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Research Article

The Effect of an Art-Based Learning Strategy on Enhancing the Ability to Express Scientific Concepts Through Color in Life Sciences Among Upper Basic Stage Students

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ABSTRACT

The study aimed to reveal the impact of the learning strategy based on artistic activities in improving the ability of color expression of scientific concepts in the life sciences among students of the higher basic stage. The study adopted the experimental curriculum with a semi experimental design. The study sample consisted of students of the basic ninth grade, the number of its members reached 60 students. The study used two Tests in color expression, the first is cognitive-theoretical, the second is practical-applied. The results showed the superiority of the experimental group over the control group in telemetry in the cognitive and practical color expression of scientific concepts, and the magnitude of the effect was high. The most prominent recommendations were the need to conduct subsequent studies on larger and more diverse samples in terms of gender and geographical location (cities, villages, camps) to ensure wider dissemination of the results.

Keywords: Learning strategy, color expression, scientific concepts, life sciences

INTRODUCTION

Life sciences are one of the main pillars in the school curriculum because of their role in developing students' awareness of vital systems and understanding their natural environment, but abstract concepts – such as plant and animal tissues – represent a special challenge for students of the higher basic stage, because they require the ability to mental perception and visual representation, which necessitates the adoption of alternative teaching strategies that go beyond traditional explanation, and rely on sensory and technical inputs that contribute to simplifying concepts and enhancing comprehension.

Perhaps the most prominent of these is the art-based learning strategy, which employs tools such as drawing, coloring and modeling to integrate scientific knowledge with creative performance. Recent studies (Marrazzo, 2024) have indicated that this approach develops critical thinking, increases class interaction and motivation, and is consistent with the theories of active learning, multiple intelligences and constructive learning that emphasize the construction of knowledge through multisensory activities (Abu al-hamail 2022).

Color expression emerges as a central tool in this context, as color contributes to enhancing the perception and organization of information and helps to understand abstract relationships. (Tabaji, 2021) pointed to the role of warm colors in activating attention, and cold colors in reducing stress, while (Gao, Wang, & Liu, 2020)

Color expression emerges as a central tool in this context, as color contributes to enhancing the perception confirmed their impact on emotional responses and emotional interaction with content, noting that the psychological impact of Colors is relative and varies depending on the cultural and educational context. For example, in tissue teaching, specific colors are used to distinguish muscle in red, nerve in blue, and wood in green, which facilitates the formation of an accurate mental image, noting that these colors are an educational symbol for illustration and are not a true reflection of the nature of tissues, and the role of coloring is not limited to visual illustration, but develops the skills of comparison, classification and conclusion through the production of scientific works of art (Gao, Wang, & Liu, 2020).

(Eisner, 2002) and (Edwards, 2020) have shown that manual drawing and coloring activate visual-spatial intelligence, contribute to linking form and function, and (Salah, 2020) has stated that they have an important role in simplifying complex processes such as blood flow or gas exchange through a tangible visual representation. The nature of ninth grade students, with their physical awareness and desire for emotional and social expression, makes artistic activities an effective way to enhance self-confidence, relieve stress, and develop skills of cooperation and scientific dialogue through group projects.

Giving students the freedom to choose colors and the layout of works of art contributes to the promotion of independent and creative thinking (Tabaji, 2021), develops aesthetic taste and expands the ability to connect art and science.in particular, tissue teaching, educational applications show the effectiveness of coloring in illustrating structure and function (Chen & Zhang, 2022), and in supporting the principles of active learning and critical thinking (Edwards, 2020). The adoption of color as a means of representing and analyzing data also enhances visual memory and helps to recall information (Elliot & Maier, 2015).

Thus, color expression represents an integrative input that connects scientific concepts and creative performance, enriching the cognitive, sensory, emotional and social aspects together. Accordingly, the integration of artistic activities in the teaching of plant and animal tissues is not just a visual enrichment, but an effective pedagogical input that is in harmony with the characteristics of learners at this stage, contributes to the development of critical and creative thinking, which positively reflects on the quality of learning.

In this context, many field studies and research based on the semi-experimental curriculum have been conducted by (Green, Trundle & Shaheen, 2018) study in the United States with the aim of reviewing the literature on the integration of Arts in Science Education. The study followed the scientific literature review approach, where 65 articles published in peer-reviewed journals were analyzed. The study sample consisted of research articles dealing with the integration of Arts in science education for pre-kindergarten through twelfth grade students. The study tools included searching databases such as ERIC and ProQuest, in addition to manual searches in scientific journals and using the "snow accumulation" approach to collect relevant articles. The results showed that integrating the Arts in Science Education achieves multiple benefits, including improving students' academic performance, promoting creative thinking, providing alternative learning methods, and improving the school climate. The results showed that teachers who participate in arts integration programs acquire new skills and feel more confident and cooperative; however, the study pointed to obstacles such as lack of time and professional training, as well as misunderstanding the importance of integrating the arts in education.

(Aslan, Kurmanbekova, Kayalar, Karagoz, & Engin, 2021) conducted a study in Yunus / Erzurum area with the aim of knowing the impact of teaching biology using conceptual cartoons based on the constructivist learning curriculum on student achievement and knowledge stability, the study followed the semi-experimental approach, the study sample consisted of (49) students from the tenth grade, three achievement tests were built, a pre-test consisting of three stages, a post-test, and a continuity test consisting of (25) questions related to the topic of environmental ecology, the results showed the superiority of the experimental group members over their counterparts in the control group, in terms of information retention test scores four weeks after (the end of the study) This shows that teaching using conceptual cartoons has had a positive effect in providing students with life knowledge compared to the usual way.

(Ozkan, 2023) conducted a study in Turkey with the aim of revealing the impact of the project-based learning method applied in the visual arts lesson for the seventh grade on students' results and trends compared to traditional teaching, the study followed the experimental curriculum, and the sample consisted of (46) students who were evenly distributed among the experimental and control groups in a simple random way, an achievement test and a trend scale were built, and the results showed statistically significant differences in favor of the experimental group in which the project-based learning method was applied.

(Tuveri, Steri & Fadda, 2024) conducted a study in Italy-Sardinia region – with the aim of employing storytelling and theatrical acting techniques to introduce high school students to the topics of black holes and gravitational waves, and integrating the arts into contemporary physics education, the study followed the informal curriculum within an interactive educational environment, where the activity was designed to include a narrative monologue followed by a scientific explanation and an open discussion with students, the study sample consisted of (200) students aged (17-19) from five secondary schools (Four scientific and One humanitarian), the study tools relied on interactive artistic activity followed by a presentation of scientific content, then a question and discussion session, and in addition to a research questionnaire to measure the effectiveness of the proposed approach, the results showed that the methodology Students of the humanitarian track appreciated the use of artistic tools such as poetry to a greater degree than their counterparts in the scientific track, with the possibility of using this approach in directing students towards the Steam tracks of Science, Technology, Engineering, Arts, and mathematics.

Previous studies at the Arab and foreign levels show an increasing interest in integrating the arts into education to enhance creativity, visual skills, and achieve better student achievement at multiple academic levels. These studies focused on various strategies such as cartoons, storytelling, theatrical acting, art projects, photographs and illustrations, but most of them were limited to art education or science in general without delving into teaching abstract and complex topics in the life sciences, such as plant and animal tissues.

In this context, the current study was distinguished by its focus on color expression as a systematic pedagogical input for tissue education in the ninth grade, taking into account the characteristics of the developmental stage of students. Colors have been used as educational symbols that contribute to simplifying complex concepts, developing visual thinking, and enhancing the emotional aspect of learners. This strategy is based on linking theoretical knowledge with visual representation, so that the student is asked to choose the appropriate color for each fabric according to its properties and biological function, both theoretically and practically, making coloring an analytical cognitive tool and not just an aesthetic means.

This study is also distinguished in that it integrates the cognitive dimension and the applied dimension, as artistic activities enhance the ability of scientific color expression, develop the skills of analysis and symbolic thinking, and also provide opportunities for students to interact with scientific images, models and drawings in an organized and gradual manner. Thus, the current study provides a qualitative and distinct addition compared to previous studies, as it combines scientific accuracy (considering colors as symbolic tools for illustration) and the psycho-aesthetic dimension (the relative effect of colors on attention and emotion), responds directly to the needs of learners, and opens up prospects for developing methods of teaching science more effectively and comprehensively.

Study Problem

Despite the increasing importance of developing artistic expression and understanding of scientific concepts among students of the higher basic stage, traditional teaching practices still dominate the teaching of Life Sciences, which leads to poor motivation of students, low levels of interaction, and difficulty in representing concepts in a meaningful way. It has been noted that most students show reluctance to abstract scientific lessons, weakness in the visual expression of scientific concepts, in addition to limited enthusiasm for scientific disciplines and professions.

These symptoms may be partly due to the lack of innovative teaching strategies in the educational environment that take into account the needs of learners in the Twenty-First Century and integrate the cognitive, emotional and skill aspects. The literature indicates the effectiveness of art-based learning in enhancing motivation and deep understanding; (Mahmoud's, 2020) and (Zamzami's, 2019) studies showed that the use of colors contributes to the development of cognitive and visual skills and concept analysis, other studies (Al-tabji, 2021; Al-Anzi, 2021; Chen & Zhang, 2022) have shown that this trend is still marginalized in many schools, leaving an educational gap that needs to be addressed.

Based on this, this study seeks to address the shortcomings in improving the ability of color expression of scientific concepts through the use of a learning strategy based on technical activities in teaching life sciences, and to verify its impact on the development of these vital aspects in student learning.

Study Questions

This study tried to answer the following questions:

- The first question: What is the impact of the strategy of learning based on artistic activities in improving the ability of theoretical cognitive color expression of scientific concepts among ninth-grade basic students in the Directorate of Education of the Kasbah brigade Irbid?
- The second question: What is the impact of the strategy of learning based on artistic activities in improving the ability of practical and applied color expression of scientific concepts among ninth-grade basic students in the Directorate of Education of the Kasbah brigade Irbid?

Objectives of the Study

The current study aimed to verify the impact of using the art-based learning strategy in improving the ability of color expression of scientific concepts theoretically and practically, in order to assess the effectiveness of this strategy in improving scientific and artistic learning outcomes, compared to traditional methods, and provide evidence supporting the integration of art in Science Education.

Study Hypotheses

The current study sought to verify the following main hypotheses:

- The first hypothesis: there are no statistically significant differences at the level of significance **(α=0.05)** between the averages of the performance of the individuals of the study sample of ninth grade students on the theoretical cognitive color expression test due to the difference in teaching strategy (art-based education, regular activities).
- The second hypothesis: there are no statistically significant differences at the level of significance **(α=0.05)** between the averages of the performance of the individuals of the study sample of ninth-grade students on the practical applied color expression test due to the difference in teaching strategy (art-based education, habitual activities).

Study Importance

The theoretical importance of this study is represented by the following axes:

This study gains its theoretical importance from its contribution to expanding the educational understanding of the process of learning science, by providing an integrated model that combines the cognitive, emotional, and artistic dimensions, which is in line with modern trends that call for integrating science and arts in education instead of separating them. The focus on color expression within artistic activities is an effective cognitive tool that enables students to understand complex scientific concepts in the Life Sciences in a deeper and more comprehensive way, away from superficial memorization.

The study also highlights the importance of color expression not only as an artistic medium, but as a cognitive tool that enables students to reconstruct scientific concepts through visual and symbolic representations, which enhances meaningful learning and deepens scientific understanding. This approach fills a clear research gap in the Arabic literature, where studies lack practical applications of the learning strategy based on technical activities in the field of life sciences, especially at the level of the higher basic stage.

Moreover, the study supports the development of education according to the skills of the XXI century, by promoting creativity and integration between fields, and promoting active and participatory learning. It also emphasizes the need to redesign the classroom environment to become a stimulating space for imagination, expression, cognitive and emotional integration, while redefining the role of teacher and learner in the education process. Thus, this study represents an important theoretical addition that contributes to building an integrated educational model that links scientific knowledge and technical performance, and supports the development of science teaching methods in accordance with modern educational developments and the needs of learners.

Practical (Applied) Significance

The practical importance of this study is to provide an educational model that integrates visual arts, such as drawing, coloring and modeling, within science teaching, creating an interactive and attractive classroom environment that enhances the motivation of students, especially those who prefer sensory and creative learning. Through this integration, the study provides educational activities based on color expression that help students to visually represent scientific concepts, which contributes to their consolidation in memory and improve analysis and interpretation skills, especially in complex concepts in the life sciences.

The results of the study also contribute to the training of teachers on the use of the Arts in the planning of lessons and the design of educational activities, which enhances the development of their professional competencies and supports the integration of school subjects according to the STEAM concept.

These results are an important information base for decision-makers and curriculum developers, as they allow them to adopt educational policies that encourage the introduction of innovative strategies combining science and the arts. In the end, this study establishes a learning experience that can be applied and generalized in similar school environments, and also opens the door for future research aimed at studying the impact of arts-based learning in different subjects and stages of education, in addition to the possibility of directing these strategies to special groups of learners.

Study Terms and Their Procedural Definitions

The study included the following terminological and procedural definitions:

- **Effect:** a term defined as a term used in various fields to express the result or effect that results from something or a certain event, that is, the result or effect that occurs as a result of a certain action or event, and this effect may be positive or negative depending on the field (2024:98, Marrazzo). It is defined procedurally: it is the observable or measurable change that occurs in the performance, behavior, or results of individuals or groups of students of the ninth grade of the Basic School of Omar Mukhtar II basic school for boys of the Directorate of Kasbah Irbid brigade as a result of the application of the learning strategy based on technical activities, and is determined using assessment tools prepared for this purpose.
- **The strategy of learning based on artistic activities:** a term; one of the areas that helps students to express and accomplish the required work by using the basics of design, and making multiple things that are extremely important (Shibl and Abdul Rahman, 2008). It is also defined as activities that rely on artistic expression such as painting, sculpture, photography, and other arts, with the aim of enhancing students' creative thinking, developing their skills in artistic expression, and linking them to specific educational content (Khalifuh, 2019). It is a teaching strategy consisting of a set of planned and methodological methods and procedures followed by a life sciences teacher and implemented to achieve certain educational goals based on the use of artistic activities (such as the use of expressive colors, painting and sculpture) to represent scientific concepts, this is implemented within a sample of ninth grade students at Omar Mukhtar Second Basic School for Boys affiliated with the Directorate of Kasbah of Irbid so that these activities become an integral part of the learning process and knowledge acquisition, and are integrated as an educational means to motivate students and enhance their abilities.
- **Color expression:** by convention; is the use of colors as a tool to express ideas, concepts or feelings, both in the arts and in education, with the aim of enhancing the understanding and visual perception of scientific concepts (Abdurrahman: 56, 2022). It is defined procedurally: it is the ability of a ninth grade student at Omar Mukhtar second Basic School for Boys affiliated with the Directorate of Kasbah Irbid brigade to choose and use colors in a consistent and accurate manner to express biological concepts and topics in the life sciences, so that the colors reflect a scientific and realistic connection with the studied concept (such as the use of green color for chloroplasts or dark brown for the liver) taking into account aesthetics and creativity in presenting works of art, achieving the following conditions: scientific accuracy, visual aesthetics, creativity in presentation and presentation, consistency with reality with natural ingredients. It is measured through a theoretical cognitive test and an applied practical test in preparation for this purpose.

METHODOLOGY

The study adopted the experimental curriculum with a semi-experimental design to measure the impact of the learning strategy based on artistic activities in improving the ability to color expression (theoretically and practically) of scientific concepts in the life sciences subject among ninth-grade basic students.

Study Personnel

In the second semester of the academic year 2024/2025, the study personnel were selected in the intentional way from the students of the ninth basic grade at the Omar Mukhtar Second Basic School for boys of the Directorate of education of the Qasba Irbid brigade, numbering (142) students, distributed among (4) study divisions, two of which were selected randomly, then one of these two divisions was selected randomly as an experimental group (the educational material was taught using the strategy of learning based on technical activities) and the number of its members reached (30) students, the second division was considered as a group officer (taught in the usual way) and the number of its members (30) students.

Study Tools and Educational Materials

The first tool: the theoretical cognitive color expression test of scientific concepts

To reveal the ability of basic ninth grade students to express theoretical cognitive color expression of the concepts contained in the module (animal and plant tissues) in the second chapter of the biology textbook for the basic ninth grade, a test was prepared and built for this purpose, based on previous frameworks and scales such as the scales covered by studies (Sananiya, 2018), and the cognitive test in its initial form may consist of (30) multiple-choice paragraphs, each paragraph has four alternatives to answer, only one of which is correct and the rest is camouflaged, measuring the ability to the color expression of the scientific concepts contained in the module (animal and plant tissues), the questions of this test have been distributed on two axes There are two main questions, namely: questions related to animal tissues, which number (15) questions, and questions related to plant tissues, which number (15) questions.

Validity of the Theoretical Cognitive Color Expression Test

The apparent truthfulness of the theoretical cognitive color expression test was verified by presenting it in its initial form to (13) competent arbitrators, in order to express their opinions about the validity of the content of the test, and its suitability for the target sample in terms of: the degree of paragraph measurement of the attribute, clarity of the linguistic wording of paragraphs, and adding, modifying or deleting what they deem appropriate paragraphs. In light of the arbitrators ' remarks, which focused on the language formulations and the technical output of the test, the proposed amendments were made, and the criterion adopted in accepting or excluding paragraphs was that the paragraph obtained the consensus of the majority of the arbitrators, and thus the test after arbitration consisted of (30) paragraphs, distributed on two axes, namely: questions related to animal tissues, 15 questions, and questions related to plant tissues, 15 questions.

Coefficients of difficulty and discrimination of paragraphs of the theoretical cognitive color expression test

The difficulty and discrimination coefficients of the test paragraphs were calculated to determine the degree of difficulty of the test paragraphs and their distinguishing strength, by applying the test to the survey sample as shown in **Table (1)**.

Table 1. Difficulty and discrimination coefficients for the paragraphs of the theoretical cognitive color expression test.

Paragraph	Coefficient of difficulty	Coefficient of differentiation	Paragraph	Coefficient of difficulty	Coefficient of differentiation	Paragraph	Coefficient of difficulty	Coefficient of differentiation
1	0.36	0.60	11	0.67	0.72	21	0.50	0.76
2	0.83	0.72	12	0.67	0.76	22	0.43	0.60
3	0.67	0.44	13	0.36	0.76	23	0.62	0.76
4	0.50	0.68	**14**	**0.67**	0.56	24	0.50	0.76
5	0.67	0.44	**15**	**0.33**	0.68	25	0.67	0.64
6	0.50	0.52	16	0.67	0.60	26	0.50	0.68
7	0.50	0.68	17	0.83	0.64	27	0.67	0.64
8	0.35	0.72	18	0.50	**0.67**	**28**	**0.50**	0.53
9	0.45	0.56	19	0.48	**0.80**	**29**	**0.83**	0.60
10	0.47	0.56	20	0.50	0.80	30	0.50	0.76

It is clear from **Table (1)** that the values of the difficulty coefficients for the paragraphs ranged between (0.33 - 0.83), and the values of the discrimination coefficients ranged between (0.44-0.80), and these values are acceptable to keep the paragraphs within the test according to the criterion of return (2010), which indicates the retention of the paragraph whose difficulty ranges between (0.20–0.80), and has a discrimination coefficient higher than (0.39), therefore none of the paragraphs were deleted based on the difficulty coefficient or the final form of the test consists of (30) paragraphs.

Stability of the Theoretical Cognitive Color Expression Test

To estimate the constancy of the internal consistency of the theoretical cognitive color expression test; Cronbach's Alpha coefficient was calculated using the application data on the survey sample, the value of which was (0.83).

Determining the right time, a theoretical cognitive color expression test

The appropriate time for the test was determined by calculating the arithmetic mean of the time taken by the survey respondents to answer the test, and it was found that the appropriate time to answer the test questions is (60) Minutes.

Application of the theoretical cognitive color expression test

The pre-test was applied to the study sample at the beginning of the second semester, and the post-test was applied after the completion of teaching the unit (animal and plant tissues) using the learning strategy based on the technical activities of the experimental group and the usual method of the control group, through the biology teacher at the school, who studies the control and experimental divisions.

Correction of the theoretical cognitive color expression test

The test was corrected, and a zero score was given for the wrong answer, and one score for the correct answer; thus, the minimum mark for the test is (zero) and the maximum mark is (30), and the higher the respondent's score on the test is an indication of the high level of the ability to color expression theoretically of the scientific concept.

Verification of the equivalence of the two study groups in theoretical cognitive color expression

To verify the equivalence of the two study groups in the tribal test of theoretical and pivotal cognitive color expression (animal tissues, plant tissues); arithmetic mean and standard deviations of the performance of the members of the tribal study sample on the test were calculated, depending on the study group (control, experimental), and the test "T" was used for independent samples (Independent - Samples T-test) to reveal the significance of the differences between the arithmetic mean, as shown in **Table (2)**.

Table 2. The results of (Independent - Samples T-test) to detect the significance of differences between the computational circles of the performance of the study sample before the theoretical cognitive color expression test with its overall significance and its sub-axes depending on the teaching method.

Test and its 2 pivots	Group	Arithmetic mean	Standard deviation	T Value	Degrees of freedom	Statistical significance
Animal tissue	Experimental Control	**9.13** **9.73**	**1.79** **1.89**	-1.260	58	0.213
Plant tissues	Experimental Control	7.73 7.20	1.95 1.37	1.226	58	0.225
Theoretical cognitive color expression (as a whole)	Experimental Control	16.17 16.93	2.69 2.60	**-0.098**	**58**	**0.923**

* A function statistically at the level of significance (α=0.05)

It is clear from **Table (2)** that there are no statistically significant differences at the level of significance (α=0.05) between the computational circles for the performance of the study sample prior to the theoretical cognitive color expression test with its total significance and its sub-axes attributable to the study group (control, experimental). For further statistical control, the ANCOVA accompanying contrast analysis and the mancova multiple accompanying contrast analysis were used.

The second tool: practical applied color expression test

To reveal the ability of ninth grade basic students to practical applied color expression of the concepts contained in the unit (animal and plant tissues) in the second chapter of the biology textbook for the basic ninth grade; a test was prepared and built for this purpose, based on previous frameworks and metrics such as the metrics covered by studies (al-sananiya, 2018;), as well as scientific sites in the internet to obtain appropriate images of tissues accurate, clear and scientifically correct, the test may be in its initial form of (30) paragraphs measuring the ability of practical applied color expression ninth graders have a basic module of concepts and knowledge (animal and plant tissues), which includes all The questions of this test were distributed on two main axes, namely: animal tissues and the number of questions (15) questions, and plant tissues and the number of questions (15) questions. This test aims to measure the ability of students to colorfully express scientific concepts in practice and in practice.

The truthfulness of the applied practical color expression test

The apparent truthfulness of the applied practical color expression test was verified by presenting it in its initial form to (13) competent arbitrators, in order to express their opinions about the ability of the images and paragraphs used to measure the target content, and the suitability of the questions and images for the target sample in the study. In light of the arbitrators' observations, which focused on enlarging the images, clarifying their features and the technical output of the test, the proposed amendments were made, and the criterion adopted in accepting or excluding paragraphs was that the paragraph obtained the consensus of the majority of the arbitrators, and thus the test after arbitration consisted of (30) paragraphs, distributed on two axes, namely: questions related to animal tissues, 15 questions, and questions related to plant tissues, 15 questions.

The coefficients of difficulty and discrimination of the paragraphs of the practical applied color expression test

The difficulty and discrimination coefficients of the test paragraphs were calculated to determine the degree of difficulty of the test paragraphs and their distinguishing strength, by applying the test to the survey sample as shown in **Table (3).**

Table 3. difficulty and discrimination coefficients for the paragraphs of the practical applied color expression test.

Paragraph	Coefficient of difficulty	Coefficient of differentiation	Paragraph	Coefficient of difficulty	Coefficient of differentiation
1	0.62	0.56	16	0.55	0.49
2	0.67	0.82	17	0.39	0.75
3	0.60	0.64	18	0.57	0.46
4	0.45	0.43	19	0.61	0.50
5	0.63	0.59	20	0.68	0.59
6	**0.75**	**0.66**	21	0.72	0.48
7	**0.44**	**0.56**	22	0.68	0.62
8	0.58	0.49	23	0.55	0.52
9	0.52	0.67	24	0.42	0.55
10	0.63	0.40	25	0.47	0.80
11	0.47	0.43	26	0.51	0.63
12	0.70	0.51	27	0.43	0.42
13	0.35	0.46	**28**	**0.35**	**0.44**
14	0.54	0.61	**29**	**0.46**	**0.49**
15	0.58	0.63	30	0.49	0.52

It is clear from **Table (3)** that the values of the difficulty coefficients for the paragraphs ranged between (0.35 - 0.75), and the values of the discrimination coefficients ranged between (0.40-0.82), and these values are acceptable to keep the paragraphs within the test according to the criterion of return (2010), which indicates the retention of the paragraph whose difficulty ranges between (0.20–0.80), and has a discrimination coefficient higher than (0.39), therefore none of the paragraphs were deleted based on the difficulty coefficient or the final form of the test consists of (30) paragraphs.

Application of the Applied Practical Color Expression Test

The pre-test was applied to the study sample at the beginning of the second semester, and the post-test was applied after the completion of teaching the unit (animal and plant tissues) using the learning strategy based on the technical activities of the experimental group and the usual method of the control group, through the biology teacher at the school, who studies the control and experimental divisions.

Practical applied color expression test correction

The test was corrected, and a score of Zero was given if the color choice was wrong, one score if the color choice was correct and the coloring output was poor, and two scores if the color choice was correct and the coloring output was correct, so the minimum mark of the test is (zero) and the maximum mark is (60), and the higher the respondent's score on the test is an indication of the high level of color expression ability in practice of the scientific concept.

Verification of the equivalence of the two study groups in the practical applied color expression

To verify the equivalence of the two study groups in the tribal test applied practical and focal color expression (animal tissues, plant tissues); arithmetic mean and standard deviations of the performance of the tribal study sample on the test were calculated, depending on the study group (control, experimental), and The Independent - Samples T-test was used to reveal the significance of the differences between the arithmetic mean, as is in **Table (4)**.

Table 4. (Independent - Samples T-test) results to reveal the significance of differences between the computational circles of the study sample's tribal performance on the applied practical color expression, with its total significance and its sub-axes depending on the teaching method.

Test and its 2 pivots	Group	Arithmetic mean	Standard deviation	T Value	Degrees of freedom	Statisticalsignificance
Animal tissues	Experimental Control	8.13	**3.48**	-0.293	58	0.771
	Experimental Control	8.40	**3.57**			
Plant tissues	Experimental Control	9.00	4.16	-0.191	58	0.849
	Experimental Control	9.20	3.95			
Practical applied color expression (as a whole)	Experimental Control	**17.13**	**5.48**	-0.331	58	0.742
	Experimental Control	**17.60**	**5.44**			

* A function statistically at the level of significance (α=0.05)

It is clear from **Table (4)** that there are no statistically significant differences at the level of significance (α=0.05) between the computational circles for the performance of the pre-study sample on the applied practical color expression test with its total significance and its sub-axes attributable to the study group (control, experimental). For further statistical control, ANCOVA contrast analysis and the MANCOVA multiple contrast analysis were used.

Educational Material

The educational material was represented by the first module of the biology textbook for the ninth grade issued by the Ministry of education for the academic year (2024/2025), the second chapter is entitled (Animal and plant tissues). The content of the educational material of the unit was organized to achieve the cognitive goals according to the strategy of learning based on artistic activities, and the teacher's guide was prepared as a guide for the application of the unit (animal and plant tissues) according to the strategy of learning based on artistic activities. It also determined the time plan for teaching the unit, which was carried out during the period from 26/1/2025 to 15/3/2025 during the second semester of the academic year 2024/2025.the number of classes necessary to implement teaching according to the learning strategy based on technical activities was twelve classes of (45) minutes per class, the same number of classes approved by the Ministry of Education to teach the unit in the usual way.

Study Procedures

To achieve the objectives of the study, the following methodological procedures were followed:

- Reviewing the theoretical literature and previous studies related to the study tools, and building the study tools in their initial form.
- Identification of the study members, who are students of the ninth grade of the Omar Mukhtar II Basic School for Boys, affiliated to the Directorate of Education of the Kasbah Irbid brigade.
- Verification of the indications of honesty and consistency of the study tools by applying them to a survey sample from the study community and from outside its sample.
- Applying the study tools in their final form, which was represented by the theoretical color expression test and the practical color expression test, to the two study groups before starting teaching the unit (animal and plant tissues), (tribal measurement).
- Training the teacher on the use of the teacher's manual and how to benefit from it through a training session and the implementation mechanism, and the role of both the teacher and the student in the strategy.
- Applying the study tools to the two study groups after the completion of teaching the module (animal and plant tissues), and (telemetry).

- Collecting the responses on the study tools, unloading them, and entering them into the computer to perform statistical manipulations using the SPSS program.

Presentation of the results related to the first question, which stated: what is the impact of the art-based learning strategy on improving the ability of theoretical cognitive color expression of scientific concepts among ninth grade basic students in the Directorate of Education of the Kasbah brigade Irbid?

To answer this question, the values of the arithmetic mean and standard deviations of the theoretical cognitive colorimetric expression of scientific concepts (as a whole) were found in the pre -, post -, and adjusted measurements, for individuals of the experimental and control groups, as shown in Table (5).

Table 5. Arithmetic mean and standard deviations of the theoretical cognitive color expression of scientific concepts in its total significance for the members of the experimental and control groups in the tribal and dimensional measurement and adjusted according to the group variable.

Group	Qty.	Pre-Test		Poat-Test		Adjusted	
		Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation	Adjusted mean	Error
Experimental	30	16.17	2.69	17.87	2.73	17.88	0.51
Control	30	16.93	2.60	22.57	2.74	22.56	0.51

It is clear from **Table (5)** that there are apparent differences between the computational circles of the theoretical cognitive color expression of scientific concepts (as a whole) among the members of the experimental and control groups of ninth-graders in the dimensional measurement depending on the group variable, and to verify the essence of the apparent differences, (One way ANCOVA) was used, after taking into account the degrees of tribal measurement of the theoretical cognitive color expression of scientific concepts (as a whole) for each of the two groups, as an accompanying variable, as shown in **Table (6)**.

Table 6. Results (One-way ANCOVA) of the dimensional measurement of the theoretical cognitive color expression of scientific concepts (as a whole) in the individuals of the study sample according to the group variable

Source of variability	Squares	Degrees of freedom	Average squares	F Value	Level of significance	Eta square
Pre-Test	0.191	1	0.191	0.025	0.875	
Teaching method	322.019	1	322.019	*42.425	0.000	0.427
Error	432.643	57	7.590			
Total	764.183	59				

* A function statistically at the level of significance (α=0.05)

** (The size of the effect according to Kilani and Sharifin, 2014: weak (less than 0.06), medium (0.15-0.06), large (0.16 and above)).

It is clear from **Table (6)** that there is a statistically significant difference at the level of significance (0.05=α) between the two computational mediums for the dimensional measurement of the theoretical cognitive color expression of scientific concepts (as a whole) depending on the group variable (experimental, control), in favor of the experimental group that was taught using the strategy of art-based education and the magnitude of the impact on the development of the theoretical cognitive color expression of scientific concepts (as a whole) indicated by the value of the ETA square () (%42.70), and this value is high according to Al-Kilani and Al-Sharifeen (2014).

The arithmetic mean and standard deviations of the pre -, post-and modified measurement of the axes of theoretical cognitive color expression of scientific concepts were also calculated depending on the group variable (experimental, control), as shown in **Table (7).**

Table 7. Arithmetic mean and standard deviations of the axes of theoretical cognitive color expression of scientific concepts among the members of the experimental and control groups in the tribal and dimensional measurement and adjusted according to the group variable

Axis	Group	Qty	Pre-Test		Post-Test		Adjusted	
			Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation	Arithmetic mean	Error
Animal tissues	Experimental Control	30	9.13	1.79	9.97	**1.99**	**9.95**	0.35
	Experimental Control	30	9.73	1.89	11.40	1.65	11.42	0.35
Plant tissues	Experimental Control	30	7.73	1.95	7.90	1.54	7.98	0.32
	Experimental Control	30	7.20	**1.37**	**11.17**	1.76	11.09	0.32

It is evident from **Table (7)** that there are apparent differences between the computational circles of the two axes of theoretical cognitive color expression of scientific concepts (animal tissues, plant tissues) in the members of the experimental and control groups in telemetry depending on the group variable, and to verify the essence of the apparent differences, the analysis of multiple accompanying single contrast (one way MAN-COVA) was used, after taking into account the degrees of tribal measurement in each axis separately for both groups, as an accompanying variable, as shown in Table(8).

Table 8. Results (one-way MANCOVA) of the dimensional measurement of the axes of theoretical cognitive color expression of scientific concepts in the study sample according to the group variable

Source of variability	Axis	Squares	Freedom	Squares average	F Value	Statistical significance	Eta square
Pre-Test	Animal tissues	0.194	1	0.194	0.056	0.814	
	Plant tissues	0.154	1	0.154	0.055	0.815	
Teaching method	Animal tissues	54.698	1	54.698	*15.795	0.000	0.220
Hotelling's Trace=0.824/ F=22.673 Sig=0.000*	Plant tissues	73.763	1	73.763	*26.353	0.000	0.320
Error	Animal tissues	193.956	56	3.463			
	Plant tissues	156.758	56	2.799			
Total	Animal tissues	248.848	59				
	Plant tissues	230.675	59				

* A function statistically at the level of significance (α=0.05)

** (The size of the effect according to Kilani and Sharifin, 2014: weak (less than 0.06), medium (0.15-0.06), large (0.16 and above)).

It is clear from **Table (8)** that there are statistically significant differences at the level of significance (0.05=α) between the computational circles of the dimensional measurement of the axes of theoretical cognitive color expression of scientific concepts depending on the group (experimental, control) in favor of the experimental group. The size of the effect in improving the ability of theoretical cognitive color expression of scientific concepts in the two axes of color expression, which is indicated by the value of the ETA square (%22.00) for the axis (animal tissues) and(%32.00) for the axis (plant tissues), and the level of this effect was high in all axes according to Al-Kaylani and Al-sharifin (2014). This means that the use of the strategy of Education based on artistic activities contributed to the development of the two axes of theoretical cognitive color expression of scientific concepts among the study sample to a high degree, and was more influential in the plant tissue axis, followed by the animal tissue axis.

Presentation of the results related to the second question, which stated: what is the impact of the learning strategy based on artistic activities in improving the ability of practical and applied color expression of scientific concepts among ninth grade basic students in the Directorate of education of the Kasbah brigade Irbid?

To answer this, the values of the arithmetic mean and standard deviations of the applied practical colorimetric expression of scientific concepts (as a whole) were found in the pre -, post-and adjusted measurement, for the individuals of the experimental and control groups, as shown in Table (10).

Table 9. Computational circles and standard deviations of the applied practical color expression of scientific concepts with its total significance for the members of the experimental and control groups in the tribal and dimensional measurement and adjusted according to the group variable

Group	Qty.	Pre-test		Post-test		Adjusted	
		Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation	Adjusted mean	Error
Experimental control	30	17.13	**5.48**	20.43	5.22	20.44	0.96
	30	17.60	**5.44**	33.60	5.18	33.59	0.96

It is clear from **Table (9)** that there are apparent differences between the computational circles of the applied practical color expression of scientific concepts (as a whole) among the members of the experimental and control groups of ninth-graders in dimensional measurement depending on the group variable, and to verify the essence of the apparent differences, the (W way ANCOVA) was used, after taking into account the degrees of the pre-measurement of the applied practical color expression of scientific concepts (as a whole) for each of the two groups, as an accompanying variable, as shown in Table (11).

Table 10. Results (One-way ANCOVA) of the dimensional measurement of the practical applied color expression of scientific concepts (as a whole) in the individuals of the study sample according to the group variable

Source of variability	Squares total	Freedom	Squares average	F Value	Deviation level	Eta square
Pre-test	2.118	1	2.118	**0.212**	0.647	
Teaching method	789.067	1	789.067	***79.120**	0.000	0.581
Error	568.449	57	9.973			
Total	1359.634	59				

* A function statistically at the level of significance (α=0.05)

** (The size of the effect according to Kilani and Sharifin, 2014: weak (less than 0.06), medium (0.15-0.06), large (0.16 and above)).

It is clear from **Table (10)** that there is a statistically significant difference at the level of significance (0.05=α) between the two computational mediums for the dimensional measurement of the applied practical color expression of scientific concepts (as a whole) depending on the group variable (experimental, control), in favor of the experimental group, and the size of the impact on the development of the applied practical color expression of scientific concepts (as a whole) indicated by the value of the ETA () (58.10%), and this value is high according to Al-Kaylani and Sharifin (2014).

The arithmetic mean and standard deviations of the pre -, post-and modified measurement of the axes of the applied practical color expression of scientific concepts were also calculated depending on the group variable (experimental, control), as shown in Table **(11).**

Table 11. Computational circles and standard deviations of the axes of practical applied color expression of scientific concepts among the members of the experimental and control groups in the tribal and dimensional measurement and adjusted according to the group variable

Axis	Group	Qty.	Pre-Test		Post-Test		Adjusted	
			Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation	Adjusted mean	Error
Animal tissue	Experimental control	30	8.13	3.48	9.77	4.00	9.78	0.72
		30	8.40	3.57	16.80	3.81	16.79	0.72

Axis	Group	Qty.	Pre-Test		Post-Test		Adjusted	
			Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation	Adjusted mean	Error
Plant tissues	Experimental	30	9.00	4.16	10.67	3.58	10.66	0.71
	control	30	9.20	3.95	16.80	4.12	16.81	0.71

It is clear from Table (11) that there are apparent differences between the computational circles of the two axes of practical applied color expression of scientific concepts (animal tissues, plant tissues) among the members of the experimental and control groups in telemetry depending on the group variable, and to verify the essence of the apparent differences, the analysis (one way MANCOVA) was used, after taking into account the degrees of tribal measurement in each axis separately for both groups, as an accompanying variable.

RESULTS

These results may be attributed to the fact that the strategy of learning based on artistic activities made students multiple learning paths that combined visual perception, color discrimination and practical skill, which was consistent with the nature of the applied test, which included images of plant and animal tissues, and the student was asked to choose the appropriate scientific color and apply it in practice. This assessment was not limited to testing theoretical knowledge, but required a thorough understanding of the biological structure of the fabric, a link between color and function, as well as a perfect visual implementation.

Hence, coloring was not a free artistic activity but a cognitive performance-practically disciplined by scientific standards, theoretical understanding translates into conscious choice and careful expressive execution, which explains the obvious differences in performance between the two groups. The high value of the ETA box (58.10%) confirms the integration of knowledge with practical skill, as the classroom activities enabled students to train on the choice of colors and understand their scientific connotations, and then employ them in a visual production that reflects understanding and not just artistic ability.

The superiority of the students in the animal tissue axis compared to the plant one was due to the more complex nature of the images, which made the interaction and previous training more influential for the experimental group. The High improvement rates (90.91%) are further evidence of the effectiveness of the strategy, as the combination of realistic images and applied assignments allowed students to transform the scientific concept into an accurate and expressive visual product.

Thus, the results confirm that artistic activities were not just supportive means, but a basic nucleus for building complex scientific-expressive abilities, reflected in the use of color as a tool for understanding, analysis and application, which makes learning deeper and more integrated between the cognitive and skill side.

RECOMMENDATIONS

Specialized training programs should be prepared for teachers in integrating art and science in a systematic way that achieves learning goals and takes into account individual differences between students.

Studying the impact of the strategy of artistic activities on the development of several variables such as: creative thinking and problem solving, gender, trends towards science, and geographical area.

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