in line with Darmawan (2021), who found that project-based learning encourages students to learn to collaborate in solving problems and to share ideas to reach satisfactory answers.

Analysis of the Development Level of Creative Thinking Ability Based on Project-Based Worksheets

The analysis of students' creative thinking skills was based on the indicators of creative thinking according to Munandar (2009), namely fluency, flexibility, originality, elaboration, and evaluation. The data on the stages of the project-based worksheet aligned with the indicators of creative thinking skills can be seen in Table 3.

Table 3. Data on the Stages of the Project-Based Worksheet

No.	Stage of the Project-Based Worksheet	Creative Thinking Indicator	Average	Level	Category
1.	Analyzing the problem	Fluency	92.53	4	Highly creative
2.	Designing the project	Flexibility	87.6	3	Creative
3.	Conducting the experiment	Originality	100	4	Highly creative
4.	Developing a draft/prototype of the product	Elaboration	92.53	4	Highly creative
5.	Assessing and comparing the product	Elaboration	100	4	Highly creative
6.	Finalization and publication of the product	Evaluation	100	4	Highly creative
	Total		95.27	4	Highly creative

Based on Table 3, the average score of students' creative thinking skills was categorized as highly creative, as shown by an overall average of 95.27, which falls within level 4. The highest average score for the creative thinking indicators on the worksheet was found at the experiment stage, with the originality indicator, and at the finalization and publication of the product stage, with the evaluation indicator, both with an average score of 100, categorized as highly creative. These results are consistent with the study by Hafiza et al. (2022), which showed that the originality indicator had the highest score because students were able to provide various answers based on their own thinking. In addition, regarding the evaluation indicator, according to Erlinawati et al. (2019), this is due to students' ability to consider and evaluate the various problems given to them.

The lowest average score for the creative thinking indicators on the worksheet was found at the project design stage, with the flexibility indicator, with an average of 87.6, categorized as creative. This lower ability was due to students' limited capacity to consider a problem from various points of view. This is in line with Shively (2011), who stated that limited perspectives can hinder understanding. Another factor that may have contributed to this is that students were previously accustomed to conventional learning, so some students still had difficulty organizing work steps. This finding is consistent with the study by Rizqi and Noor (2025), which found that one-way conventional learning tends to provide less room for the development of creative thinking skills.

In addition to the scores obtained from the project-based worksheets on dried noodle production, assessment scores were also obtained from performance, product, packaging, presentation, and poster assessments. However, these scores were only used as supporting data for the research on the application of project-based worksheets to measure students' creative thinking skills. The following describes the performance, product, packaging, presentation, and poster assessments.

For the performance assessment of dried noodle production with the addition of natural dyes, most students in this study were able to demonstrate creative thinking skills, obtaining an average score of 93.4, which falls within level 4, categorized as highly creative. This is in line with Nani (2016), who stated that student creativity can be seen when they are able to create new activities through a creative thinking process and manifest them in the form of a work. In the performance assessment, students were able to carry out the practical work in

accordance with the procedures that had been previously designed, thereby proving the process and results of their experiments for themselves.

For the product assessment of dried noodle production with the addition of natural dyes, most students in this study were able to demonstrate creative thinking skills, obtaining an average score of 87.3, which falls within level 3, categorized as creative. This is in line with the study by Arini (2008), which stated that product assessment is the process of evaluating a work based on certain criteria. Through this assessment, the extent of the development of students' creative thinking skills through project creation can be determined. In the product assessment, students were able to evaluate the product they had made, thereby identifying its strengths and weaknesses through result testing.

For the packaging assessment of dried noodle production with the addition of natural dyes, most students in this study were able to demonstrate creative thinking skills, obtaining an average score of 88.8, which falls within level 3, categorized as creative. In this assessment, students were able to package the product they had made as attractively as possible. Students' ability to package the product was assessed based on how good the packaging aesthetics were. According to Karma et al. (2021), packaging aesthetics are defined as the aspect of beauty in a product, including an attractive brand name, brand logo design, and packaging appearance.

For the presentation assessment of dried noodle production with the addition of natural dyes, most students in this study were able to demonstrate creative thinking skills, obtaining an average score of 91.1, which falls within level 4, categorized as highly creative. This is in line with the study by Fahmi and Wuryandini (2020), which found that the ability to express ideas in discussions and answer questions can develop students' creative thinking skills. In this assessment, students presented the product they had made. After the presentation, a question-and-answer discussion session was held. Other groups were given the opportunity to provide feedback and ask questions related to the discussion results of each group. Discussion allowed students to be more active in explaining their products and in giving and responding to questions. This is in line with the study by Refiyanti et al. (2021), which found that active engagement can stimulate students' creative thinking and direct them toward clear learning objectives. Thus, students who are actively involved in the learning process generally show better creative thinking skills compared to those who are passive.

For the poster assessment of dried noodle production with the addition of natural dyes, most students in this study were able to demonstrate creative thinking skills, obtaining an average score of 85.7, which falls within level 3, categorized as creative. This is in line with the study by Nury et al. (2019), which found that the use of posters in the project-based learning model can fulfill students' creativity criteria. In this assessment, students created a poster containing a report of their experimental results, aimed at assessing the extent of students' creative abilities. This is further supported by Sari et al. (2015), who explained that involving students in projects that produce works such as reports, products, and task completion can build students' creative thinking skills.

The level of students' creative thinking skills was obtained based on the results of the project-based worksheet, as well as the performance, product, packaging, presentation, and poster assessments. The achievement of students' creative thinking skill levels can be seen in Table 4.

Table 4. Overall Level of Students' Creative Thinking Ability

Group	Worksheet Assessment	Performance Assessment	Product Assessment	Packaging Assessment	Presentation Assessment	Poster Assessment	Average	Level
1	93.18	86.27	76.19	88.8	93.3	80.95	86.44	3
2	98.13	100	90.47	88.8	90	85.71	92.18	4
3	96.26	94.11	95.23	88.8	90	90.47	92.47	4

Based on Table 4, it can be seen that students' creative thinking skills were at level 4, indicating a highly creative level of thinking ability. The average level for all groups can be seen in Figure 1.

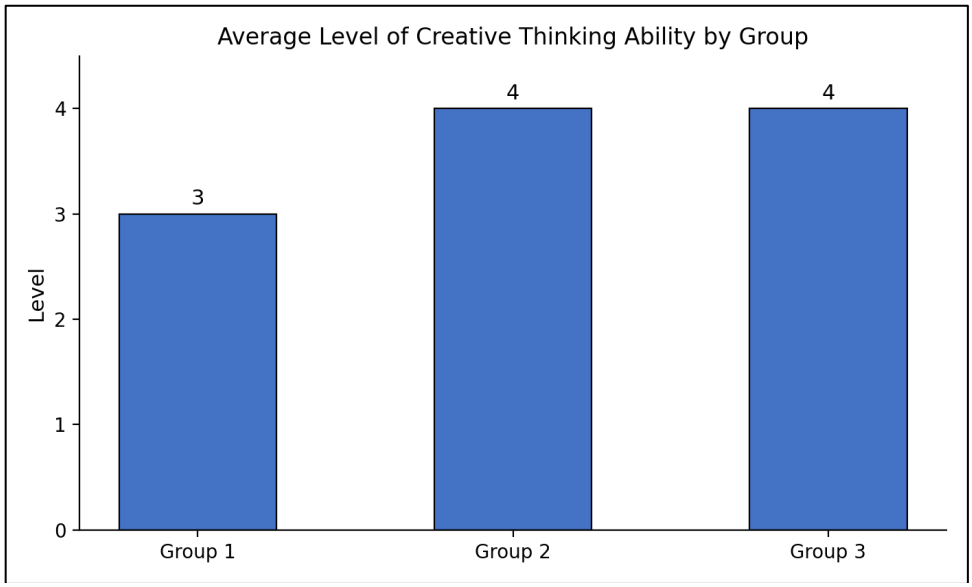

Figure 1. Average Level of Creative Thinking Ability Across All Groups

Limitation and Future Work

Nevertheless, this study has several limitations. The research was only conducted on an extracurricular activity at a single school, so the results cannot yet be broadly generalized. In addition, this study did not compare the effectiveness of project-based worksheets with other learning models or media. Therefore, future research is recommended to involve a larger sample size with more diverse student characteristics, as well as to apply a research design that includes a control group or a comparison with other learning models.

CONCLUSION

Based on the research results, the implementation of project-based worksheets in the production of dried noodles with natural dyes was carried out very well, as shown by an average student activity score of 88.88% across all project stages. In addition, students' creative thinking skills also developed optimally, as shown by an average score of 95.27, which falls within level 4 (highly creative), covering the aspects of fluency, flexibility, originality, elaboration, and evaluation. Additional assessments through performance, product, packaging, poster, and presentation evaluations further supported these findings, so it can be concluded that the implementation of project-based worksheets was effective in developing students' creative thinking skills across every indicator assessed.

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