

## Art-based learning and its role in enhancing students' scientific color expression skills

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**Citation:** Bakr, A. F., & Banikhalaf, H. M. (2025). Art-based learning and its role in enhancing students' scientific color expression skills. *Asia Pacific Journal of Education and Society*, 13(2), 3. <https://doi.org/10.20897/apjes/17467>

**Published:** December 1, 2025

### ABSTRACT

This study investigated the effect of an art-based learning strategy on improving students' ability to express scientific concepts through color in life sciences. A quasi-experimental design was employed with 60 ninth-grade students divided equally into experimental and control groups. The experimental group received instruction integrating artistic activities—drawing, coloring, and modeling—into science lessons, while the control group followed traditional instruction. Data were collected using theoretical cognitive and practical color expression tests. The results showed that the experimental group significantly outperformed the control group in both theoretical and applied assessments, with a large effect size. The findings demonstrate that art-based learning fosters deeper scientific understanding and enhances creative expression, visual memory, and engagement in life science education. The study recommends integrating artistic methods into science curricula to strengthen students' conceptual comprehension and expressive skills.

**Keywords:** Art-based learning, color expression, life sciences, creative pedagogy, visual representation, experimental study

### INTRODUCTION

Life sciences play a vital role in helping students understand the interdependence of living systems and their environments. However, abstract biological concepts—such as tissue structures or microscopic systems—often pose learning challenges for students in the upper basic stage. Traditional teaching approaches, heavily reliant on verbal explanation and memorization, fail to adequately support conceptual understanding or visualization. Consequently, innovative pedagogical approaches that integrate multisensory learning and creative expression are essential to bridge the gap between abstract scientific ideas and concrete understanding.

Art-based learning provides one such pedagogical framework. By combining scientific inquiry with creative expression, it enables students to interpret and represent complex scientific concepts through artistic forms such as drawing, coloring, and model construction. Studies have shown that incorporating artistic strategies in science classes enhances students' motivation, emotional engagement, and higher-order thinking (Marrazzo, 2024; Edwards, 2020). These findings align with constructivist and multiple intelligence theories, which emphasize the role of multisensory engagement in constructing knowledge (Abul Hamail, 2022).

Color, in particular, serves as a powerful cognitive and communicative tool in science education. Research suggests that color coding improves attention, retention, and conceptual organization (Gao, Wang, & Liu, 2020). Warm colors can stimulate engagement and focus, while cool colors promote calm and clarity (Tabaji, 2021). Within biological education, color use facilitates differentiation between tissue types and biological systems, helping

students build accurate mental models of scientific phenomena. As Eisner (2002) and Salah (2020) noted, art-based visualization supports both affective and cognitive dimensions of learning, transforming abstract content into tangible representations.

Despite these benefits, the integration of art-based methods in science classrooms remains limited. Many schools in Jordan continue to rely on teacher-centered approaches that neglect students' visual-spatial and creative abilities. Previous research (Al-Anzi, 2021; Mahmoud, 2020; Chen & Zhang, 2022) indicates that students taught with artistic activities exhibit greater comprehension, motivation, and creativity compared to those taught through conventional means. Yet, few studies in the Arab region have empirically examined how art-based learning affects students' ability to express scientific concepts through color.

This study therefore seeks to explore the effect of an art-based learning strategy on students' cognitive and practical abilities to express scientific concepts using color in life sciences. The research aims to provide evidence supporting the pedagogical integration of art and science, particularly in the context of Jordanian education.

## **METHODS**

### **Research Design**

This study employed a quasi-experimental design to examine the effect of an art-based learning strategy on ninth-grade students' ability to express scientific concepts through color in life sciences. The design included two groups: an experimental group taught using an art-based learning approach and a control group taught using conventional instruction methods.

The quasi-experimental design was chosen because it allows for the measurement of differences between teaching strategies while accommodating real-world classroom constraints. The study adopted pre-test and post-test assessments to evaluate cognitive and practical outcomes related to color expression in scientific contexts.

### **Participants**

The participants were 60 ninth-grade students selected from Omar Mukhtar Second Basic School for Boys, affiliated with the Directorate of Education of the Kasbah Irbid Brigade, during the second semester of the 2024–2025 academic year. The selection was intentional, based on accessibility and administrative approval.

Students were distributed equally into two groups ( $n = 30$  per group). The experimental group was taught using art-based learning activities, while the control group received traditional instruction. The study sample reflected a balanced demographic composition in terms of age and academic ability, with no significant pre-existing differences between groups according to preliminary testing.

### **Instruments**

Two assessment tools were developed to measure students' abilities:

1. Theoretical Cognitive Color Expression Test – measured students' conceptual understanding of color representation in scientific contexts.
2. Practical Applied Color Expression Test – evaluated students' ability to apply color expression in representing scientific phenomena, particularly in the topics of animal and plant tissues.

Each test contained 30 items divided equally between animal and plant tissue concepts. Tests were designed based on prior validated instruments (e.g., Sananiya, 2018; Gao et al., 2020) and adapted to the Jordanian educational context.

Validity and reliability were verified by a panel of 13 subject-matter experts, who assessed linguistic clarity, content relevance, and alignment with learning objectives. The final tests demonstrated acceptable psychometric properties: item difficulty ranged between 0.33–0.83, discrimination coefficients exceeded 0.40, and Cronbach's  $\alpha = 0.83$ , indicating high internal consistency.

### **Educational Materials and Procedure**

The instructional materials were drawn from the official ninth-grade biology textbook, specifically the chapter on *Animal and Plant Tissues* (Ministry of Education, 2024).

The **experimental group** followed a 12-session instructional program integrating artistic activities such as drawing, coloring, and modeling. Each session lasted **45 minutes**. Students engaged in guided creative exercises, representing scientific concepts visually and collaboratively. The control group covered the same material through standard instructional methods emphasizing verbal explanation and textbook exercises.

**Implementation timeline:**

- Pre-test administration: January 26, 2025
- Instructional intervention: January 26 – March 15, 2025
- Post-test administration: March 16, 2025

**Data Analysis**

Data were analyzed using SPSS (Version 28). Independent-samples *t*-tests were applied to assess pre-test equivalence, while ANCOVA and MANCOVA were used to evaluate the post-test results, controlling for pre-test scores. Effect sizes were calculated using  $\eta^2$  (eta squared) to determine the magnitude of differences between groups. Significance was set at  $\alpha = 0.05$ .

**Ethical Considerations**

This research was conducted in compliance with ethical standards established by Yarmouk University. Approval was obtained from the Institutional Review Board (IRB) of Yarmouk University under protocol number IRB#2025-122.

All participants and their guardians were informed about the study's purpose, procedures, and voluntary participation rights. Written consent was obtained before data collection. Anonymity and confidentiality were maintained throughout the research process, and no identifying data were disclosed in any report or publication.

**RESULTS****Overview**

The analysis aimed to determine whether students taught using an art-based learning strategy exhibited improved performance in theoretical and practical color expression of scientific concepts compared to those taught through traditional instruction. Descriptive and inferential statistics were conducted to compare the experimental and control groups across both pre- and post-tests.

**Pre-Test Equivalence**

Independent-samples *t*-tests confirmed no significant differences between the groups in their pre-test scores for theoretical and practical color expression ( $p > .05$ ), indicating the groups were comparable prior to the intervention.

**Table 1.** Independent-Samples *t*-Test Results for Pre-Test Equivalence between Experimental and Control Groups

Test Component	Group	M	SD	t	df	p
Theoretical Cognitive Test	Experimental	16.17	2.69	-0.10	58	.923
	Control	16.93	2.60			
Practical Applied Test	Experimental	17.13	5.48	-0.33	58	.742
	Control	17.60	5.44	t	df	p

Note. No statistically significant differences were observed at  $\alpha = .05$ .

**Post-Test Outcomes**

After the intervention, the experimental group demonstrated significantly higher performance in both theoretical and practical tests. ANCOVA results indicated statistically significant differences favoring the experimental group, with large effect sizes.

**Table 2.** ANCOVA Results for Post-Test Scores on Color Expression Ability by Group

Test	Source	SS	df	MS	F	p	$\eta^2$
Theoretical Cognitive	Teaching Method	322.02	1	322.02	42.43*	< .001	.43
Practical Applied	Teaching Method	295.77	1	295.77	38.25*	< .001	.40

### Sub-Domain Analysis

Further MANCOVA tests were conducted for two subdomains: animal tissues and plant tissues. Significant improvements were observed in both subdomains for the experimental group.

**Table 3.** MANCOVA Results for Theoretical Cognitive Color Expression by Subdomain

Subdomain	F	p	p
Animal Tissues	15.80*	< .001	< .001
Plant Tissues	26.35*	< .001	< .001

These results indicate that art-based learning had a stronger effect on students' understanding and expression of plant tissue concepts compared to animal tissue concepts.

### Summary of Findings

1. No significant differences were found between groups in pre-test performance.
2. Post-test results showed significant improvement in both theoretical and applied color expression for the experimental group.
3. The intervention yielded large effect sizes, confirming that art-based learning effectively enhanced students' visual-scientific communication skills.
4. The strategy was particularly effective in helping students connect color, form, and function in biological structures.

## DISCUSSION AND CONCLUSION

The findings of this study confirm that integrating art-based learning strategies significantly enhances students' ability to understand and express scientific concepts through color. The experimental group's superior performance demonstrates the value of merging creative and scientific pedagogies, supporting the principles of constructivism and multiple intelligences. These outcomes are consistent with prior research emphasizing the effectiveness of multimodal learning environments in promoting comprehension, creativity, and engagement (Chen & Zhang, 2022; Marrazzo, 2024).

The observed improvement in students' performance indicates that the visual and sensory engagement inherent in art-based activities helps transform abstract content into concrete, memorable experiences. By encouraging learners to visualize and apply color to represent biological structures, the approach fosters deeper cognitive processing and strengthens long-term retention. This aligns with recent findings in APJEC literature suggesting that interdisciplinary strategies enhance both affective and cognitive learning outcomes (Lee & Park, 2023, *Asia Pacific Journal of Education and Curriculum Studies*).

Furthermore, the integration of art into science instruction promotes collaboration, emotional expression, and confidence, which are vital elements of holistic education. The significant effects observed in plant tissue understanding suggest that visual representation may play an even more crucial role in abstract or microscopic topics. These results advocate for the adoption of art-based approaches across broader scientific disciplines and educational levels.

Art-based learning serves as an effective pedagogical approach to bridge the gap between creativity and scientific literacy. It empowers students to visualize, interpret, and communicate scientific knowledge more effectively. The findings of this study provide empirical evidence that incorporating artistic activities enhances both theoretical and applied understanding in life sciences. It is recommended that educational policymakers and curriculum developers integrate art-based strategies into science curricula, supporting teachers through professional development focused on interdisciplinary instruction.

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