The Effect of Learning Styles on Students' Creativity in Biology Classes at SMAN 5, Jambi City

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Abstract

Creativity has become an essential competency in biology education because students are not only required to understand concepts but also to generate ideas, solve problems, and develop innovative learning products. However, differences in students' learning styles can influence how creativity develops during the learning process. Unlike previous studies that primarily examined the correlation between learning styles and creativity, this study specifically analyzes the influence of visual, auditory, and kinesthetic (VAK) learning styles on students' creativity in biology learning using the Structural Equation Modeling–Partial Least Squares (SEM-PLS) approach. This study employed a quantitative correlational design involving 11th-grade science students at SMAN 5 Kota Jambi during the 2025/2026 academic year, selected through purposive sampling. Data were collected using a Likert-scale questionnaire and analyzed using SEM-PLS. The results indicate that visual and kinesthetic learning styles have a positive and significant influence on student creativity, whereas the auditory learning style does not show a significant influence. These findings indicate that learning that incorporates visual media and hands-on activities is more effective at fostering students' creativity in biology. This study also underscores the importance of implementing diverse, student-centered learning strategies to support the development of creativity in classrooms with students of varying backgrounds.

Keywords: *Learning Styles, Creativity, and SEM-PLS.*

INTRODUCTION

Students who are creative are able to create something new, but they can also combine existing elements (Firmansyah et al., 2023). Students who are creative learners will demonstrate their creativity through various activities. They are enthusiastic about solving problems, enjoy seeking new experiences, are willing to take risks even difficult ones and have confidence in themselves (Junita et al., 2024). Creativity is important in learning because it encourages students to think innovatively, solve problems, and develop new ideas.
Based on interviews with biology teachers at State High School 5 in Jambi City, it can be concluded that students' creativity is already evident in the biology learning process taking place in the classroom. This is particularly evident when they are asked to produce learning outcomes such as posters, presentations, or lab reports featuring a wide variety of ideas and designs.

Enhancing creativity is a challenge and requires a deep understanding of the factors that influence it. Some of the factors that influence creativity include school-related factors such as teaching methods, curriculum, teacher-student relationships, peer relationships, school discipline, academic standards, learning

methods, and homework assignments (Windayani et al., 2021). Enhancing student creativity requires a comprehensive strategy, which is consistent with Asnawi *et al.* (2023) every student has different learning needs, so teachers need to provide a variety of teaching strategies that accommodate different learning styles.

A learning style is a combination of methods for processing and absorbing information so that the learning process can take place more easily and effectively (DePorter & Hernacki, 2010). Generally speaking, learning styles are divided into three categories, commonly known as VAK (Visual, Auditory, and Kinesthetic) (Solihah *et al*., 2020). The concept of learning styles cannot be understood in a rigid or one-dimensional way. This is consistent with the view that Bruyckere *et al*. (2015) who states that most individuals do not fully fit into a single learning style, and the diversity of learning styles actually makes attempts to categorize students into a single style less accurate.

Each learning style involves a different way of processing information and can potentially influence students' creativity. The visual learning style is a method of learning that uses images, colors, and diagrams. Engaging in this process fosters students' imagination and helps them develop new ideas (Fadlilah et al., 2021). Meanwhile, the kinesthetic learning style emphasizes hands-on experience through laboratory work and physical activities. These activities help students actively build conceptual understanding, thereby fostering flexible thinking and the ability to generate creative solutions to problems encountered in biology (Magulod Jr, G, 2019; Weisberg & Newcombe, 2017). Thus, these two learning styles can theoretically foster the development of students' creativity by enabling them to generate various ideas, solutions, and new concepts in biology education.

Based on the information obtained, a biology teacher at SMAN 5 in Jambi City stated that the teaching methods used to date have influenced students' learning styles. The consistent use of methods tailored to the subject matter has led students to adapt to certain learning tendencies. This finding aligns with the view that Sembiring *et al*. (2024) who states that differentiated instruction is a key strategy for accommodating the diverse learning needs of students in biology classes.

Several previous studies have shown that learning styles are related to student creativity. Eishani et al. (2014) found a positive correlation between several learning style components and creativity. Unlike previous studies, which generally only found a significant relationship between learning styles and creativity, this study not only examined the relationship between variables but also determined the extent to which visual, auditory, and kinesthetic learning styles influence students' creativity in biology learning using Structural Equation Modeling–Partial Least Squares (SEM-PLS). The SEM-PLS approach was chosen because it is capable of analyzing simultaneous relationships between latent constructs, testing the validity and reliability of indicators more comprehensively, and providing estimates of the direct influence of each learning style on student creativity.

METHODOLOGY

Research Methodology

Research Design:

This study employs a correlational design with a quantitative approach. The population of this study consists of all 11th-grade students who selected the science track at SMAN 5 Kota Jambi during the 2025/2026 academic year. The sample in this study consisted of 11th-grade students in classes AI, A2, A3, D2, and E1 at SMAN 5 in Jambi City during the 2025/2026 academic year. The

sampling technique used was purposive sampling, taking into account specific conditions and characteristics relevant to the research objectives. These considerations included the suitability of the research timeline, the respondents' willingness to participate, and the availability of research support resources and facilities.

The data collection method used in this study was a questionnaire distributed via Google Forms. The instrument employed a 6-point Likert scale (1–6), as a 6-point scale is considered effective in encouraging respondents to take a stance rather than remain neutral (Taherdoost, 2019). The use of an even-numbered scale is intended to eliminate the neutral midpoint and encourage respondents to express clearer agreement or disagreement. A neutral category can disrupt the measurement continuum and reduce the accuracy of responses (Nemoto & Beglar, 2014).

The research instrument used to measure learning styles was developed according to the researcher's needs and initially consisted of 36 items. After conducting Confirmatory Factor Analysis (CFA), six items that did not meet the validity criteria were removed, resulting in 30 valid items. The remaining items demonstrated good reliability, with Cronbach's Alpha values ranging from 0.837 to 0.903, while the instrument for measuring student creativity was adapted from a previous study Lehmkuhl *et al*. (2021) which demonstrated high reliability with Cronbach's Alpha of 0.961.

The researchers used nonparametric path analysis based on using the Structural Equation Modeling–Partial Least Squares (SEM-PLS) model. Two evaluations of the testing process model were conducted in stages, including:

a) Evaluation of measurement models (*Outer Model*)
   In the outer model, tests of convergent validity, reliability, and discriminant validity were conducted to ensure that the indicators consistently represent the constructs and that each construct measures a distinct concept.
b) Structural model (*Inner Model*) In the inner model, a multicollinearity test was conducted to ensure there were no issues with relationships between variables. Hypothesis testing was performed using bootstrapping to assess the significance of the effects. Next, the R-squared and F-squared values were calculated to determine the ability of the independent variables to explain the variance in the dependent variable, as well as the magnitude of each variable's effect.

RESULTS AND DISCUSSION

Evaluation of measurement models (*Outer Model*) The aim is to determine whether each indicator is related to its latent variable. Data analysis was conducted using smartPLS 4.0 software. The following are the results of the convergent validity test based on the factor loadings presented in Figure 1.

Table 1. Results of Outer Loading and VIF

Variable	Code item	*Outer Loading*	VIF
Visual	VSL4	0,732	1,729
	VSL5	0,760	1,690
	VSL7	0,786	1,886
	VSL8	0,778	1,807
	VSL10	0,719	1,761
	VSL12	0,734	1,681
Auditory	AUD4	0,759	1,595
	AUD10	0,811	1,752
	AUD11	0,790	1,410
	AUD12	0,776	1,669
Kinesthetic	KNSTK1	0,724	1,762
	KNSTK2	0,716	1,804

	KNSTK3	0,731	1,690
	KNSTK4	0,727	1,947
	KNSTK5	0,747	2,091
	KNSTK6	0,735	1,750
	KNSTK7	0,707	1,627
	KNSTK 8	0,721	1,738
	KNSTK 12	0,726	1,752
Creativity	CRVT1	0,756	1,725
	CRVT2	0,823	2,487
	CRVT3	0,795	1,943
	CRVT5	0,813	2,052
	CRVT7	0,771	2,069
	CRVT9	0,853	1,825
	CRVT11	0,808	2,710
	CRVT12	0,839	2,111
	CRVT13	0,739	2,376
	CRVT14	0,737	1,846
	CRVT15	0,853	1,735
	CRVT16	0,815	1,963
	CRVT17	0,861	2,184
	CRVT19	0,833	1,904

	CRVT21	0,729	1,486
	CRVT23	0,858	1,675
	CRVT24	0,757	1,618
	CRVT25	0,758	1,626
	CRVT26	0,820	1,702
	CRVT27	0,782	1,765
	CRVT28	0,873	2,210
	CRVT29	0,737	1,524
	CRVT30	0,855	1,737
	CRVT31	0,828	1,598
	CRVT32	0,847	1,802
	CRVT33	0,821	1,965
	CRVT34	0,755	1,616
	CRVT35	0,891	2,493
	CRVT36	0,795	1,755
	CRVT37	0,830	1,774
	CRVT38	0,726	1,527
	CRVT39	0,750	1,666
	CRVT40	0,737	1,750

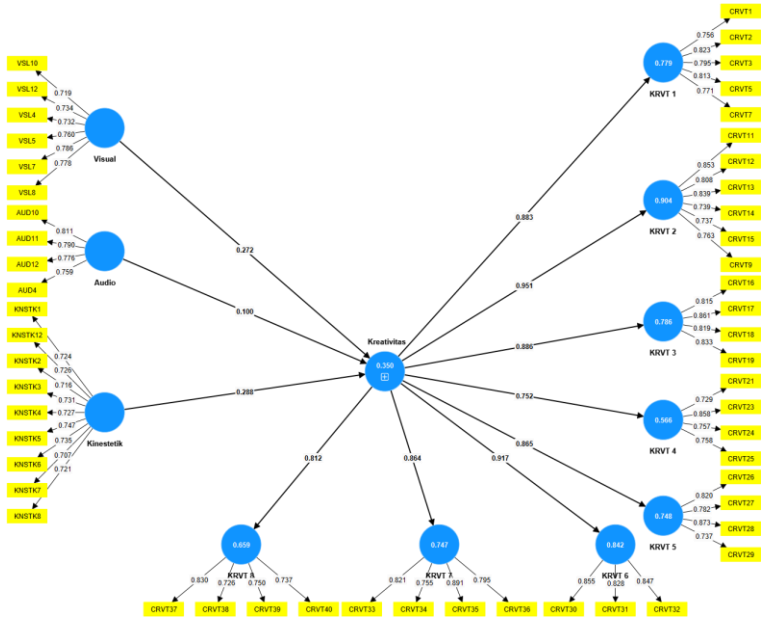

Figure 1. Model Diagram

Table 1, which presents the SEMPLS output results, shows that all items for each variable such as visual, auditory, and kinesthetic learning styles, as well as creativity have factor loadings > 0.7 and VIF < 5.00. This indicates that the items used are capable of representing their respective variables and do not interfere with one another in measuring their respective constructs (Hair et al., 2014).

Table 2. Results of Average Variance Extracted (AVE)

Variable	**Average Variance Extracted (AVE)**
Visual	0,565
Auditory	0,615
Kinesthetic	0,527

Creativity	0,586

Table 2 shows that all constructs have an AVE value of ≥ 0.50, indicating that the items are capable of measuring the variables under study and meet the criteria for convergent validity (Hair et al., 2014). After establishing convergent validity, a reliability test was then conducted.

Table 3. Reliability Test Results *Cronbach's alpha* and *Composite reliability*

Variable	*Cronbach's alpha*	*Composite reliability*
Visual	0,847	0,886
Auditory	0,794	0,865
Kinesthetic	0,888	0,909
Creativity	0,961	0,964

Table 3 shows that Cronbach's alpha values range from 0.808 to 0.961 and composite reliability ranges from 0.865 to 0.964. According to Hair *et al.* (2014) *cronbach's alpha* values and *composite reliability* ≥ 0,70 demonstrate good reliability.

Table 4. Discriminant Validity Test Results *Heterotrait-Monotrait Ratio* (HTMT)

	Audi-otory	Kines-thetic	Crea-tivity	Visu-al
Auditory				
Kinesthetic	0,657			
Creativity	0,477	0,586		
Visual	0,726	0,852	0,596	

Table 4 shows the results *Heterotrait-Monotrait Ratio* (HTMT). According to Henseler *et al.* (2015) and Hair *et al.* (2017), an HTMT value < 0.90 indicates that discriminant validity is met. Thus, each latent variable measures a distinct concept, and there is no measurement overlap between constructs. The structural model (inner model) was evaluated using R-squared (coefficient of determination) for the dependent variable and F-squared (effect size test).

Table 5. Coefficient of Determination *R-square*

	R-square
Creativity	0,350

Table 5 shows that the R-squared value for the creativity variable is 0.350, which is classified as small. According to Hair *et al.* (2014) an R-squared value of 0.75 is classified as high, 0.50 as moderate, and 0.25 as low. This indicates that the auditory, kinesthetic, and visual variables account for 34% of the variance in creativity, while the remainder is explained by other variables outside the research model. Next, effect size tests and hypothesis tests were conducted, as shown in Figure 2 and Table 5.

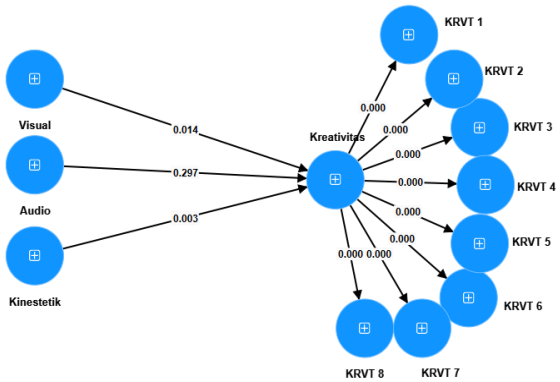

Figure 2. *Bootstrapping* Results

Figure 2 shows the bootstrapping results for the structural model illustrating the relationships among the independent and dependent variables. Furthermore, Table 6 shows the path coefficient values, *T-statistics, P-values* and the value *effect size* (*f-square*).

Table 6. Hypothesis Test Results

	Original sample (O)	*T statistics* (|O/STDEV|)	*P values*	*f-square*
Visual -> Creativity	0,272	2,469	0,014	0,045
Auditory -> Creativity	0,100	1,044	0,297	0,009

Kinesthetic -> Creativity	0,288	2,923	0,003	0,053

Path coefficients are estimated values that indicate the strength and direction of the relationship between constructs. A path coefficient close to +1 indicates a strong positive relationship, while a negative value indicates the opposite (Hair *et al.*, 2014). As for hypothesis testing, in which a hypothesis is considered significant if *T-statistics* > 1,96 and *P-values* < 0,05 at a 5% significance level (Hair *et al.*, 2014). The f-square values are classified into three effect size categories of impact (*effect size*), that is 0,02 small, 0,15 medium, and 0,35 large (Hair *et al.*, 2014).

Hypothesis testing on the relationship between visual learning styles and student creativity revealed a significant effect, with a positive path coefficient. These findings indicate that the higher a student's tendency to process information visually, the greater their creative potential. Although the contribution is relatively small, it remains significant. Contextually, this can be explained by the fact that when students view illustrations, videos, or presentation designs, they not only receive information but are also encouraged to explore and modify ideas into more engaging forms.

This is evident in the learning process at SMAN 5 in Jambi City, which shows that the learning process makes extensive use of visual media such as PowerPoint presentations, educational videos, posters, and group presentations. This is particularly evident when students are assigned projects, posters, or group presentations that give them the freedom to determine the design and method of presenting information. This is supported by research Sari *et al*. (2024) which states that the integration of interactive visual media in biology instruction, such as animations or 3D models, can enhance students' understanding and creativity. Thus, these findings support the notion that a visual learning style has a positive effect on creativity, meaning that the more students tend to utilize visual information, the greater their ability to generate and develop ideas.

Future research could explore the use of media such as augmented reality (AR), a literature review indicates that the use of AR technology in biology education is growing due to its ability to clarify the visualization of complex biological structures and processes and to enhance student engagement and understanding (Stanič & Špernjak, 2025). In addition, the use of visual aids such as diagrams, concept maps, charts, and illustrations enables individuals to develop new ideas, explore various possible solutions, and generate more original and innovative ideas (Wang et al., 2023).

Unlike the visual learning style, the auditory learning style did not show a significant effect on student creativity. This finding can be explained by the characteristics of biology instruction at SMAN 5 Kota Jambi, where lessons typically begin with an explanation of the material, followed by a video or practical activity. This suggests that the auditory processes occurring in the classroom tend to remain focused on receiving information rather than verbal activities that encourage in-depth exploration of ideas. However, if listening activities are limited to merely receiving explanations, the potential of the auditory learning style to support creativity becomes less than optimal.

In theory, creativity is a person's ability to think outside the box, create something new, and find innovative solutions to problems. Creative students tend to find it easier to understand abstract concepts, identify connections between ideas, and generate new ideas that can enhance their

understanding of the material being studied (Baihaqi et al., 2025). In addition Octaviana & Sinaga, (2023) believe that a person's creativity enables them to think outside the box and consistently produce something new in their work.

Creativity is influenced by intrinsic motivation, the learning environment, and learning strategies, and can be enhanced through the design of a learning environment that encourages student engagement, reflection, and interaction (López et al., 2024). Although auditory learners have strong communication skills, creativity requires the ability to think flexibly, generate unique ideas, and have the courage to try new things (Lehmkuhl et al., 2021). Therefore, it is necessary to combine auditory, visual, and kinesthetic learning styles through various learning activities, such as laboratory work, group discussions, mini-projects, and the use of visual, auditory, and kinesthetic learning materials, so that students gain a more diverse learning experience (Millaty et al., 2025).

Testing the hypothesis regarding kinesthetic learning style indicates that kinesthetic learning style has a significant effect on student creativity, with a positive path coefficient showing that the higher the tendency toward kinesthetic learning, the greater the students' creativity; although relatively small, this contribution remains significant in terms of the variation in creativity. This finding can be explained by the fact that biology instruction at SMAN 5 Kota Jambi has incorporated activities such as laboratory work, experiments, and projects.

These findings support the view that Firdaus *et al*. (2018) which states that creativity can be fostered through active and meaningful learning experiences. Participation in laboratory work, experiments, field observations, and science projects enables students to develop ideas independently, enhance their flexibility of thought, and generate original ideas (Lehmkuhl et al., 2021). This is in line with the view that Hamidah & Inganah (2025), which emphasizes that a variety of learning activities tailored to students' characteristics can maximize the development of creativity. Therefore, biology instruction should include more hands-on activities, experiments, and collaborative projects that allow students to move around and explore in real-world settings to stimulate creative ideas (for example, through laboratory settings or science simulations that foster creativity and innovation) (Legaspino et al., 2024).

Direct engagement through kinesthetic activities encourages students to actively explore ideas, try new solutions, and generate more innovative ideas, thereby optimizing the creative process (Ghufron & Risnawati, 2012; Baihaqi et al., 2025). Therefore, biology instruction should include more hands-on activities, experiments, and collaborative projects that allow students to move around and explore in a tangible way, in order to stimulate creative ideas. This is supported by researchers Wicaksana (2016) shows that a group-based inquiry learning model focused on life skills effectively enhances students' creativity. This type of learning, such as in a laboratory setting or through science simulations, fosters creativity and innovation.

CONCLUSION

Based on the research findings, visual and kinesthetic learning styles have a positive and significant effect on students' creativity in biology learning, whereas the auditory learning style does not show a significant influence. These findings indicate that learning activities involving visual exploration and direct practical experiences are more effective in encouraging students to generate ideas and develop creativity. Therefore, biology

teachers are recommended to implement differentiated and product-based learning models, such as project-based learning, inquiry-based laboratory activities, digital poster design, concept mapping, and science simulation projects that integrate visual and kinesthetic elements. In addition, the R-square value of 0.350 indicates that learning styles explain only 35% of the variance in students' creativity, while the remaining 65% may be influenced by other factors outside this study. Therefore, future research is recommended to examine other variables that may contribute to creativity development, such as critical thinking skills, self-efficacy, motivation, collaborative learning, and digital learning environments in biology education.

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