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STEM-Local wisdom of the Sundanese Community: Efforts to improve students' verbal creativity

Virgynia Salma Azahra, Setiono*, Billyardi Ramdhan
Biology of Education Study Program, Faculty of Teacher Training and Education, Muhammadiyah University of Sukabumi
Jl. R Syamsudin SH. No 50, Kecamatan Cikole, Kota Sukabumi, Jawa Barat, Indonesia
*Corresponsding author: setionoase@gmail.com

ABSTRACT

This study aims to determine the effect of STEM–Local Wisdom learning of the Sundanese community on the verbal creativity of high school students in the concept of biodiversity. The research employed a quantitative approach with a quasi-experimental design involving 71 tenth-grade students at a high school in Sukabumi. The experimental class implemented STEM–Local Wisdom learning, while the control class used the discovery learning model. Data were collected through a verbal creativity test, a student response questionnaire, and product assessments. Test data were analyzed using the T-test and N-Gain, while questionnaire data were analyzed using the Likert scale. The results showed a significant difference between the two classes (sig. 2-tailed = 0.000) and an N-Gain of 0.74 (high category) for the experimental class and 0.59 (medium category) for the control class, indicating that STEM–Local Wisdom learning significantly affects students' creativity. In addition, the average percentage of student response questionnaires across indicators was 91%, reflecting a high level of student engagement and satisfaction. These findings support the use of STEM–Local Wisdom learning as an effective alternative to foster students' creativity in biology learning, particularly on the topic of biodiversity contextualized with local wisdom

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INTRODUCTION

Creativity is one of the essential skills every individual must possess in today's world. It is a crucial competency to acquire (Sulaeman et al., 2024). Creativity not only helps individuals generate new ideas but also serves as a foundation for solving problems innovatively and adaptively amid rapidly changing conditions (Wati & Maemunah, 2021). In the context of education, creativity plays a vital role in equipping students to face future challenges, improving their quality of life, and advancing society and the nation (Ahmad & Mawarni, 2021; Silaen et al., 2024). Creative students tend to be more adaptable, think critically, and collaborate effectively in various learning situations (Cutikawati, 2024; Putri et al., 2025)

According to the Global Creativity Index (GCI) survey, Indonesia ranks 150th out of 160 countries (Florida & Mellander, 2023). This survey assesses a country's creativity index based on three indicators: technology, talent, and tolerance (Rusmana, 2020). The results indicate that education in Indonesia, particularly in creativity skills, is relatively low. This condition is further supported by other findings stating that the creativity of most students from elementary to secondary levels still needs improvement (Pradana & Walid, 2025; Yustira et al., 2025). This is marked by students' lack of courage to generate new and original ideas in learning (Utomo et al.,2024). One strategic solution to enhance students' verbal creativity is to implement STEM-based learning (Science, Technology, Engineering, and Mathematics). Science is the most dominant aspect in fostering students' verbal creativity through activities such as observation, problem formulation, hypothesis development, and experimentation. These processes encourage students to think divergently and generate new ideas scientifically. STEM emphasizes the integration of cross-disciplinary knowledge and the application of concepts in real-life contexts, thereby encouraging students to experiment, innovate, and solve problems independently (Silaen et al., 2024).

STEM (Science, Technology, Engineering, and Mathematics) is a learning model that integrates concepts and processes from each STEM discipline into a unified whole (Aswirna et al., 2022). STEM learning encourages students to actively participate in the exploration process and apply concepts in practical ways, making learning more meaningful and relevant to everyday life (Widiastuti & Budiyanto, 2022). Previous research on STEM has shown a positive impact on science learning, including improvements in critical thinking and problem-solving skills (Barokah et al., 2024), and creativity (Astuti et al., 2023; Ridha et al., 2022). STEM learning developed contextually and grounded in local resources has proven effective in enhancing 21st-century skills, including creativity (Setiono & Windyariani, 2023). One of the main characteristics of STEM learning is the presence of the Engineering Design Process (EDP). This systematic process engages students in identifying problems, designing solutions, building prototypes, testing, evaluating, and iteratively improving the design (Tipmontiane & Williams, 2021). The products generated through this EDP have great potential to foster creativity (Sulaeman et al., 2024).

The EDP process in STEM learning has great potential to foster students' creativity. By having the opportunity to develop ideas, explore alternative solutions, and conduct evaluations and revisions, students are encouraged to think creatively and innovatively (Aini et al., 2024). EDP-based learning can also sharpen students' ability to produce various new and original ideas (Widiastuti & Budiyanto, 2022). For the sustainability of the EDP process, one essential skill students must possess is creativity. Creativity plays a vital role in the EDP process; therefore, its presence significantly impacts product development (Setiono et al., 2023).

To maximize the learning model used in this study, the researcher employed the STEM–Local Wisdom learning model of the Sundanese community, namely the preservation of traditional Sundanese foods using local ingredients. The novelty of this study lies in integrating Sundanese local wisdom into the STEM learning model. STEM that integrates local wisdom can benefit students by enabling them to understand science better (Aswirna et al., 2022). In addition, integrating local wisdom offers opportunities to connect modern scientific knowledge with local culture (Handayani et al., 2022). This is supported by Yusni et al. (2023), who state that local wisdom topics that can be integrated include the use of traditional foods made from plants found in each student's local area.

The implementation of STEM–Local Wisdom learning from the Sundanese community has great potential for application in biology learning, particularly in biodiversity, specifically the diversity of local food in the Sukabumi area, which is often used to make various types of the region's signature dishes. Local wisdom in this study focuses on the diversity of traditional Sundanese foods made with local ingredients in Sukabumi. The use of local materials in the processing of regional traditional foods reflects the community's knowledge and cultural values passed down from generation to generation. Local wisdom also has substantial potential to support a region's wealth and identity (Trisnowati et al., 2023). Research by Ramdhan et al. (2015) also emphasizes that indigenous communities in West Java maintain a close relationship between food resources and local culture, which is passed down to sustain the environment and the community's social life. Another study conducted by Ridha et al. (2022) shows that STEM-based learning tools integrated with local wisdom meet the criteria for validity, practicality, and effectiveness as learning media. In addition, the use of these tools in the learning process positively impacts students' creativity. The innovation in this study lies in integrating Sundanese local wisdom into the STEM learning process to enhance students' creativity.

Therefore, this study aims to investigate the effect of STEM–Local Wisdom learning among the Sundanese community on students' verbal creativity regarding biodiversity. This study is also crucial because it integrates biology learning with traditional food-making activities using local ingredients, enabling students to understand biodiversity concepts in context while developing creativity and awareness of local culture.

METHOD

This study employed a quantitative, quasi-experimental design. The Quasi-Experimental method is a research method used to determine the effect of the independent variable, namely the implementation of STEM–Local Wisdom learning of the Sundanese community, on the dependent variable, which in this case is creativity. In this study, there were two groups: the experimental class, which implemented STEM–Local Wisdom learning, and the control class, which used the discovery learning model. Both classes took a pretest and a posttest. The research design is shown in Figure 1.

E :	O_1	X_1	O_2
C :	O_3	X_2	O_4

Figure 1. *Pola non-equivalent control group design*
Source : (Sugiyono, 2019).

The description indicates that E represents the experimental class and C represents the control class. In the experimental class, a creativity pretest (O1) was administered before the treatment, and a creativity posttest (O2) was conducted after the implementation of STEM–Local Wisdom learning (X1). Meanwhile, in the control class, a creativity pretest (O3) and a creativity posttest (O4) were administered, with discovery learning (X2) implemented as the treatment.

This study was conducted at SMA Negeri 4 Sukabumi City, involving tenth-grade students in the 2025 academic year. The sample was selected using purposive sampling based on the equivalence of average final semester examination scores. Two classes with relatively similar average scores were chosen as the research sample. Subsequently, one class was randomly assigned to the experimental group, and the other to the control group. The total research sample consisted of 71 tenth-grade students, divided into two groups: 35 students in the experimental class and 36 students in the control class.

The independent variable is a factor that can influence other aspects. The independent variable in this study was the implementation of STEM learning integrated with the local wisdom of the Sundanese community. The dependent variable is the outcome influenced by another factor. The dependent variable in this study was high school students' creativity.

In implementing STEM–Local Wisdom learning, the researcher used the STEM learning steps according to James Morgan 2013 : 1) *Identify Problem and Constraint, 2) Research, 3) Ideate, 4) Analyze Ideas, 5) Build, 6) Test and Refine, 7) Communicate and Reflect*. One of the most essential characteristics of the STEM learning model is the implementation of the Engineering Design Process (EDP) (Setiono et al., 2023). Meanwhile, the control class used the discovery learning model. The instruments used in this research were a verbal creativity test and a student response questionnaire on the implementation of STEM–Local Wisdom learning of the Sundanese community. The student response questionnaire consisted of three indicators: 1) Students' interest in the implementation of STEM-Local Wisdom learning, 2) Students' responses regarding creativity in the implementation of STEM-Local Wisdom learning, and 3) Students' interest in the implementation of STEM–Local Wisdom learning of the Sundanese community with the concept of biodiversity.

The data analysis in this study was conducted using Microsoft Excel and SPSS version 25. Pretest and posttest data were first entered and processed using Microsoft Excel to obtain mean scores and improvement scores. Subsequently, the data were analyzed using SPSS version 25 to conduct normality and homogeneity tests as prerequisite analyses. After the data met the required assumptions, a t-test was performed to determine differences in learning outcomes between the experimental and control groups. Furthermore, students' creativity improvement was analyzed using the N-Gain calculation to determine the level of improvement during the learning process. The N-Gain formula is as follows:

$$\text{N} - \text{Gain} = \frac{\text{Posttest} - \text{pretest}}{\text{Ideal Score} - \text{Posttest}}$$

Table 1. N-gain category creativity test

N-Gain Range	Criteria
$(\langle g \rangle) \geq 0{,}7$	High
$0{,}3 \leq g < 0{,}7$	Medium
$g < 0{,}3$	Low

Source : (Hake, 1998)

The analysis of non-test instruments in this study used questionnaires. This research employed a Likert scale for data analysis by assigning scores to each positive and negative question. The following describes how to calculate the scores from the student response questionnaire.

$$\%\ \text{Score} = \frac{\text{Total student score}}{\text{Maximum score}} \times 100\%$$

Table 2. Likert scale criteria

Percentage Score	Category
0% - 24,99%	Not Good
25% - 49,99%	Poor
50% - 74,99%	Good
75% - 100%	Very Good

Source : (Sugiyono, 2019)

RESULT AND DISCUSSION

The Effect of Implementing STEM–Local Wisdom Learning of the Sundanese Community on Students' Creativity

After confirming that both classes had equivalent pretest scores, the effect of STEM–Local Wisdom learning could be determined by testing the hypothesis using posttest scores. Before performing the hypothesis test, prerequisite tests were required: normality and homogeneity tests. Subsequently, hypothesis testing was carried out. The results of the data analysis are presented in Table 3.

Table 3. Recapitulation of normality test, homogeneity test, and hypothesis test

	Class	Score (sig.)		Independent sample t-test		
		Normality	Homogeneity	df.	Sig.(2-tailed)	Description
Posstest Scores	Experiment	.332	.074	69	0.000	Significantly Different
	Control	.102				

Based on the results presented in Table 4, the normality test showed significance values of 0.332 for the experimental class and 0.102 for the control class, indicating that both datasets were normally distributed. The homogeneity test also indicated homogeneous variance (sig. = 0.074). Therefore, hypothesis testing was conducted using an independent sample t-test with equal variances assumed. The results showed a significant difference between the posttest scores of the experimental and control classes (sig. 2-tailed = 0.000), indicating that STEM–Local Wisdom learning had a significant effect on students' creativity. These results suggest that students engaged in STEM-based learning integrated with local wisdom gained more meaningful, challenging, and contextually relevant learning experiences, which, in turn, fostered the emergence of creative ideas.

The success of this learning approach cannot be separated from the application of the Engineering Design Process (EDP), which is a key characteristic of the STEM learning model. The EDP stages *1) identify need or problem, 2) research criteria, 3) brainstorm possible solution, 4) select best solution & construct prototype, 5) test product, 6) present solution, 7) and redesign* allow students to actively engage in the process of creating solutions to real-world problems related to the local cultural context. Students identified problems, gathered relevant information, generated and selected ideas, developed and tested prototypes, and refined their products through feedback. These activities promoted the generation of diverse, flexible, and elaborated ideas, thereby enhancing students' creativity. The EDP stages are shown in Figure 2.

The EDP process helps students enhance their creativity. This is because the learning activities implemented in the STEM–Local Wisdom learning of the Sundanese community systematically applied the EDP stages. One of the most essential characteristics of the STEM learning model is the implementation of the Engineering Design Process (EDP) (Setiono et al., 2023). The EDP process can be simplified into a series of cycles, as shown in Figure 2. The Engineering Design Process (EDP) in STEM–Local Wisdom learning was implemented systematically through problem identification, idea development and selection, prototype construction and testing, and product refinement. These stages promoted students' creativity, including fluency and flexibility through the generation of multiple ideas, originality through unique solutions, and elaboration through detailed idea development informed by feedback and reflection. Thus, the implementation of EDP directly contributed to improvements in students' creativity.

Figure 2. *Engineering design process*

Differences in Student Creativity Between Experimental and Control Classes

There are several indicators in the creativity test adopted from Wallach & Torrance, (2018), namely: *1) Fluency, 2) Flexibility, 3) Originality, 4) Elaboration*. These indicators served as the basis for an analysis evaluating improvements and differences in students' verbal creativity between the experimental and control classes. The study used N-Gain values for each indicator to represent students' improvement from pretest to posttest. Comparisons of N-Gain values across indicators were used to identify which aspects of creativity showed the most significant improvement.

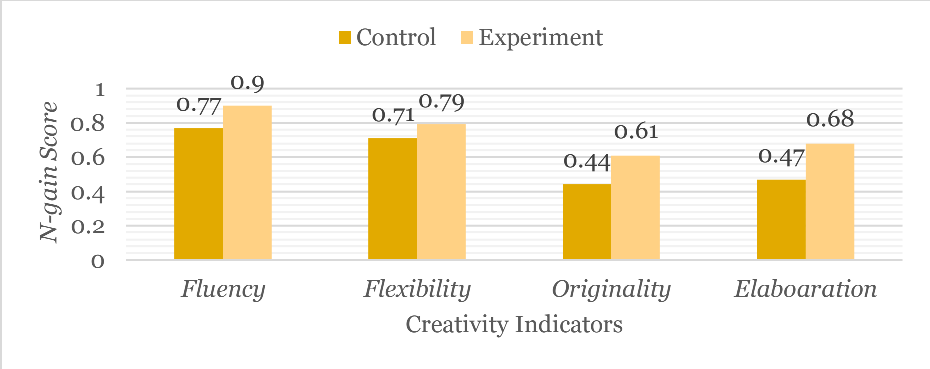

Figure 3. N-gain of each creativity indicator

The diagram in Figure 3 shows that the fluency indicator in the experimental class achieved the highest N-Gain (0.9), indicating an improvement in students' ability to generate a wide variety of ideas quantitatively. This finding aligns with Wilis et al., (2023), who identified fluency as the most responsive indicator to STEM learning, with the most significant improvement occurring in this aspect. The largest increase in this indicator occurred during the *Ask* and *Imagine* stages of the EDP, when students were asked to identify local problems and propose possible solutions. Students' creativity at each stage of STEM–Local Wisdom learning was identified through classroom activities and supported by verbal creativity test results and students' products. At the problem identification and idea exploration stages, creativity emerged as fluency, as students generated multiple ideas, as evidenced by their test responses and the variety of proposed product ideas. During the discussion and solution-selection stages, students demonstrated flexibility by applying different approaches and perspectives to develop their products. At the prototype development stage, creativity was reflected in originality, as students produced unique product ideas that differed from commonly found products. Finally, during the testing, presentation, and refinement stages, students demonstrated elaboration by developing ideas in greater detail in response to feedback and reflection. Thus, the creativity observed at each STEM stage was not based solely on students' answers and discussions, but was also supported by creativity test data and students' products. This is supported by Hasanah et al. (2021), who state that fluency is greatly influenced by a safe, open learning environment that welcomes diverse student opinions.

For the flexibility indicator, although the difference in scores was not large (0.79–0.71), the experimental class still showed an increase in students' flexibility in thinking when faced with new challenges. This is consistent with Khalil et al., (2023) ho reported that STEM learning has a significant impact on flexibility. This indicator improved because, during the *Plan* and *Create* stages, students were asked to consider various alternative ways to present food products based on ingredients, tools, and cultural aspects. In this process, they were encouraged to think from different perspectives—such as aesthetics, local traditions, and consumer needs. However, since most solutions still referred to common food patterns, the increase in flexibility was not as high as in fluency. Students' thinking flexibility can increase substantially when exploration is guided through planning and product development activities that require students to consider various alternative materials, forms, and local cultural values (Dewi et al., 2024).

In this study, originality is defined as students' ability to generate product ideas that differ from commonly practiced approaches, particularly in the context of utilizing local food resources. Originality was achieved through modifications to ingredients, variations in presentation, or the integration of local cultural values into students' products. The greater increase in originality in the experimental class (0.61) compared to the control class (0.44) indicates that some students began producing ideas that were not entirely conventional. However, this improvement remained moderate, as several students tended to choose familiar solutions, such as adapting commonly known traditional food products. These findings suggest that the development of originality requires sustained practice, exploratory courage, and continuous learning stimulation to enable students to generate increasingly unique ideas. Time and habituation are needed for students to explore more original ideas. Originality requires long-term stimulation and consistent learning to develop (Nurdayanti et al., 2020; Primayonita et al., 2020).

The elaboration indicator in both the experimental and control classes showed a fairly significant difference, with scores of 0.68 and 0.47, respectively. The difference in elaboration between the experimental and control classes lies in the depth of students' idea development. In the experimental class, students developed ideas in greater detail through product construction, testing, presentation, and refinement within the Engineering Design Process (EDP), which enabled them to add more information based on feedback and reflection. In contrast, in the control class, idea elaboration was limited to conceptual explanations without iterative product revision, resulting in higher elaboration scores in the experimental class. This aligns with Torrance's criteria, which state that elaboration is closely related to the ability to enrich ideas and that it develops when students are given time for reflection and repeated revision of ideas (Yanuar et al., 2022).

The comparison of the average N-Gain scores for the four creativity indicators in Figure 3 shows that the experimental class outperformed in all creativity indicators. Thus, STEM–Local Wisdom learning of the Sundanese community provides greater opportunities for creative thinking in terms of idea quantity, uniqueness, flexibility, and depth. The most significant improvement occurred in the fluency indicator, indicating that STEM–Local Wisdom learning of the Sundanese community is highly effective in encouraging students to generate as many ideas as possible as solutions to a problem (Hasanah et al., 2021). The originality indicator showed moderate improvement relative to other indicators, which is reasonable, as students were still less confident in expressing their own ideas to produce truly original solutions and required more stimulation, time, and deeper experience (Nurdayanti et al., 2020).

Based on the differences in N-Gain per creativity indicator, the overall N-Gain for both classes was obtained. The experimental class had a higher average N-Gain score of 0.7432, categorized as high because it is greater than 0.7, while the control class scored 0.5932, classified as medium because it is less than 0.7. These N-Gain results indicate that STEM–Local Wisdom learning in the experimental class was more effective at improving students' creativity than the discovery learning model in the control class. This shows that STEM learning combined with local wisdom can provide more meaningful learning experiences and significantly impact students' creativity development. This is supported by Arianti et al. (2022), who state that utilizing STEM also helps students consolidate prior learning, encourages them to identify, analyze, and solve presented problems, and enhances creativity (Putri et al., 2023; Setiawan et al., 2020; Sumaya et al., 2021). Moreover, STEM learning grounded in local wisdom can help students better understand the material being taught (Khotimah et al., 2025).

Students' Responses to the Implementation of STEM–Local Wisdom Learning of the Sundanese Community

The student response questionnaire regarding the implementation of STEM–Local Wisdom learning was administered only to the experimental class. This questionnaire consisted of three indicators: 1) Students' interest in the implementation of STEM-Local Wisdom learning 2) Students' responses regarding creativity in the implementation of STEM-Local Wisdom learning, and 3) Students' interest in the implementation of STEM–Local Wisdom learning of the Sundanese community with the concept of biodiversity. The percentage results of the student response questionnaire are presented in the following diagram.

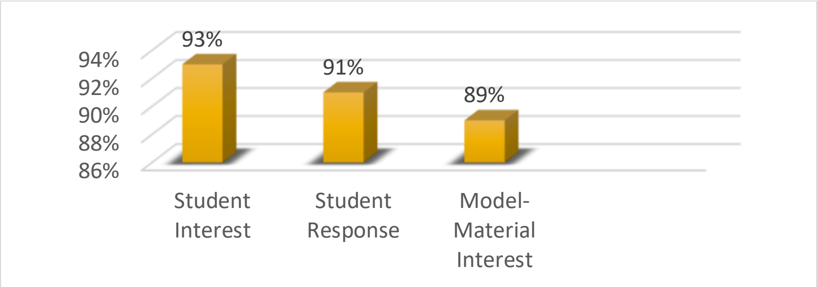

Figure 4. Percentage of student questionnaire responses to the implementation of STEM learning - Local wisdom of the Sundanese people

Based on the diagram in Figure 4, the student response questionnaire results indicate that the majority of students provided highly positive feedback on the implementation of STEM-Local Wisdom learning. The high percentages for each indicator 93% for Indicator 1, 91% for Indicator 2, and 89% for Indicator 3, suggest that most students felt satisfied, motivated, and interested in the applied learning process. According to Apriliani et al., (2021) questionnaire results with a percentage above 80% are generally classified as very good responses. Enthusiastic responses to local wisdom-based learning are not merely a sign of comfort or enjoyment but also an essential indicator of the learning process's effectiveness and sustainability. This is consistent with the findings of Saputri & Desstya (2023), which explain that local wisdom-based learning receives positive responses because it can encourage students to be more active in discussions, think creatively, and contribute productively. The high questionnaire percentages therefore not only reflect the success of the learning implementation but also indicate an increase in students' motivation, enthusiasm, and active engagement during the learning process, particularly in enhancing their creativity (Aisyah Apriliana et al., 2022; Mardianto et al., 2022).

CONCLUSION

The implementation of STEM–Local Wisdom learning of the Sundanese community has a significant effect on students' creativity, as evidenced by the hypothesis test result with a sig. (2-tailed) value of 0.000. The difference in creativity between the two classes also shows that the experimental class improved more than the control class. This is reflected in the N-Gain value of the experimental class, which falls into the high category, while the control class is in the medium category. Furthermore, students' responses to the implementation of STEM–Local Wisdom learning in the Sundanese community were very positive. Based on these findings, STEM–Local Wisdom learning within the Sundanese community is recommended as an alternative model to enhance students' creativity, particularly in biology, by linking it to local context.

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