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The Expressive Effect of Symbolist Painting in College Arts Education Based on Deep Learning and IoT Technology

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Abstract The arts hold a significant position in human culture, serving as a medium for preserving national heritage and conveying distinctive cultural elements, emotions, and national spirit. The historical development of the arts has given rise to diverse cultural forms, contributing to the establishment of a distinctive system of artistic traditions in China that constitutes a valuable and integral part of Chinese culture. Arts education in colleges and universities should foster an understanding of the essential role of the arts in cultural preservation, encourage active engagement with cultural heritage, and cultivate genuine emotional connections and a profound appreciation for national culture. Symbolist painting encompasses diverse styles that employ suggestive expressions to explore a spiritual realm beyond reality, making it a significant subject of study within arts education. This research analyzes the concepts and cultural background of Symbolist painting theory and investigates its application in college arts education in China, considering current teaching practices. The findings demonstrate that the optimized Graph-Cut method substantially enhances the accuracy and fitting performance of Symbolist painting analysis, providing technical support for its study and application in college arts education. The research highlights the potential value of incorporating Symbolist painting into arts education to enrich teaching content and encourage aesthetic understanding.

Index Terms symbolism; college arts education; Graph-Cut algorithm optimization; data fitting

I. Introduction

The symbolist movement emerged in nineteenth-century France in response to social changes and inner turmoil, reflecting feelings of disillusionment, vulnerability, and sensitivity. Symbolist thinkers and their ideas shaped the movement, which significantly influenced various forms of artistic expression, including literature, music, and painting [1], [2].

In recent years, colleges and universities offering arts programs have expanded considerably. However, humanities and social sciences education within some arts programs remains insufficient, with greater emphasis placed on professional skills than on exploring the essence of artistic expression. Traditional teaching methods often neglect students' subjectivity and emotional awareness, limiting the development of their aesthetic abilities. In painting-related programs, some students prepare for admission through short-term intensive courses that prioritize examination performance over a solid artistic foundation. Such preparation may result in a superficial and utilitarian understanding of artistic knowledge.

Although the term "symbolism" originated in poetry, its influence on painting is undeniable. Symbolist painters, responding to the darker aspects of industrial society, expressed their inner emotional experiences through metaphorical representations. Symbolist painting explores profound human concerns, including life, death, desire, love, nature, and the

mystical [1], [3]. Rather than merely depicting the external world, it investigates fundamental aspects of human experience.

Within painting-related courses in university arts education, existing Western-style sketching instruction presents several challenges. First, a narrow understanding of the value of sketching can lead to a limited instructional approach. Second, teaching may prioritize extended drawing assignments over fundamental artistic principles and compositional awareness. Third, an excessive emphasis on entrance examinations and formulaic drawing exercises can hinder effective instruction. During their pre-admission studies, some students develop passive thinking patterns and standardized approaches to painting. Insufficient attention to active observation, subjectivity, and aesthetic awareness can subsequently limit meaningful teacher-student interaction at the university level.

Symbolism encompasses various artistic groups connected by shared creative pursuits and conceptual orientations [1]. It developed during a complex and turbulent period in Europe that provided fertile ground for artistic experimentation [1]. Symbolist painting flourished within this context, displaying diverse styles and substantial creative productivity.

This paper examines existing research on Symbolist painting theory and practice to establish a foundation for its application in college arts education. It explores the expressive

characteristics of Symbolist painting and its educational relevance, particularly its capacity to encourage reflection on human nature [3].

Studies of Symbolist art discuss how images evoke spiritual themes and convey symbolic meanings [3]. Within art history, Symbolism is not confined to a single conventional genre but represents an artistic tendency that developed during a particular historical period. Artists associated with this tendency employed symbolism and allegory to construct imaginary and illusory worlds within their works [1]. In late nineteenth-century France, artists from different schools incorporated symbolic expression into their paintings without adhering to a uniform style. Their shared emphasis on symbolic meaning contributed to the recognition of “Symbolism” as a distinctive artistic tendency [1].

The adoption of Western drawing and painting practices, including sketching and color studies, remains an important component of painting-related courses within college arts education. However, the expansion of enrollment in China’s higher education institutions has introduced new instructional challenges. Meeting the needs of contemporary arts education requires continuous refinement of teaching content and methods. Multimedia technologies have become increasingly common in arts classrooms, incorporating background music, film, television, and animation into instruction [4]–[7]. Carefully selected classroom examples can stimulate students’ creativity, imagination, and individuality while supporting engagement with traditional national arts and the development of aesthetic understanding. Such an approach reflects the broader educational purpose of aesthetic education [6].

In the early twentieth century, modernist artists associated with Fauvism introduced significant changes in artistic expression through experiments with form and color. Their explorations challenged conventional relationships between form, content, and the representation of reality, contributing to broader discussions of artistic expression and abstraction [1], [3]. Symbolist artists, influenced by irrationalist philosophy and psychology, sought to express their understanding of the world through inner intuition rather than relying solely on external sensory experience. They valued sincere emotional expression and treated expressiveness as an important consideration in their selection of artistic forms. The intensity and depth of this expression distinguished Symbolism from other approaches to painting [1]–[3].

Symbolist artists employed powerful visual language to move beyond conventional representation and communicate emotional responses to the dissatisfaction and disappointment of their time [1], [3]. Originating in France, Symbolism offered an alternative to the emphasis on external reality associated with Impressionism and Naturalism. Its connections with mysticism and the ideal world encouraged the exploration of experiences beyond direct observation. This artistic tendency spread across Europe, resonating with contemporary emotional and intellectual concerns.

In a related but distinct image-processing setting, Zhou et al. [8] proposed a method for enhancing underwater images

through multi-interval subhistogram perspective equalization. The method addresses challenges associated with underwater imaging, including low contrast, color distortion, and loss of detail. By analyzing subhistograms across different intensity intervals, the technique improves visual quality through enhanced contrast, reduced color casts, and clearer details. Experimental results support its effectiveness in underwater image enhancement.

Another study by Zhou et al. [9] presented a cross-view enhancement network specifically designed for underwater images. Using deep learning, the network addresses limited visibility and image degradation caused by water turbidity and inadequate lighting. Through training on a large underwater image dataset, it learns to restore image clarity and improve visibility. Experimental evaluations demonstrate its effectiveness in enhancing underwater image quality.

Introducing Symbolist painting theory into college arts education in China can enrich instructional content and encourage students to explore the relationship between artistic expression, cultural meaning, and human experience. This paper examines the concepts and cultural background of Symbolist painting theory and considers its relevance to contemporary arts education. An optimized Graph-Cut method is employed to support the analysis of Symbolist painting, with the reported results indicating a 5% improvement in accuracy and enhanced fitting performance. These technical findings support the proposed image-analysis approach, while the educational discussion highlights the potential contribution of Symbolist painting to curriculum development. Integrating Symbolist painting theory into university arts curricula may provide opportunities to strengthen students’ aesthetic interpretation, reflective thinking, and engagement with artistic meaning [1].

II. Graph-Cut Algorithm Optimization

Processing pixel-level class probability maps requires addressing the limitations of assigning each pixel directly to the class with the highest predicted probability. For painting images used in arts education, particularly traditional figure paintings, preserving lines and boundaries is essential for retaining visual structure and expressive details. However, pooling and downsampling operations in convolutional neural networks may cause the loss of fine spatial information, reducing the precision of segmentation boundaries. Moreover, when the predicted probabilities of competing classes are similar, selecting the highest-probability class without considering spatial relationships may produce incorrect or inconsistent labels. Post-processing is therefore introduced to refine the network’s segmentation outputs while preserving details relevant to artistic interpretation.

To address these limitations, this study uses Graph-Cut post-processing to combine pixel-level predictions with relationships between neighboring pixels [10], [11]. The image is represented as a weighted graph G with pixel nodes and two terminal nodes: a source S , representing the foreground, and a sink T , representing the background. Edges connect

neighboring pixels and link individual pixels to the terminal nodes, as illustrated in Figure 1.

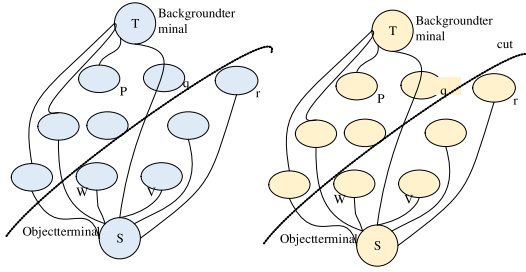


Figure 1: Graph-based image representation for Graph-Cut segmentation

In the binary segmentation formulation, edges between neighboring pixels encode spatial-consistency constraints. They encourage strongly connected pixels to receive the same label, without requiring all adjacent pixels to belong to the same class. Instead, their weights determine the cost of assigning different labels to neighboring pixels. Edges connecting pixels to the terminal nodes encode the costs of foreground and background assignments.

Segmentation is performed by finding a minimum-cost cut that separates the source and sink nodes. Pixels connected to S after the cut are assigned to the foreground, whereas pixels connected to T are assigned to the background. Thus, each pixel receives a label through graph-based optimization rather than an independent maximum-probability decision. The segmentation energy is defined in Eq. (1).

$$E(A, I) = U(A, I) + B(A, I). \quad (1)$$

In Eq. (1), I denotes the image-pixel matrix, A denotes the corresponding segmented-label matrix, $U(A, I)$ is the unary data term, and $B(A, I)$ is the boundary term. Each label represents either the background or the target foreground. The unary term is defined in Eq. (2).

$$U(A, I) = \sum_{i,j} -\ln(h(A(i, j), I(i, j))). \quad (2)$$

The boundary term measures the weighted disagreement between neighboring pixel labels. Its pairwise formulation is given in Eq. (3).

$$B(A, I) = \lambda \sum_{(m,n) \in N} \delta(A(m), A(n)) \exp(-\beta \text{dist}(m, n)). \quad (3)$$

This section also describes brushstroke-feature extraction. The six brushstroke subimages with the highest densities in each painting are selected as input features for classification. The extraction procedure is shown in Figure 2.

A brushstroke is the trace left by an artist's brush during painting. Its distinctive features are often visible at the beginning and end of a stroke, particularly near image boundaries. An image edge is a local region where pixel intensity changes

sharply enough to be visually perceptible. Edge detection is widely used in applications such as face recognition and motion detection in video. The three forms of image edges considered in the extraction process are illustrated in Figure 3.

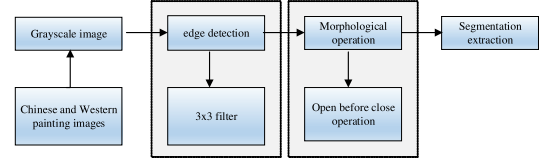


Figure 2: Flowchart of extracting brushstroke features

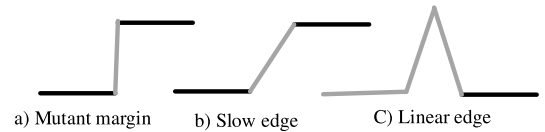


Figure 3: Three forms of image edges

The Laplacian operator applied to a function f is defined in Eq. (4).

$$\Delta f = \nabla^2 f = \nabla \cdot \nabla f. \quad (4)$$

Pixel-class probability distributions estimated from gray-level histograms and Gaussian mixture models are often approximate. For image segmentation, iterative refinement or manual interaction may therefore be required. Chinese painting commonly emphasizes the relationships between colors and variations in ink intensity. To characterize local color variation, the pixelwise color difference is calculated using Eq. (5).

$$d(I_i) = \sum_{j \in N(i)} |I_i - I_j|. \quad (5)$$

The color-difference values are then mapped into a histogram. Assuming that M denotes its maximum value, the resulting color-contrast feature f_1 is expressed in Eq. (6).

$$f_1 = \log M. \quad (6)$$

Variance describes how a model's predictions change across training sets and thus reflects sensitivity to variations in the training data. The expected error is expressed as a combination of squared bias, variance, and irreducible noise in Eq. (7).

$$E(f; D) = \text{bias}^2(x) + \text{var}(x) + \varepsilon^2. \quad (7)$$

The algorithm trains a style-specific feedforward generator φ . During training, batches of content and style images are used to calculate a perceptual loss, and the model parameters are updated iteratively. During inference, the trained network transforms a new content image. Perceptual-loss approaches to image style transfer have been described in the literature

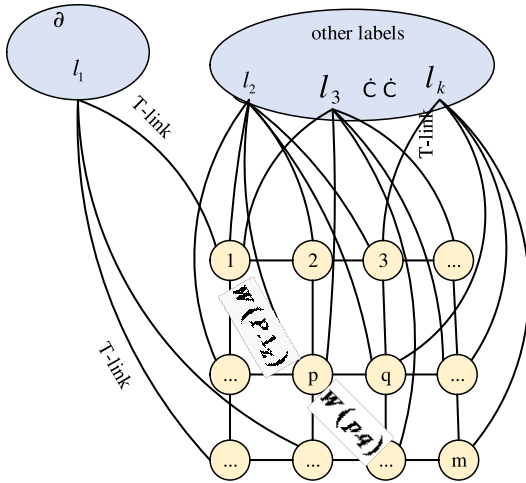


Figure 4: Image-based iterative flowchart

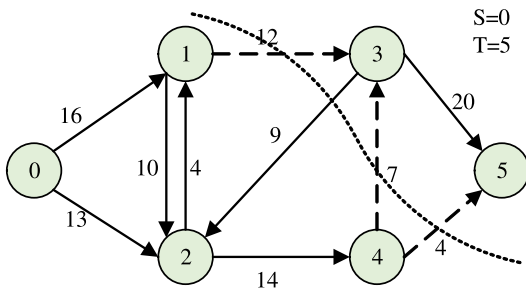


Figure 5: Model-based iterative flowchart

[12]. The image-based iterative procedure and the model-based iterative procedure are presented in Figures 4 and 5, respectively.

Image segmentation is a fundamental computer-vision task in which an image is partitioned into meaningful, distinct regions. It supports applications such as object detection, image recognition, and medical imaging. Several segmentation algorithms are available, each with specific advantages and limitations.

Graph-Cut is a graph-based optimization method that partitions an image by minimizing the cost of separating regions. Pixels or superpixels are represented as graph nodes, and edges encode relationships between neighbors. Weighted edges, defined using similarities or differences in pixel characteristics, allow the method to identify segmentation boundaries while balancing regional consistency and boundary preservation [10], [11].

Graph-Cut methods can handle complex image structures and preserve fine boundaries; some formulations also support multiclass segmentation. However, computation can be demanding for large images, and some applications require manual initialization or parameter tuning.

The selection of a segmentation algorithm depends on the application and on the characteristics of the input images. Ongoing research therefore seeks to improve segmentation accuracy, computational efficiency, and robustness.

The proposed image-segmentation procedure combines convolutional-neural-network predictions with Graph-Cut optimization. The parameter λ in Eq. (3) controls the influence of the boundary term on the resulting cut and, consequently, on the segmentation output. Because segmentation quality depends on this parameter, λ can be adjusted interactively and the optimization repeated to obtain suitable segmentation results for different images.

The potential advantages of the combined image-segmentation approach include:

- Accurate segmentation: The algorithm can provide precise and fine-grained segmentation results, capturing intricate details and boundaries in the image.
- Handling complex structures: The algorithm is effective in dealing with images that contain complex structures, textures, and objects with irregular shapes.
- Multi-class segmentation: It can handle segmentation tasks with multiple classes or labels, allowing for the differentiation of various objects or regions in the image.
- Preservation of boundaries: The algorithm considers the relationships between neighboring pixels and aims to preserve meaningful boundaries between segments, resulting in visually coherent segmentation results.
- Flexibility: The algorithm can be adapted to different types of images and applications, allowing for customization based on specific requirements.

III. Methods

Symbolist theorists explored synesthesia and the relationship between visible appearances and an imagined, more mysterious world. From this perspective, visible artistic forms can suggest experiences or meanings that cannot be directly observed. The painter's task is to convey this concealed dimension through recognizable images and symbols. Symbolist painting can transform familiar figures through fragmentation, distortion, and recombination to create images with greater expressive tension.

Symbolist painting uses metaphor and symbolic imagery to suggest an imaginary or spiritual world through recognizable objects. Transformations of forms drawn from reality contribute to this expressive process. Figure 6 presents the perceptual-loss network and its relationship to the proposed style-transfer and Graph-Cut optimization procedure, which is used to obtain the objective function.

After optimization, the minimum-cut procedure produces the cut set C . This cut is used to complete image segmentation and refine the output of the deep-learning-based semantic-segmentation network. The sequence of steps in the improved Graph-Cut algorithm is illustrated in Figure 7.

Teachers need to draw selectively on knowledge from art and related disciplines, taking account of learning objectives and limited classroom time. Practical arts courses rely heavily on direct observation and perception. Teachers therefore use models, paintings, physical objects, visual teaching aids, and demonstrations at the drawing board. These activities help students recognize the shapes and color characteristics of

objects [13]. However, students enter university with different levels of preparation, and live demonstrations cannot always be repeated or adapted to individual learning needs. Limited class time and the amount of material to be demonstrated can also prevent students from fully understanding the techniques being taught.

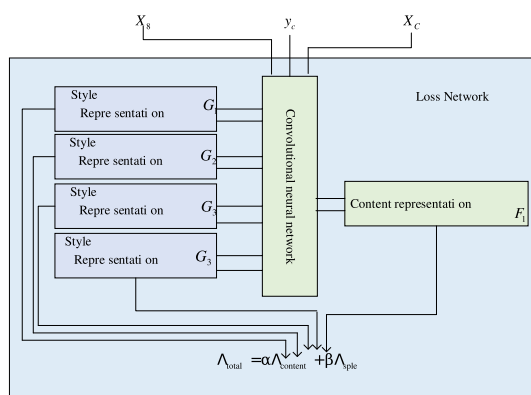


Figure 6: Schematic diagram of image style transfer Graph-Cut algorithm optimization

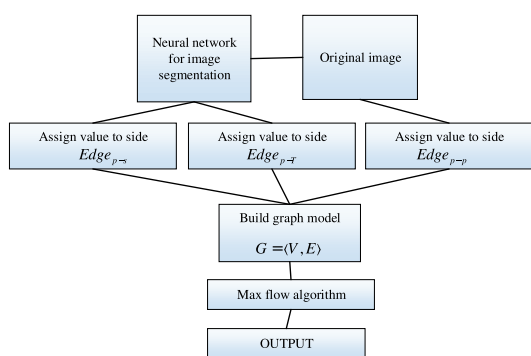


Figure 7: Flowchart of the improved Graph-Cut algorithm

The blended arts-teaching model comprises eight steps: defining learning objectives, establishing expected learning performance, selecting channels and media, designing learning activities, determining support strategies, observing student actions, evaluating learning, and revising the learning plan. This sequence is illustrated in Figure 8.

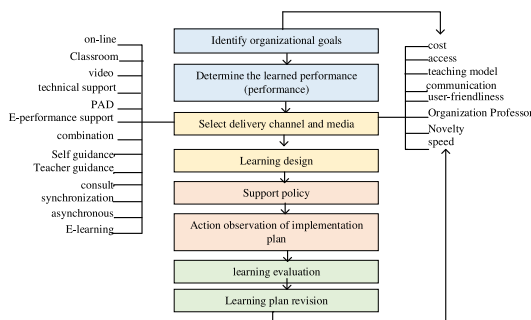


Figure 8: Blended teaching model

Figure 9 presents an online–offline instructional design model organized around six components: teaching analysis, teaching content, teaching strategy, teaching media, teaching process, and teaching evaluation.

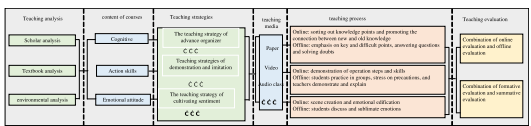


Figure 9: Online–offline blended teaching model

The online–offline blended-teaching approach draws on humanist and constructivist perspectives as well as Edgar Dale’s Cone of Experience. Dale’s model represents learning experiences along a continuum from concrete participation to more abstract forms of representation; it does not establish fixed learning-retention percentages [14]. This conceptual relationship is illustrated in Figure 10.

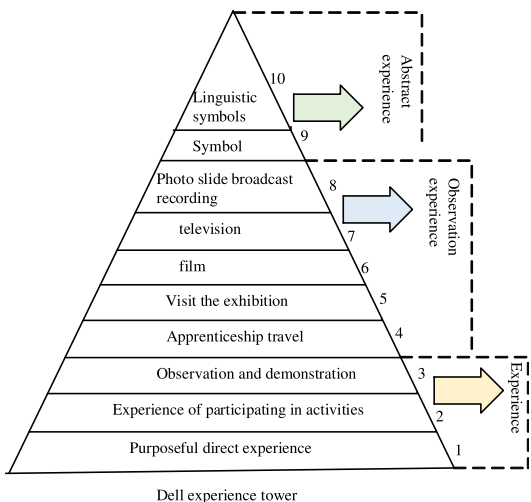


Figure 10: Dale’s Cone of Experience

Symbolist painting emerged in the late nineteenth century and emphasized emotions, abstract ideas, and subjective experiences through symbols and metaphors. Departing from conventional realism, Symbolist painters explored dreams, spirituality, and the subconscious, often creating an atmosphere of mystery and introspection. Their work sought to move beyond physical appearances and convey deeper meanings, contributing to later artistic experimentation.

The influence of Symbolist painting theory can also be traced in the expressive priorities of later Western painters. Across changes in artistic style, artists’ intended meanings and viewers’ interpretations remain central concerns. Symbolist painting extends beyond naturalistic representation, and its emphasis on personal expression contributed to the development of modern painting. Studying this approach also informs the author’s reflections on artistic practice.

In summary, Symbolist artworks use specific images and symbolic forms to communicate dreams and subjective experiences. Their emphasis on imaginative and abstract think-

ing offers opportunities for artistic experimentation. Contemporary college arts education should encourage students to develop aesthetic awareness while acquiring diverse artistic knowledge and practical skills, thereby supporting the education of innovative practitioners.

IV. Case Study

The improved algorithm was evaluated on an art-image dataset. During the experiment, interactive parameter settings were supplied to the segmentation procedure. Table 1 compares the reported mean intersection over union (mIoU) and mean pixel accuracy (MPA) of the neural-network baseline, the combined method at three values of λ , and the standalone Graph-Cut algorithm. The combined method achieved its highest reported results at $\lambda = 100$, with an mIoU of 84.6% and an MPA of 96.3%, compared with baseline values of 80.8% and 90.3%, respectively.

Table 1: Results of the improved Graph-Cut algorithm on the art-image dataset

Algorithm	mIoU	MPA
Neural network algorithm	80.8%	90.3%
Neural network algorithm + improved Graph-Cut algorithm ($\lambda = 50$)	81.2%	92.2%
Neural network algorithm + improved Graph-Cut algorithm ($\lambda = 100$)	84.6%	96.3%
Neural network algorithm + improved Graph-Cut algorithm ($\lambda = 150$)	78.6%	88.1%
Graph-Cut algorithm	32.4%	41.2%

For one-shot learning, resampling is one way to generate supplementary training data. If resampled subsets are entirely disjoint, each base discriminator may receive too little information to learn effectively. Some overlap is therefore necessary; however, excessive overlap makes the learned discriminators too similar and reduces their diversity. For online single-sample generation, the resampled subsets should retain as much information as possible from the available examples. In few-shot generation tasks that allow offline processing, part of the data can be reserved for testing while the remaining data are resampled for training, for example through bootstrap sampling. The loss-function polyline learning process is illustrated in Figure 11.

Symbolist painting developed amid changing social ideas, and artists continually reconsidered and refined their expressive methods. Rather than remaining confined to representations of physical objects, Symbolist works invite imaginative interpretation and often convey mystery. In college teaching, the design of foundational modeling courses should respond to the conditions of individual institutions; no single teaching model is equally suitable for every discipline. Basic color-modeling courses combine practical training with theoretical study. Color and graphic-language courses can employ a wide range of tools, materials, and expressive techniques, with graphic language serving as a form of visual communication.

Combining new forms of university arts instruction with traditional classroom teaching can accommodate differences in students' prior knowledge and support the integration of

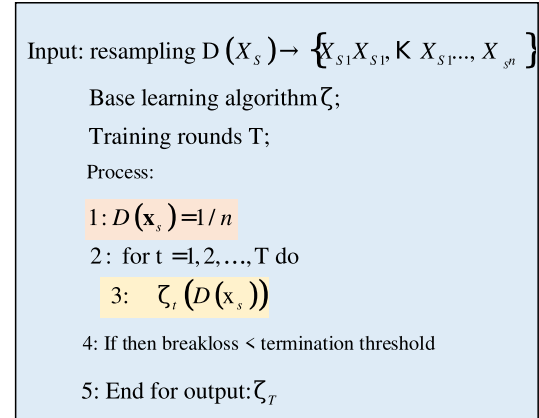


Figure 11: Loss-function polyline learning flowchart

theory and practice. Online materials offer flexibility, replay, and access independent of the classroom schedule, whereas face-to-face instruction supports immediate demonstrations and guided practice. Table 2 compares the learning formats, student capacity, instructional content, flexibility, interaction, and flipped-learning activities of online and traditional classrooms.

Table 2: Comparison of online and traditional classrooms

Category	Online classroom	Traditional classroom
Learning form	Video-based learning and on-line discussion	Teacher-led instruction and demonstration, followed by guided practice
Number of students	No fixed classroom seating limit	Limited by classroom capacity
Lesson format	Short videos of approximately 5–15 minutes suit focused instruction	A 40-minute class supports more integrated and systematic instruction
Course content	Content can extend beyond classroom time and include additional resources	Content must be selected and refined to fit the available class time
Freedom	Videos can be replayed; students need self-direction and initiative	Scheduled face-to-face attendance; live explanations may not be repeated
Interaction	Self-thinking after listening and watching the video, the teacher's influence on students is weakened, and it is suitable for non-face-to-face network Interaction	Face-to-face guidance, demonstration, questioning, and immediate practice
Flipped learning	Short preparatory videos supplemented by interactive questions and answers	Lectures, demonstrations, practice, and questions and answers

Symbolist painting reflects artists' responses to the social changes and tensions of the nineteenth century. Some artists used metaphor and symbolic imagery to convey dissatisfaction, disillusionment, and emotions that conventional realism could not readily represent. Their paintings address themes such as life, death, desire, love, the passage of time, and mysterious natural settings. Figure 12 presents examples of classical Symbolist painting forms.

In works associated with Symbolism, artists often return to particular metaphoric images. Such recurring symbols help establish an individual visual language, while differences in experience and worldview shape each artist's selection and interpretation of imagery. Symbolist painting frequently priv-

illegals fantasy, dreamlike atmosphere, and spiritual meaning over the depiction of physical reality. Religious and mythological subjects provide particularly rich sources of mystery and symbolic associations. Figure 13 illustrates this hazy, suggestive quality.

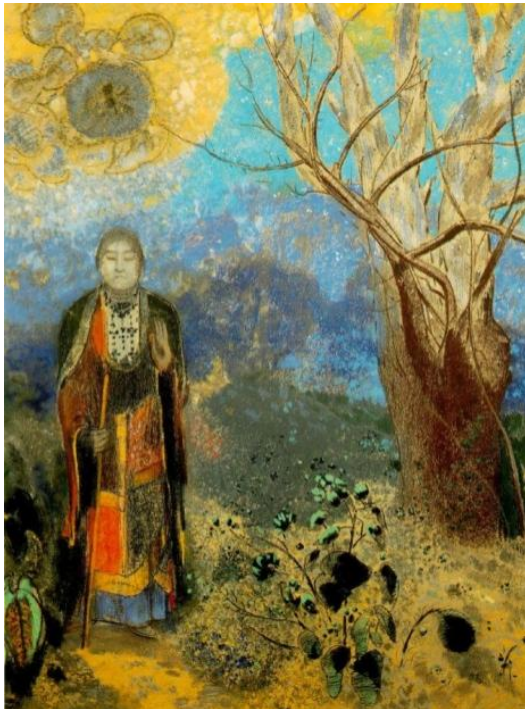


Figure 12: Classical Symbolist painting forms



Figure 13: The hazy beauty of Symbolist painting

Like verbal language, painting communicates ideas and emotions. Through symbolic images, artists convey subjective

experiences that viewers may interpret in different ways. In the scene discussed here, a goddess of fate holds a sword and appears to govern life and death. Heavy colors and a stylized, non-naturalistic figure contribute to an atmosphere of fear and mortality. Viewers actively construct meaning by considering the work's expressive choices and symbolic details. This form of spiritual and emotional communication is illustrated in Figure 14.

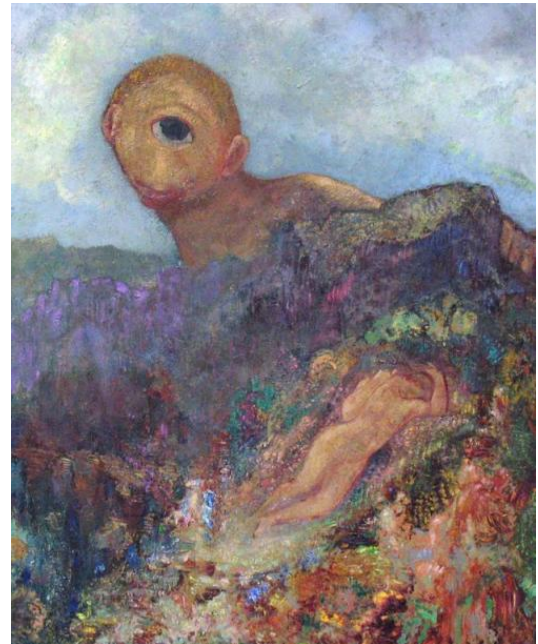


Figure 14: Spiritual communication in Symbolist painting

In contemporary offline teaching for art and design majors, both teaching-process data and learning-outcome data can be collected. Integrating these data across the teaching-management system can make it easier to analyze instructional activities. Data visualization may support teaching management through clearer information hierarchies and the deliberate use of graphical and color contrasts. However, information collected by one module of a teaching-management application is often used only within that module. For example, attendance information may be reduced to a score rather than used to understand attendance patterns and classroom participation. Linking related data across modules can help administrators review teaching activity more comprehensively and improve the coordination of teaching resources.

In summary, introducing Symbolist painting theory into modern arts instruction allows teachers to explain the movement's origins and development, discuss its visual language, and present representative works. Digital materials and blended classroom activities can provide additional ways to organize and communicate these lessons [4], [5].

V. Conclusion

This study examines the expressive characteristics of Symbolist painting and their relevance to contemporary artistic prac-

tice and college arts education. Symbolist painting extends beyond the representation of external appearances to explore inner experiences, spiritual concerns, and interpretations of human nature. Its symbolic, decorative, and mysterious visual language provides distinctive approaches to communicating emotions and constructing artistic meaning. Although artistic movements and forms of expression continue to change, the relationship between artists' expressive intentions and viewers' aesthetic experiences remains central to understanding artistic creation.

The analysis highlights the contribution of Symbolist painting to the development of modern artistic expression. Rather than following a uniform style, artists draw on symbolic imagery and diverse expressive techniques to communicate personal experiences, attitudes toward life, and understandings of human nature. The significance of Symbolism therefore lies not merely in its recognizable visual features but also in its emphasis on the relationship between artistic form and inner meaning. Studying these relationships offers opportunities to reconsider creative choices, deepen reflection on emotional experience, and develop an individual artistic language rather than reproduce established styles.

Within college arts education, Symbolist painting provides a valuable subject through which to connect technical practice with aesthetic interpretation, emotional awareness, and reflection on human experience. Its educational application should encourage students to examine how imagery, composition, and expressive choices contribute to meaning, while recognizing that artworks may invite multiple interpretations. These implications represent pedagogical possibilities rather than demonstrated improvements in learning outcomes. Future teaching and creative practice should further explore how engagement with Symbolist painting can support independent interpretation and experimentation, enabling students to draw critically on artistic traditions while developing their own expressive approaches.

Consent for publication

The author reviewed the results, approved the final version of the manuscript, and consented to its publication.

Data Availability

The experimental data used to support the findings of this study are available from the author upon request.

Conflicts of Interest

The author declares no conflicts of interest regarding this work.

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