

Exploring the Significance and Path of Interdisciplinary Integration of Art Education in Primary and Secondary Schools in the Era of Artificial Intelligence

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Abstract: With the advent of the artificial intelligence (AI) era, there is a need to create a more flexible and humanistic educational ecosystem to adapt to the changes. Education needs to move from a unidirectional focus on skills to the cultivation of creative “whole people.” Due to the non-standardized evaluation system of the art discipline, its education has a unique advantage for the cultivation of students’ creativity. At the same time, the interdisciplinary integration of fine arts points to the educational goals in the era of AI and the educational requirements for cultivating students’ core qualities in China. Therefore, this paper analyzes the theoretical basis and developmental evolution of interdisciplinary integration, studies the significance of interdisciplinary integration in art education from the three levels of students, teaching, and disciplines, and explores four effective paths to realize interdisciplinary integration in art education in the era of AI. In this way, students can realize the contextualized analysis of knowledge, in-depth understanding of the content of the discipline, and accurate expression of the spiritual values embedded in art interdisciplinary learning. The ultimate goal is to cultivate students’ ability to solve complex problems, promote the development of students’ free personalities, and respond to the national education requirements.

Keywords: Artificial intelligence (AI); Art education; Primary and secondary art education; Interdisciplinary; Core literacy

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1. Theoretical basis and significance of interdisciplinary integration in art education

1.1. Theoretical basis of interdisciplinary integration

In the field of education, Jan Christian Smuts’ holistic education theory emphasizes that the whole is far greater than the sum of its parts, rejecting the notion that the whole is merely an accumulation of parts^[1]. The integrity of education points towards the holistic development of individuals. Fragmentation and isolation among disciplines can lead to a scattered and fragmented knowledge structure. Interdisciplinary integration acts as a bridge between

disciplines, facilitating amalgamation and permeation, aiming to cultivate the core competencies of individuals.

Zhang Hua, in the book *Letting Children Grow Through Creation*, extensively traced the theoretical development of interdisciplinary learning. The “interdisciplinary movement” originated in the 1970s. The first major work representing interdisciplinary studies, *Interdisciplinarity: Problems of Teaching and Research in Universities*, was published in 1972 and edited by Leo Apostel and others. Entering the 21st century, along with the development of the “core competency movement,” interdisciplinary learning has become one of the main learning orientations for cultivating core competencies from kindergarten to primary and secondary schools, as well as universities. After a decade-long international interdisciplinary effort, in 2010, *The Oxford Handbook of Interdisciplinarity* was officially published, marking a new stage in the development of the international interdisciplinary movement ^[2].

In the field of art education, American educator Kerry Freedman believes that art education can be conducted through interdisciplinary approaches such as art and popular art, art and ethnic culture, art and popular culture, art and mass culture, multiculturalism and subcultures, traditional media and new media, student interests and disciplines, as well as multiple visual modes and multimedia ^[3]. This construction of an art curriculum based on broad concepts forms the basis for interdisciplinary curriculum construction, providing the conceptual background and imaginative thinking necessary for artistic creation.

The journey from the inception of integrated education theory to the development of interdisciplinary learning and further to interdisciplinary integration in the field of art education has traversed a considerable path, accumulating a profound theoretical foundation for present-day interdisciplinary fusion, contributing to the exploration of interdisciplinary integration in art education.

1.2. Significance of interdisciplinary integration in art education

1.2.1. From the perspective of students

Interdisciplinary integration in art education contributes to the development of the teaching subject. Firstly, it aids in fostering students’ holistic thinking. Art has been proven to enhance cognitive development in numerous studies in neuroscience. Roger Sperry, an American psychobiologist and neurobiologist, proposed the theory of “left-brain/right-brain specialization”: the left and right hemispheres of the brain have distinct functions. Typically, the left brain is termed the “conscious” or “academic brain,” primarily engaging in logical and abstract thinking. Conversely, the right brain is regarded as the “artistic” or “creative brain,” crucial for higher-order thinking processes like creativity, imagination, and critical thinking, all of which heavily rely on the support of the right brain. Therefore, integrating art with other disciplines supports the simultaneous activation of both brain hemispheres, leading to a harmonious state of the whole brain, which physiologically benefits students’ long-term development. Secondly, it contributes to molding students in multiple dimensions. For instance, art subjects usually focus on analyzing composition, brushstrokes, color, etc., nurturing students’ appreciation and creative abilities. On the other hand, language classes emphasize developing students’ understanding of emotional changes in character roles and the comprehension of texts ^[4]. Hence, integrating art with language allows students to experience and comprehend artistic knowledge within the context of interdisciplinary fusion, enabling a better multidimensional perspective and understanding of the world, thereby shaping their values. Concurrently, these complementary disciplines enable students to have a deeper understanding of the beauty of human nature.

1.2.2. From the perspective of teaching

The integration of art education across disciplines contributes to the transformation of educational paradigms. Firstly, it is evident in its facilitation of complementary differences between subject teachings. There are often

distinct differences in thinking and logic among disciplines. Taking art and physics as an example, physics learning mostly relies on abstract thinking, while art often pursues visual thinking. However, these two are intricately connected. In art classes, there are often aspects that require supplementary understanding using physics knowledge, such as the aerial perspective in Da Vinci's paintings or the principles of light and color involved in Impressionist art. Additionally, technological advancements provide foundational support for artistic expression. In the era of artificial intelligence, the fusion of scientific technology and artistic creativity has directly spawned a plethora of entirely new forms of art, opening unprecedented new dimensions for artistic expression.

Secondly, it demonstrates the advantages of uncovering the educational values behind disciplinary knowledge. The spiritual values conveyed by a single discipline have significant limitations and tend to remain at the level of subject knowledge. As mentioned earlier, art and language each have their distinct focuses. However, when the two are combined in a thematic curriculum design, they can better explore the zeitgeist and educational values concealed behind disciplines.

1.2.3. From the perspective of disciplines

Interdisciplinary integration in art education contributes to broadening the perspective of artistic creation. Firstly, the organic combination of fine arts with other disciplines allows art education to present a more diverse range of expressions, fostering closer integration and inspiration among various art forms. This is particularly evident in the era of artificial intelligence, where blending art with other fields has opened entirely new dimensions of creativity, presenting artworks with greater possibilities. For instance, the artwork "Dance of Robots" by British artist Giuseppe Lo Schiavo integrates elements of ancient Greek culture, robotics technology, and non-fungible token (NFT) art, bridging the gap between art and science.

Another example is the collaborative creation of a large-scale new media interactive installation titled "Shan Hai Jing" by Chinese artists Ying Huang, Zaifeng He, the Y&Z team, and Ke Guo. This digitally constructed computational universe engages in a dialogue about technology and life, tradition, and modernity. These emerging contemporary art forms provide new materials for art education, allowing art classrooms to explore various creative methods in appreciation and creation, broadening students' understanding and cognition of fine arts.

Secondly, the beauty of art, when harmonized with beauty from other disciplines, can form novel creative forms in a state of "heterogeneous isomorphism." For instance, the artwork "Ink and Indigo Bamboo Illusion" created by Chinese artist Hanqian Zhang in 2022 composed of 63 ink bamboo stalks, illustrates climate change over 63 years since scientists began collecting carbon dioxide data through modern industrial methods in 1958. The color of the bamboo changes according to the temperature, driven by carbon emission data, creating a shifting landscape through a warm wind machine. The touch of the viewer also alters the appearance of the bamboo forest, symbolizing human intervention and its impact on the surrounding environment. The artist combines fine arts, geography, and physics using the same element, elucidating a new spirit of the times.

By altering the composition of elements, these artworks breathe new life into artistic creations, providing more possibilities for art creation and advancing and extending art education from the perspective of disciplines' essence.

2. Exploration of interdisciplinary integration in primary and secondary art education

2.1. Seeking common ground among disciplines: From segregation within individual disciplines to cross-disciplinary integration

The core of school education at the primary and secondary levels lies in subject-specific teaching. The subject

curriculum serves as the fundamental backbone of school curriculum development, constituting a significant aspect of curriculum construction. In the curriculum setting and scheduling of the new standards of compulsory education by the Ministry of Education, we witness the presentation method of courses and the allocation of hours. The curriculum is composed of individual subject teachings such as ethics, Chinese language, mathematics, foreign languages, physical education, music, fine arts, science, physics, chemistry, geography, biology, history, and information technology.

Subject knowledge forms the starting point of the school curriculum, involving the selection of knowledge. Thus, debates regarding “which knowledge holds the highest value” or “which knowledge is worth learning” essentially revolve around differing standards of knowledge selection. Therefore, the most crucial aspect of integrating disciplines lies in identifying the commonalities among them, delineating the boundaries where subjects intersect, and establishing unified selection criteria. Deeper subject knowledge often erects formidable barriers, with each discipline possessing its unique discourse system and operational logic, resembling distinct “compartments” that create disciplinary barriers.

While mastery of subject knowledge remains pivotal, learning cannot be confined solely within these boundaries. In the era of artificial intelligence, where information iteration accelerates, uncertainties grow unprecedentedly. The real world presents increasingly complex and comprehensive issues. Therefore, singular subject knowledge frequently falls short in addressing intricate problems. Delving too deeply within a single “compartment” impedes students from analyzing real-world problems and exploring them comprehensively in the actual world of uncertainty.

Due to the systematic, logical, and clear nature of disciplines, finding a unified standard requires a shift from the value of disciplinary knowledge to the value of nurturing individuals within the discipline. However, it is essential to note that interdisciplinary integration is built upon a highly compartmentalized school curriculum. Currently, it is a secondary integration aiming to comply with the comprehensive education requirement. Therefore, when designing a curriculum integrating disciplines, it is crucial to emphasize the intrinsic attributes of each discipline. Integration across disciplines should not weaken the dominant nature of the primary discipline solely for the sake of interdisciplinary collaboration.

In art education at primary and secondary levels, there are primarily two approaches that can be adopted for integration. One of the approaches is the overlaying of subjects, known as “Art + X.” Art serves as the core, horizontally aligning with other subjects. The fundamental purpose remains to use other subjects as supplementary tools to enhance students’ understanding of artistic knowledge. For instance, consider the 5th lesson, “The Aesthetic of Rhythm,” in the 4th-grade art textbook from the People’s Education Press. The “Art + Music” approach correlates the emphasis on beats and rests, long and short notes, compactness, and relaxation in music with the size, thickness, length, and density of visual art language. This integration with music aims to help students intuitively perceive the rhythmic beauty in the language of art.

The second approach is themed courses, focusing on identifying suitable “points of fusion” between art and other subjects. It involves organizing and integrating related knowledge from various disciplines to form thematic courses, aligning with the advocated unit-based art teaching design. Taking the unit design of the folk song “Homeward Bound—Autumn Scenery with Magpies” as an example, this course expands on themes like homeland, homesickness, and the homeland’s significance.

2.2. Real-world context: Transitioning from shallow learning in a single discipline to interdisciplinary depth of understanding

From the early 21st century to the present, there has been a frequent juxtaposition and analysis of education

with the popular topic of artificial intelligence, delving into the fundamental differences between human “deep learning” and machine “deep processing.” 21st-century education aims to cultivate individuals with expert thinking and the capacity to solve complex problems, and deep learning stands as one of the primary approaches to equip students with skills relevant to the new era. This section seeks to explore how better integration of interdisciplinary approaches can facilitate “deep learning” in art classrooms for students in the era of artificial intelligence.

“Meaningful learning with teaching at the forefront” is a crucial concept in contemporary education. In the era of artificial intelligence, the “transmissive” teaching method has become obsolete. However, some art teachers still adhere to this instructional style in art classrooms, following a basic process of introduction through appreciation of masterpieces, teaching foundational knowledge, demonstrating creative techniques, limiting creative scope, student imitation exercises, and simple evaluation and summary. This method carries historical inertia in educational development. However, the problem it poses is that students can only master disciplinary skills and create propositional works under singular themes, unable to address real-world creative or expressive demands. Despite the emphasis placed by educational principles and educators on the importance of interaction and inspired education, the unidirectional transmission of education persists in art education in today’s primary and secondary schools.

To better facilitate “deep learning” for students in art classes through interdisciplinary integration, it is essential to foster interdisciplinary understanding within a “real” context. Firstly, the scenarios set in the curriculum should have genuine existence. Regardless of where these scenarios occur, they should establish a connection with students’ daily lives or potential future environments, rather than being purely fabricated. Taking the example of the painting “Travelers Among Mountains and Streams” from the book *Why Art Classes Should Be Taught This Way*, it is evident that the problematic scenario in this lesson points towards reality. In an art class, upon introducing a course on appreciating traditional Chinese landscape paintings, certain students expressed their confusion and stated that they did not understand traditional Chinese painting. Others remarked that they only perceive a mass of ink. In response, the teacher quoted Shitao: “In the ink mass, there lies the wide world.” However, the students still appeared perplexed.

Secondly, the issues addressed in the curriculum need to be real. For instance, in the competition to design a poster featuring a small animal in the introductory part of an art class, if students encounter difficulties, this kind of problem setting detaches the problem-solving process from a real scenario, making it fail to resonate with students. The issues to be solved become virtual “simulated” problems and are not directly aligned with the classroom objectives. In interdisciplinary thematic learning, students can face genuine situational problems, apply knowledge from disciplines beyond art, learn to choose reasonable solutions, implement strategies in complex environments, and tackle intricate problems. The fusion of art with other subjects enables students to creatively express ideas and solve problems adeptly, ultimately cultivating core competencies in students. Additionally, shallow learning and deep learning are not mutually exclusive but rather form a transformational relationship. The framework of interdisciplinary thematic learning promotes deep understanding among students, allowing them to “think like experts.”

2.3. Integration of teaching content: From loose connections between subjects to the construction of meaningful wholes

Meaning construction refers to the individual transformation process of the human knowledge system. Ausubel proposed that meaningful learning occurs in two ways: one originates from childhood, forming concepts through direct human experiences, while the other occurs through concept assimilation. As individuals grow

older, assimilation becomes the primary method of learning new concepts. Learners assimilate new information into their existing cognitive structures to interpret novel concepts. The acquired new concepts and knowledge then construct a new cognitive structure for the learner, determining their updated learning of knowledge and information ^[5]. Therefore, in the teaching process, establishing connections between new teaching content and students' existing cognitive structures is particularly important. The information and knowledge provided to learners will determine the new cognitive structure that will be established in their minds. It is essential to note that the establishment of cognitive structures is not about loose connections between subjects but rather requires integrating teaching content from a meaningful standpoint, thereby constructing new knowledge systems for learners to study.

In the teaching of art courses, the construction of comprehensive meaning can be reflected through the design of major unit teaching. Firstly, unit teaching design is guided by “big concepts,” supported by “major units,” and driven by “major tasks,” enabling teaching objectives, content, and the teaching process to possess a more evident, systematic, directional, and integrative nature. Content across interdisciplinary subjects under the umbrella of big concepts is no longer rigidly confined but rather integrates and bridges across the original disciplinary boundaries and other subjects. In major unit art education, a continuous understanding of subject content can be achieved, simultaneously further deepening the ideology within the discipline of art itself. Secondly, with each unit of study, students can acquire a level of big concept, essentially establishing an “anchor” in their minds to leverage for the next set of learning tasks. Learners navigate between specific facts and abstract concepts, mutually explaining and substantiating each other. Based on this in-depth understanding, factual knowledge might fade, but concepts can persistently remain in the mind. Students can flexibly extract, transfer, and apply these concepts to tackle new situations and solve novel problems.

2.4. Coping with the emergence of technology: From mechanistic question-answer generation to the reasonable utilization of multidisciplinary integration

In the face of rapid societal transformations driven by technological advancements, the cumulative knowledge of humankind has exponentially increased, with existing knowledge swiftly losing value. The educational concept of “schools and parents restricting students' internet access” is gradually being abandoned because it fails to meet the demands for human development in the era of artificial intelligence. Relying solely on printed materials for classroom teaching is no longer a viable model, as digital technology and intelligent software learning have become not just a philosophy but a necessity to adapt to societal progress. Artificial intelligence (AI), proposed in 1956, has undergone multiple cycles of iteration and updates. With the emergence of diffusion models and pre-trained large models, tools like Midjourney, Stable Diffusion, and Stability AI, among others, have made qualitative leaps in their applications within the field of artistic creation, providing robust technological support for artistry. However, the improper utilization of these tools might contradict the goal of fostering students' core competencies. For instance, image generation software like Midjourney operates on the principles of Generative Adversarial Networks (GANs). This AI software can generate images based on simple commands and parameters, and its extensive resource library adequately fulfills students' daily “creative” needs. Similarly, if students rely on large models like ChatGPT to directly query AI for homework answers, it conflicts with the objective of assigned classroom exercises. As Heidegger explored, in this form of “technological concealment,” everything becomes a “resource in preparation.” Once students develop a dependence on AI software, rather than exploring resources based on the real world, their imagination could be obscured, leading to a crisis of technological spirit or gradually being “dispatched” and “commanded” by technology, unbeknownst to them. Therefore, constructing interdisciplinary learning approaches centered around artificial intelligence, transitioning from simplistic question-and-answer using intelligent software to a

collaborative human-machine teaching model, is undoubtedly a crucial shift in basic education stages.

On September 7, 2023, the United Nations Educational, Scientific and Cultural Organization (UNESCO) released the “Guidance for Generative AI in Education and Research,” marking the world’s first comprehensive guideline on generative AI. The aim is to facilitate a better integration of generative AI into education. Within the section on interdisciplinary approaches, it mentions: “AI providers, educators, researchers, as well as representatives from parents and students collaborate to plan comprehensive adjustments to curriculum frameworks and assessment methods, to fully harness the potential of Generative AI in education and research” [6]. In recent years, numerous art institutions have initiated interdisciplinary collaborations at the intersection of art and science, exploring new paradigms for art education in the era of artificial intelligence, including the Center for Art, Science & Technology (CAST) established by the Massachusetts Institute of Technology (MIT) and the joint program in Computer Graphics and Computational Art by the Computer Science Department and the Tisch School of the Arts at New York University.

Therefore, similar models can be adopted in primary and secondary school art classrooms. With artificial intelligence as a technological support, under the guidance of teachers, students can use AI-supported adaptive learning systems sensibly to establish interdisciplinary connections. This requires a shift in mindset where the current co-creative systems powered by AI are not merely tools but serve as “creative partners.” This concept of human-computer co-creativity aims to enhance users’ problem-solving and creative capabilities, rather than solely providing knowledge in specific domains [7]. Students can design and train intelligent entities within virtual spaces, and then translate these actions into real-world artistic expressions such as sculptures, paintings, and various other forms of artwork. Through this approach, students systematically grasp disciplinary knowledge, employ new technology to revisit tradition, and achieve human-computer collaborative integration in classroom teachings.

3. Conclusion

The purpose of interdisciplinary learning is to contextualize knowledge, aid in cross-disciplinary understanding, and foster the development of students’ core competencies and free personalities. This article analyzes the background and theoretical basis of integrating art into interdisciplinary studies in the AI era, examining its significance from the perspectives of students, teaching, and disciplines. The core focus lies in establishing the path for interdisciplinary integration in art education within the backdrop of the AI era. Firstly, shifting from the “compartmentalization” among singular disciplines to integration with others hinges on finding “integration points,” utilizing commonalities among disciplines as a crossroads for fusion. Secondly, after establishing disciplinary connections, grounding in real scenarios is crucial to nurturing students’ ability to solve complex problems, transitioning from shallow learning of individual subjects to a comprehensive understanding through multidisciplinary connections. Subsequently, content integration and concretization are necessary. Defining unit teaching themes, establishing links between core concepts of disciplines, and consistently transforming the human knowledge system into individualized learning, fostering overarching concepts transferable to students. Simultaneously, in the swiftly evolving world of artificial intelligence, guiding students from mechanized use of intelligent software to genuine human-machine collaboration, and training personalized models assists in achieving interdisciplinary integration. It harnesses intelligent technology for “human” use, equipping students with irreplaceable qualities that artificial intelligence lacks. Through these strategies, culminating in the interdisciplinary field of art amidst the AI era, the ultimate aim is to cultivate human subjectivity and creativity, and practice a closed-loop of teaching objectives centered on core competencies.

Disclosure statement

The authors declare no conflict of interest.

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