Use of Digital Technologies in the Process of Teaching Art Education to Students: A Mixed Methods Study

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ABSTRACT

The aim of the study was to investigate the impact of digital technologies on the art education process, focusing on their role in developing educational programmes, building key skills in students, and increasing accessibility to learning. Qualitative and analytical methods were used to achieve the aim. Publications describing the problems and perspectives of technology integration in art education were also reviewed. The results of the study indicated that digital technologies have significantly changed approaches to learning in art higher education institutions. The main stages of technological integration were identified, such as the development of courses in digital painting, animation, and interactive design, which contributed to modernising educational methods. It was found that the use of modern tools, including graphics and animation software, helps students to build in-demand skills while developing creative thinking and the ability to solve complex problems. Analysis of the accessibility of arts education has shown that digital platforms play a key role in creating an inclusive environment. They provide access to educational materials and classes for students from remote regions, which contributes to democratising art education. The study of existing challenges and constraints revealed a lack of technical training for teachers and insufficient infrastructure in some institutions. However, the prospect of integrating technologies such as virtual reality, artificial intelligence, and 3D printing was recognised as significant for further improving the quality of art education. The study confirmed the significance of digital technologies for the transformation of art education and their potential to overcome existing barriers.

Keywords: Digital painting curriculum, Virtual reality-enhanced art instruction, AI-driven personalized learning, Online art education platforms, Teacher digital competence barriers

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Additional material is published online only. To view please visit the journal online.

Cite this as: Zhang C, Karabalaeva G, Yu J, Han B and Asipova N. Use of Digital Technologies in the Process of Teaching Art Education to Students: A Mixed Methods Study. Premier Journal of Science 2025;14:100140

DOI: https://doi.org/10.70389/PJS.100140

Peer Review

Received: 8 September 2025

Last revised: 25 September 2025

Accepted: 30 September 2025

Version accepted: 4

Published: 28 October 2025

Ethical approval: N/a

Consent: N/a

Funding: No industry funding

Conflicts of interest: N/a

Author contribution: Chongyang Zhang and Gulmira Karabalaeva – conceptualization, methodology, data curation, writing – original draft preparation
Jie Yu – visualization, investigation, and supervision

Introduction

Contemporary art education is undergoing dramatic changes influenced by digital technologies that are transforming teaching methods, approaches to learning, and students' perceptions of art.[1] Technological innovations such as artificial intelligence (AI), virtual reality (VR), and digital platforms are opening up new possibilities for knowledge creation, transfer, and integration. These technologies not only facilitate a more interactive and personalised approach to learning, but they also provide students with access to various resources previously unavailable in traditional formats.

Professional development of art teachers in the context of digital technology integration was considered by Yang.[2] The author emphasised changes in the professional competencies of art teachers in the 20th and 21st centuries, noting that the use of technology contributed to the development of innovative approaches to teaching in a multicultural environment. The application of AI and VR in the creation of digital media art was the key research topic of Qian.[3] The author concluded that VR simulators and AI technologies significantly enhance students' creative thinking capabilities and promote deeper immersion in the process of media creation.

Using AI to modernise art teaching was studied by Zhang et al.[4] Their work showed that AI technologies simplify routine tasks and create additional opportunities for teachers to work individually with students, increasing the overall effectiveness of the educational process. VR technologies in teaching art were investigated by Hui et al.[5] They demonstrated that the use of VR provides an interactive environment that enhances students' interest in art and improves their ability to visualise complex artistic concepts.

The role of new media in preserving traditional culture and its application in the field of art was investigated by Guo and Zhang.[6] The authors emphasised that digital technologies open up opportunities for interaction with cultural heritage through interactive projects and multimedia formats, contributing to the popularisation of traditional values.

The personalisation of education using AI was the subject of the work of Holmes and Tuomi.[7] The study found that AI technologies allow the educational process to be tailored to the individual needs of students, thus increasing student engagement and learning outcomes. The impact of digital technology on art learning in Chinese middle schools was studied by Ramasamy et al.[8] They showed that the introduction of digital tools had a positive impact on student engagement, improved students' skills when working with modern technology, and increased access to educational resources.

The integration of digital technology in art teacher education in China was analysed by Jing and binti Omar.[9] Their study showed that the development of digital literacy of teachers enhances their ability to utilise modern tools in the learning environment, improving the quality of education. The use of big data technologies to reform art education was studied by Wu.[10] The author noted that data analytics allows for personalised learning, which enables more focused student development in the arts. Technologies that support student collaboration in creating art projects were investigated by Lee et al.[11] The authors found that digital tools enhance students' cooperative work, foster their creativity, and help improve the quality of art projects.

Bingjie Han and Nurbubu Asipova – software, validation, writing–reviewing, and editing

Guarantor: Chongyang Zhang

Provenance and peer-review: Unsolicited and externally peer-reviewed

Data availability statement: N/a

Despite numerous studies on the integration of digital technologies in art education, key issues remain unresolved regarding their accessibility for students, especially those from regional and less-equipped higher education institutions. These students often face limitations when accessing the necessary hardware, software, and learning platforms, creating a significant gap between the capabilities of different educational institutions. There is also a lack of holistic approaches to building digital skills that not only include basic technical competencies but also foster creative thinking, analysing and applying technology to the artistic process.

In addition, how digitalisation affects the structure of curricula by changing traditional teaching methods is still poorly understood. While most studies focus on the technical aspects of technology use, there is little analysis of how it is implemented in the actual educational process and its impact on students' motivation, creativity, and learning achievements. These gaps require further analysis.

The aim of this study was to investigate the impact of digital technologies on art education. The research questions guiding this study were:

- What essential skills students acquire from using digital technologies, and how are they incorporated into art education programmes;
- What role digital platforms play in making art education more widely available, especially to students in underserved or remote areas;
- What difficulties and restrictions are involved in using digital tools in art education.

Materials and Methods Research Desing and sampling

The research design for this study involved a qualitative approach, focusing on an analysis of educational programmes and the digital platforms used in art education. Purposive sampling was applied to select three leading institutions recognised for advanced integration of digital technologies into art education: the Central Academy of Fine Arts (CAFA, Beijing), the Beijing University of Communications, and the School of Design and Arts at the Zhengzhou Institute of Industrial and Applied Technology. A total of twelve 2024 academic year curricula, including courses in interactive design, digital painting, animation, and video editing, were gathered. The chosen universities offer advanced courses in digital tools like animation and design, making them leaders in China's digital art education. The study also included an analysis of the online platforms Tencent Classroom, DingTalk, and XuetangX, which provide access to educational materials, virtual lectures, and projects that make art education more accessible to students from different regions. Ten experts were chosen for expert interviews based on two criteria: (1) professional knowledge in the digital art and design industries; and (2) academic involvement in curriculum development and teaching at the aforementioned universities. This dual viewpoint guaranteed both pedagogical and applied insights. Purposive sampling was used to maximise the richness and relevance of the data gathered by guaranteeing the inclusion of organisations and specialists with firsthand knowledge of incorporating digital technologies in art education.

Analysis of the introduction of digital technologies into the educational process was carried out by the method of content analysis. Twelve curricula from these universities were examined in total; they covered various topics, including interactive project development with Unity and Adobe Premiere Pro, 3D animation with Blender and Maya, and digital painting with Adobe Photoshop. The syllabi covered learning objectives, teaching strategies, and course content. To gather data from the chosen online platforms, user manuals, course descriptions, and platform documentation, which included information on the interactive teaching tools these platforms offer, like video conferencing, virtual galleries, and multimedia file sharing, were examined.

Expert Interviews

The semi-structured interviews focused on important topics like how well digital tools improve students' technical and creative abilities, how difficult it is to integrate these tools in the classroom, and how digital platforms affect access to art education. Each interview took place in person or via video conference and lasted roughly 20 to 30 minutes. Among the important guiding questions were:

- What role can digital technologies play in helping students hone their technical and artistic abilities?
- What difficulties does digital technology present when incorporated into the curriculum?
- How can online platforms impact diversity and accessibility in art education?

To ensure anonymity, all interviews were audio recorded, verbatim transcribed, and anonymised. After the transcription, researchers examined expert feedback for recurrent themes to provide a more comprehensive understanding of the educational landscape and to validate the conclusions drawn from the student interviews and document analysis. These knowledgeable viewpoints enhanced the research by providing expert analysis of the real-world difficulties and advantages of incorporating digital technology into art instruction.

To support the thematic validity, representative quotes were included in the Results section. These quotes had a direct connection to the topics of integrating difficulties and skill development.

Coding Process

The gathered data was analysed using a thematic coding approach. The coding scheme concentrated on identifying important themes in art education, including accessibility, student engagement, and the integration of digital tools.

Every platform document and syllabus was coded according to the inclusion of phrases and ideas such as "creative thinking," "digital tools," "student collaboration," and "accessibility." These terms were categorised into major themes that were compiled along with operational definitions and representative excerpts into a codebook (Table 1).

To better group and analyse the data, the researchers employed qualitative software, like NVivo, to manage and organise the thematic codes. Large volumes of text were organised with the help of this software, which made it easier to spot reccurring themes pertaining to the use of digital tools in art education.

Coder training was offered to guarantee uniformity in the coding procedure. Inter-coder reliability was assessed using Cohen's kappa for each theme: Digital Accessibility ($\kappa = 0.78$), Skills Development ($\kappa = 0.86$), Technology Integration ($\kappa = 0.82$), Engagement and Collaboration ($\kappa = 0.80$), and Integration Challenges ($\kappa = 0.83$). These values indicate substantial to almost perfect agreement, confirming the reliability of the coding process. To make sure the coding was applied consistently, this required having several coders examine the same collection of documents. Through discussion and additional coding scheme improvement, discrepancies in the code were settled.

A categorisation process was used to distil the raw text from online platform documents and syllabi into the reported themes. For instance, references to particular software programmes, such as Blender and Adobe Photoshop, were categorised under the more general heading of "digital tool integration." Referencing websites like Tencent Classroom and DingTalk, which facilitate remote access to educational resources and virtual collaboration, was also included in the category of "accessibility in art education." The researchers were able to synthesise the data and offer insights into how digital technologies are changing art education thanks to this approach.

TPACK Framework

To improve the analytical depth, this study used the Technological Pedagogical Content Knowledge (TPACK) framework. TPACK examines the interaction between technology, pedagogy, and content knowledge, which makes it particularly useful for analysing the integration of digital tools in art education. The TPACK framework also allowed for examination of how teaching strategies and student outcomes were influenced by the intersection of technology, pedagogy, and content knowledge. The study's validity was guaranteed by a careful examination of the body of existing research, adherence to accepted theoretical frameworks, and the use of trustworthy data sources. This method assisted in confirming the research methodology's legitimacy and applicability.

A comparative analysis of educational strategies aimed at mastering technologies related to graphics, animations, and interactive projects was used to study the development of digital skills among students. The study included an analysis of teaching methods, teaching materials, and programmes used to develop key competencies, such as digital art skills, project management, creative problem-solving, teamwork, critical thinking, and technical proficiency in software. Attention was paid to how the use of digital tools influences the development of professional and creative skills, as well as helps prepare students for the requirements of the modern digital market.

Ethical Considerations

Ethical considerations included obtaining informed consent from all participants and ensuring confidentiality throughout the study. Ethical approval of the study was obtained from the Scientific Committee of Ethics of the Kyrgyz State University named after Ishenaly Arabaev with No. AB-3456.

Results

Introduction of Digital Technologies in the Educational Process

The development of digital technologies from 2010 to 2024 has significantly changed the approaches to teaching art disciplines. In Chinese universities, the introduction of digital technologies to the teaching process began in the mid-2000s, when educational institutions realised the need to adapt to the requirements of the digital age.[12] During this period, universities began to actively develop new teaching modules based on the use of digital tools, such as graphics

Table 1 | Codebook of themes

Theme	Operational Definition	Representative Excerpts
Digital Accessibility	Instances where digital platforms or tools reduce barriers to participation in art education, including geographical, financial, or infrastructural constraints.	"Platforms like Tencent Classroom are crucial for reaching students in remote areas, ensuring that access to quality art education is not limited by geography."
Skills Development	References to the acquisition of technical, creative, or professional competencies enabled by digital technologies.	"Students who engage with tools like Photoshop, Blender, and Unity quickly develop both technical proficiency and creative problem-solving skills."
Technology Integration	Descriptions of how specific digital tools, platforms, or software are embedded into course syllabi and teaching strategies.	"Digital painting courses now require proficiency in Adobe Photoshop, blending traditional and digital techniques in the curriculum."
Engagement and Collaboration	Evidence of increased student interest, teamwork, or interactive learning facilitated by digital tools.	"When students participate in real projects under professional guidance, they not only consolidate their digital skills but also understand industry standards and expectations."
Integration Challenges	Barriers to effective adoption of digital technologies, such as insufficient teacher training, limited resources, or unequal student access.	"The varying levels of technical readiness among teachers and students remain a major obstacle; ongoing support and training are essential."

Source: Compiled by the authors.

tablets, specialised software and multimedia platforms. A key step in this process was the integration of technologies related to digital art, animation, design, and 3D modelling in the curriculum. This allowed not only the modernisation of teaching methods, but also the provision of students with the opportunity to learn in-demand skills that have applications in both creative and commercial spheres.

The integration of digital technologies into educational programmes has also been driven by government initiatives aimed at modernising higher education in China. In particular, under the Digital China programme, launched in the 2010s, universities were supported to develop and implement specialised courses and modules related to digital arts.[13] As a result, Chinese educational institutions began to invest heavily in digital laboratories and state-of-the-art equipment to give students access to innovative tools and programmes.

A change in pedagogical approaches has also accompanied the introduction of digital technologies. Teachers started fusing traditional teaching methods like hand drawing and sculpture with digital technologies, providing students with a broader spectrum of creative opportunities.[14] One feature of this approach is the use of interactive programmes that encourage the development of creative thinking and analytical skills.

Digital technology has also transformed the evaluation and presentation of student work. Digital portfolios complement traditional assessment, allowing students to organise and showcase their projects in innovative ways. These portfolios not only serve as a tool for assessment but also as a platform for students to engage with a global audience, presenting their work in virtual exhibitions and competitions. The digital shift allows for more flexible, timely feedback, facilitating a deeper connection between students, instructors, and peers.[15]

The CAFA in Beijing, as one of China's leading art educational institutions, is actively integrating digital technology into the educational process. One prominent example is the digital painting course, which allows students to learn modern methods of creating artwork using Adobe Photoshop software. This course teaches students the fundamentals of using a graphics tablet and introduces them to a variety of digital painting techniques. The course places significant emphasis on mastering Photoshop tools, including layer manipulation, brush creation, and lighting effect adjustment.

The course is structured so that students can learn both basic elements, such as lines and textures, and complex techniques, such as creating portraits or landscapes digitally. The hands-on portion of the course includes projects in which students create original illustrations or redesign famous works of art. The course is highly interactive. Students also work in groups, which allows them to develop teamwork skills. Upon completing the course, students compile a portfolio showcasing their best work produced throughout the duration of the course.[16]

One piece from the CAFA digital painting course was a large-scale digital recreation of a traditional ink landscape. The student combined digital lighting effects and layered brush textures to mimic the flow of ink using Adobe Photoshop and a graphics tablet. The finished artefact, which demonstrated the fusion of contemporary technology and cultural history, was displayed first electronically and then in a digital portfolio.

The animation course at CAFA serves as another noteworthy example. The course focuses on the use of Blender and Maya to create 3D animation and visual effects. Blender is used to develop animated scenes and objects, while Maya allows students to work with more complex models and special effects. The animation course is divided into several stages, starting with mastering the basic functions of the software and ending with the creation of a full-fledged animation project. During the course, students learn elements such as character modelling, texture development, lighting control, and visualisation.[17] A special emphasis is placed on motion work: students learn how to create smooth animation that looks natural and realistic.

One of the students' projects was a short 3D animated video produced in Blender. It depicted a narrative of urban transformation, with students modelling cityscapes and animating environmental changes over time. Faculty reviewers praised the project for "its ability to connect technical modelling skills with sociocultural themes in a visually compelling way."

As one Central Academy of Fine Arts expert put it, "Students are not only learning technical skills when they put together a digital portfolio that incorporates Blender models and Photoshop illustrations, but they are also learning how to present their artistic identity in new and professional ways." This illustrates how student creations, such as interactive prototypes, digital paintings, and animations, function as genuine learning materials that showcase both technical mastery and inventiveness.

One of the key features of the course is the emphasis on creativity. Students are given the freedom to choose the subjects of their projects, allowing them to realise their own ideas. For example, some of them create short films, while others develop concepts for video games or virtual installations. The course includes regular presentations of student projects, which take the format of open demonstrations. This allows students to not only present their work but also receive feedback from faculty and peers.

The final project of the course is a full-fledged animated video that students defend in front of an expert panel.[18] Graduates of these courses are successful in various fields, including graphic design, film production, and video game creation. Their skills, highly valued in the industry, also give them a competitive advantage.

The introduction of digital technologies into the educational process has significantly transformed approaches to learning in art education. Modern tools have become an important part of the curriculum,

helping students develop the key skills needed to work in a digital environment. These changes allow traditional teaching methods to be combined with innovative technologies, providing a deeper immersion in the creative process.[19] This approach contributes to the training of professionals with relevant competencies that are in demand in a rapidly evolving digital world.

Formation of Key Digital Competencies in Students

The development of digital skills has become a key element of student training in China's modern art institutions. By incorporating advanced technology into the curriculum, students acquire a wide range of skills that encompass both technical and creative components. These skills include working with professional software, creating digital images, animations and 3D objects, and managing projects using specialised platforms.[20] These competencies are based on the ability to work with programmes to process and edit media content, create animations, and develop interactive projects (Table 2).

The information in Table 2 was gathered by carefully examining the curricula and educational programmes offered by a few chosen universities. This required examining curricula that included key digital tools for project management and the creation of digital images, animations, and 3D objects, such as Adobe Photoshop, Blender, Maya, and Unity. The interviewed experts support this statement, "Students who engage with tools like Photoshop, Blender, and Unity quickly develop both technical proficiency and creative problem-solving skills, which are essential for modern art careers." The creative component was evaluated through practical projects in which students used them to promote creative thinking, while the development of real-world projects that satisfied industry standards and added to students' digital portfolios demonstrated the practical application of these tools. According to this analysis, digital technologies help students develop their technical skills while also fostering their creative thinking and preparing them for careers in the digital art sector.

A matrix mapping observed practices to TPACK intersections (TK, PK, CK, TPK, TCK, PCK, and TPACK) is presented in Table 3. This matrix synthesises the application of digital tools and their alignment with pedagogical and content objectives across the institutions studied.

Additionally, cross-case comparisons show clear trends in the relative importance of pedagogical and topic knowledge across courses. Courses that focused on interactive media and design, like those at Zhengzhou, placed more emphasis on pedagogical knowledge and the use of digital tools to promote collaborative learning than did traditional art courses, like CAFA's digital painting, which emphasised mastering classic artistic techniques through digital media. In these classes, technology served as a platform for student interaction and learning through shared digital environments, in addition to being a tool for creation. This disparity implies that interactive design and media production courses are more likely to use digital technologies as platforms for experiential and collaborative learning, whereas content-driven courses continue to emphasise mastering certain artistic methods.

Several recurrent patterns emerged from a thorough examination of the coding findings for each course. With 80% of course descriptions and 75% of interview excerpts mentioning digital tool integration, this was the most commonly coded theme. 70% of courses emphasise creativity and problem-solving abilities, suggesting a significant pedagogical focus on using technology to foster students' critical thinking.

Table 2 | Expanded table of key digital competencies

Aspect	Description	Goal
Key digital skills	Includes working with professional software, creating digital images, animations, 3D objects, and project management	Developing basic and advanced competencies for working in the digital industry
Tools and Technologies	Utilization of software for media content processing, animation creation, and interactive project development	Mastering key tools required for professional activities
Creative component	Students explore innovative approaches that simplify the process of creating art	Fostering creative thinking and an artistic approach
Practical application	Practical application of skills enables students to develop projects that meet the demands of the digital industry	Preparing for professional tasks in real-world conditions

Source: Compiled by the authors based on Duester;[16] Zhao.[18]

Table 3 | Matrix of observed practices mapped to TPACK framework

Course	Technological Knowledge (TK)	Pedagogical Knowledge (PK)	Content Knowledge (CK)	TPACK Intersection(s)
Digital Painting (CAFA)	Adobe Photoshop, Graphics Tablets	Demonstrating techniques, individual projects	Traditional Art Techniques (e.g., landscapes, portraiture)	TK-CK (Tool integration with art content)
3D Animation (CAFA)	Blender, Maya	Collaborative project design	3D Art and Animation Theory	TPK (Technology applied to teamwork and project design)
Interactive Design (Zhengzhou)	Unity, Adobe Illustrator, Blender	Interactive media, prototyping	Graphic Design, User Experience	TPK (Interactive design using digital tools)
Video Editing (Beijing Univ.)	Adobe Premiere Pro, After Effects	Video editing workflows, narrative techniques	Film Studies, Media Production	TCK (Film content created with advanced editing tools)

Source: Compiled by the authors.

Cooperative learning environments are highly valued, as evidenced by the fact that 65% of all coded instances involved student cooperation, particularly in 3D and interactive design courses.

Beijing University of Communications prioritises the training of media and arts professionals, which includes the development of digital skills in students. The programmes offered by the university aim to master the tools used in the film, television, animation, and gaming industries.

One of the key programmes is the video editing and special effects course, which uses programmes such as Adobe Premiere Pro and After Effects. Students learn the main stages of working on video material, from editing to adding visual effects. The training includes theoretical and practical modules. In the theoretical part, students learn about the basics of video editing, the principles of colour correction, and how to work with effects. Practical classes focus on the development of individual and group projects. For example, students create short films, adding special effects and complex visual elements. This process helps develop creative thinking as well as teamwork and project management skills.

Another important part of the training is using Unity to create interactive and multimedia projects. Students master the development of interactive environments by creating visual installations and game prototypes. The course provides an introduction to the basics of programming and working with 3D objects. One notable artefact involved a group of students who collaborated to create a short promotional video combining live-action footage with digitally generated visual effects in Adobe Premiere Pro and After Effects. Advanced motion tracking, colour correction, and the incorporation of 3D-rendered objects in actual situations were all part of their work. According to the supervising instructor, "The project demonstrated not only strong technical competence but also the ability to tell a cohesive visual story, which reflects the professional standards of contemporary media production."

Another vignette illustrates the practical impact of collaborative projects. In one instance, a group of students co-produced a short film using these tools. The project included special effects, video editing, and narrative design. The finished product "was not only technically accomplished but also revealed students' ability to merge storytelling with advanced visual techniques, an essential skill in the film and gaming industries," according to their instructor.

The peculiarity of the Beijing University of Communications programme lies in the active integration of real cases from professional practice. The university cooperates with media companies and movie studios, which allows students to participate in real projects under the guidance of experienced professionals. This helps to consolidate the acquired knowledge and develops an understanding of industry requirements. The interviewed experts stated, "When students participate in real projects under professional guidance, they not only consolidate their digital skills but also understand industry standards and expectations."

The School of Art and Design, based at the Zhengzhou Institute of Industry and Applied Technology, offers unique educational programmes aimed at developing students' digital skills. Learning here focuses on using technology to solve applied problems in design and art, which makes the programme particularly relevant to the industry. Students learn to work with tools such as the Adobe Creative Suite, including Photoshop and Illustrator, as well as 3D modelling and animation programmes such as Blender.

Emphasis is placed on developing skills in using graphics tablets and creating complex digital images. The learning process involves several stages. At the elementary level, students are introduced to a software interface, its basic functions and the fundamentals of digital design.

The next stage is dedicated to mastering more complex tools, including working with textures, creating interactive prototypes, and developing user interfaces. Project management is emphasised. Students work on complex assignments that require the integration of multiple software tools. For example, they may create a project that includes designing a logo, making an animated video, and visualising a product in 3D. This approach fosters students' time management, planning, and effective teamwork skills.

The programme also includes modules aimed at preparing students to participate in international competitions and exhibitions. For example, students present their projects on virtual platforms, which allows them to showcase their work to a wide audience. This develops their professional competencies and helps to build a career in the industry.

Additionally, students from the Zhengzhou Institute of Industrial and Applied Technology used Unity to create interactive installations. One of them created a prototype for a virtual exhibition where users could navigate a 3D gallery. "It forced me to think not only as an artist but also as a user-experience designer, which broadened my perspective," the student explained. This case demonstrates how cross-disciplinary skill sets that are in line with both the artistic and technical domains are fostered by digital projects.

To illustrate how digital technologies are embedded in different institutional contexts, Table 4 summarises the relationships between course focus, tools employed, expected student outcomes, and the specific dimensions of the TPACK framework addressed. This comparative synthesis provides a systematic perspective that connects pedagogical intent with technological practice and subject knowledge, highlighting the various ways that curricula operationalise digital integration.

Educational programmes for digital technologies combine theoretical training with practical projects, allowing students to develop a wide range of skills. Special attention is paid to mastering the tools needed to create modern media content and work in the digital industry. Preparing students for the requirements

DOI: https://doi.org/10.70389/PJS.100140 | Premier Journal of Science 2025;14:100140

Table 4 | Overview of courses, tools, learning outcomes, and mapped TPACK elements

Institution	Course Focus	Tools and Platforms	Learning Outcomes	TPACK Elements Mapped
CAFA (Beijing)	Digital Painting & 3D Animation	Adobe Photoshop, Blender, Maya	Mastery of digital painting, 3D modelling, portfolio development	Technological Content Knowledge (TCK): Integration of specialised tools with artistic content
Beijing University of Communications	Video Editing & Interactive Media	Adobe Premiere Pro, After Effects, Unity	Production of films with special effects, teamwork, project management	Technological Pedagogical Knowledge (TPK): Collaborative learning supported by digital media
Zhengzhou Institute of Industrial and Applied Technology	Interactive Design & Graphic Arts	Adobe Creative Suite, Unity, Illustrator	Creation of interactive prototypes, UI/UX skills, exhibition readiness	Technological Pedagogical Content Knowledge (TPACK): Linking technology, pedagogy, and art content holistically

Source: Compiled by the authors.

of the digital market becomes a key objective of such educational initiatives. Professionals with strong digital skills are in greater demand as fields like graphic design, animation, and game development continue to grow. For example, in graphic design, companies look for professionals who know how to use programmes like Adobe Photoshop and Illustrator to produce eye-catching content for branding and digital marketing.

Accessibility of Art Education Through Digital Platforms

Modern digital technologies play a crucial role in ensuring equal access to arts education for students living in remote regions. They make it possible to overcome geographical and social barriers by providing opportunities to participate in learning processes that were previously available only in large cities. Digitalisation also allows universities to integrate interdisciplinary approaches, including modern media, animation, and 3D design, into their curricula. Technology has become a powerful tool for democratising education, making it more accessible and inclusive.[21]

Distance learning classes actively use Tencent Classroom, one of China's leading educational platforms. The platform offers an intuitive interface that simplifies the interaction process between students and instructors. For art education, it provides tools for interactive classes, including video conferencing, screen-sharing features, and material uploading. One of the key advantages of Tencent Classroom is its accessibility even in regions with unstable internet connections. The platform is optimised for mobile devices, allowing students to participate in classes via smartphone or tablet. This is especially relevant for remote regions where students often do not have access to high-performance computers.

For art education, Tencent Classroom provides lecture recording capabilities, that allow students to revisit classes, analyse complex art concepts, and replay key points. It was designed with low-bandwidth accessibility and mobile optimisation in mind, which is essential for students in areas with limited internet infrastructure. The platform seamlessly integrates screen sharing, file uploads, and video conferencing, ensuring minimal latency during live sessions.

For art education, its capacity to manage high-resolution multimedia content is essential because it enables real-time student interaction with digital drawing and design tools. The platform's flexibility is further increased by features like lecture recordings and asynchronous learning, which let students access materials and lessons at their own pace from anywhere in the world.[22]

DingTalk, developed by Alibaba, is another popular platform used for distance learning, including in art education. It improves the quality of art education by offering cloud storage features that accommodate large multimedia files, including 3D models and high-quality photos. Additionally, it offers features for managing assignments, providing feedback, and setting up online galleries where students can view and comment on their work. If the platform integrates with other creative software, students could collaborate and upload projects with ease.

Furthermore, DingTalk's synchronous and asynchronous communication tools encourage constant communication between teachers and students, which is essential for personalised instruction and innovative growth. In addition, the platform supports feedback features where instructors can evaluate students' work by providing detailed comments. The platform is also used to organise virtual exhibitions. For example, students can upload their artworks to galleries, which faculty and peers can view and discuss. This not only develops self-presentation skills but also creates opportunities for interaction, even at a distance.[23]

XuetangX stands out by offering a vast array of digital art courses, supporting rich multimedia content like video lectures, interactive tutorials, and virtual exhibitions. It is perfect for students with different skill levels because it can track their progress and offer personalised learning paths, guaranteeing that each person's educational journey is tailored to meet their needs.

Moreover, XuetangX promotes creativity and the development of technical skills by facilitating participation through interactive tests, peer review, and project-based assignments. By offering acknowledged credentials in digital art tools and techniques, the platform's certification system further solidifies its role in raising students' competitiveness and guarantees that students are ready for professional opportunities.[24]

These platforms not only help students from remote regions to get a quality education but also contribute to the formation of digital skills, which is an important aspect in today's environment. These technologies enable students to unlock their creative potential, engage in competitions and exhibitions, and enhance their

competitiveness in the job market. Digital platforms play an important role in expanding the accessibility of art education, providing equal opportunities for students regardless of their location. Their integration into the educational process becomes an important step towards the democratisation of education and the creation of an inclusive environment for the development of creative abilities.

The Challenges and Opportunities of Digital Technology Integration

The introduction of digital technologies in art education presents several challenges that hinder the full utilisation of their potential. Teachers often face the problem of insufficient technical training. Many of them, especially representatives of the older generation, have limited experience with modern digital tools, which complicates their integration into the educational system. The experts confirmed this: "The varying levels of technical readiness among teachers and students remain a major barrier; ongoing support and training are essential for effective integration." Such an outcome requires additional training efforts for educators, often accompanied by a lack of time and resources.

Students, in turn, also face challenges. One of the main problems is the different levels of access to the necessary technologies. For example, students from remote regions or low-income families cannot always afford modern devices or licensed software, which creates a gap in their educational opportunities.[25,26] As a result, these students are forced to use outdated tools or be limited to free but less functional programmes.

Additionally, the digital learning process requires students to develop not only technical skills but also self-discipline. Working in a virtual environment involves greater autonomy, which for many students becomes difficult due to a lack of motivation or time management skills. These factors often lead to lower levels of engagement and lower quality of learning.[27]

Technical aspects remain one of the key obstacles to digitising art education. One of the main problems is the lack of infrastructure, especially in universities and colleges located in regions with limited resources. For example, the lack of a stable Internet connection makes it impossible to participate in online courses or master classes, which is especially noticeable for students from rural areas.[28-30] In addition, high hardware and software requirements become a barrier for many educational institutions. Maintaining up-to-date technical equipment requires significant financial investment, which is not always possible with limited budgets.[31,32]

However, in most cases, there is no unified strategy for technology implementation, which leads to inconsistency. Another aspect is the lack of professional support for students and faculty. Although many universities offer technical support, it is often insufficient. This is especially true for complex digital tools, such as 3D modelling software or VR platforms, which require specialised knowledge to be used effectively.[33-35]

Several ethical concerns arise when using digital tools in the classroom, especially when it comes to handling students' personal information. Data breaches and misuse are becoming more likely as digital platforms gather and store more sensitive data, including communication logs, personal identifiers, and academic records. Significant privacy concerns are raised by this, particularly if data is shared or accessed without the required authorisation.

Furthermore, the prevalence of online content makes digital copyright and plagiarism a recurring problem. It is challenging to uphold the integrity of academic work when students can readily reproduce and disseminate copyrighted content without giving due credit. These problems draw attention to the intricate moral environment that surrounds the use of digital tools, where safeguarding private information and intellectual property rights requires careful thought.

Despite the existing problems, modern technologies open wide prospects for the development of art education. One of the most promising areas is the use of virtual and augmented reality (VR/AR) technologies. These technologies make it possible to create interactive educational environments where students can immerse themselves in the study of art, participate in virtual exhibitions and even create their own works in 3D space. [36-38] The experts stated, "VR and AI allow students to experiment with new forms of digital art in ways that were previously impossible, encouraging innovation and immersive learning."

3D printing technologies represent another promising area. They allow students to create physical prototypes of their digital designs, which is particularly useful for studies in areas such as industrial design, architecture or sculpture.[39,40] Being able to visualise and bring their ideas to life helps students better understand the process of creating artwork, as well as develop their engineering skills. In addition, the integration of mobile arts learning apps provides an opportunity for more flexible and personalised learning. This makes learning more accessible and interactive.[41,42]

To overcome the existing limitations and exploit the opportunities of new technologies, educational institutions need to develop a comprehensive approach to digitalisation. One of the key steps should be the creation of systematic teacher training that includes not only technical training but also the development of pedagogical methods adapted to the use of digital tools.

Special attention should be paid to creating an inclusive digital infrastructure that provides equal access to educational resources for all students. This includes the introduction of free or affordable educational apps and platforms and support for students who face financial difficulties.

Design/Technical Implications

The findings of this study have significant implications for the technical advancement and design of digital platforms used in art instruction. The need for low-bandwidth and mobile-first user experience

DOI: https://doi.org/10.70389/PJS.100140 | Premier Journal of Science 2025;14:100140

design is among the most important criteria that surfaced. Platforms must optimise their interfaces for smartphones and tablets with adaptive streaming of high-resolution media and offline access to learning materials, given that students from underserved or distant locations rely on mobile devices and erratic internet connections. This strategy guarantees that inequalities in infrastructure won't limit access to art education.

Support for collaborative tools that facilitate version control and co-creation is equally crucial. According to the report, peer review and group projects are essential for the growth of digital competencies. Therefore, platforms should provide collaborative editing areas, shared sketching environments, and versioning systems so that students may monitor changes and improve their work together.

The study also emphasised the need for inclusion and wide device accessibility. Students use an extensive variety of gear, from powerful graphics stations to entry-level tablets; therefore, platform design needs to provide flexible compatibility modes that adjust to various processing speeds. To serve students with different needs and abilities, universal design principles such as text-to-speech, captioning, and scaled interfaces should be included. The incorporation of learning analytics dashboards is another prerequisite. These dashboards ought to present instructors and students useful information about participation rates, skill development, and progress monitoring.

Such analytics enable students to critically reflect on their learning paths while informing adaptive teaching tactics by revealing patterns of engagement and performance.

Finally, platform architecture needs to incorporate ethical and legal considerations through copyright management and privacy by design. Strong security measures are required to protect personal information and intellectual property due to the growing popularity of digital portfolios and online displays. Therefore, to protect student rights and institutional accountability, platforms should include automatic copyright detection, consent management, and encryption.

When combined, these technical and design ramifications highlight the need for art education platforms to actively promote accessibility, inclusivity, collaboration, ethical standards, and reflective learning rather than just

providing content. Digital platforms can become viable tools for democratising art education and training students in the modern creative sector by converting pedagogical criteria into technical specifications.

Discussion

Digital technologies have a significant impact on changing teaching methods in art education. Sun[43] investigated the implementation of multimedia and interactive platforms in the learning process of creative students. The author concluded that such technologies help increase student engagement and improve the quality of the educational process. Unlike the work of the researcher, which focused on general aspects of digitisation, the present study focuses on the analysis of specific educational programmes, such as courses in digital painting and animation.

The aspect of digital literacy of teachers was studied by Zhao et al.[44] They found that the low level of technical training provided by teachers in Chinese schools limited their ability to effectively integrate digital technologies into the teaching process. This study confirmed these findings, emphasising that the teacher training problem is also relevant to higher education. However, the researchers' study focused more on secondary educators, whereas this study analysed the barriers associated with teachers in universities and colleges.

Mobile technology in art teaching was studied by Yi[45] who analysed its use for teaching painting. The author noted that mobile platforms provide students with flexibility in learning and increase the accessibility of the educational process. These findings are consistent with this study, which also emphasised the importance of digital tools for building students' professional skills. However, unlike the work of the researcher, this study focused on a wider range of technologies, including graphic editors, animation programmes, and online platforms.

The use of computer technology in art education was reviewed by Ying.[46] The author concluded that using graphics and 3D modelling tools improves the quality of student projects, stimulates students' creative development, and broadens their opportunities for self-expression. These results are in line with this study, which also emphasises the importance of digital technology when creating innovative artwork. However, the researcher's study concentrated on the technical aspects of using computer technology, while this study highlighted educational approaches and their effects on students.

The accessibility of art education through digital platforms was discussed by Zhoubin et al.[47] Online platforms assist in removing geographical and social barriers by providing students from remote regions with access to educational resources. These findings are consistent with the results of this study, which confirmed the importance of digital technologies in creating an inclusive educational environment. However, the researchers focused on school education, while this study analysed accessibility for university and college students.

Yan[48] analysed digital resources in art teaching, exploring the impact of accessibility in educational materials on the learning process. The author concluded that the use of digital resources facilitates the learning of complex art concepts by providing students with access to multimedia materials, interactive lectures, and virtual tours. These findings are consistent with this study, which also emphasises the role of digital platforms in creating inclusive educational environments, especially for students from remote regions. However, unlike the researcher's work, which focused on a general analysis of the benefits of digital materials, the

present study examined specific use cases of educational platforms such as Tencent Classroom, DingTalk, and XuetangX.

Li[49] conducted a thorough analysis of big data technologies in art education. The author emphasised that the use of big data allows for effective collection and analysis of data on students' performance, preferences, and skills. The researcher also noted that big data technologies facilitate the process of monitoring students' progress, providing teachers with a deeper understanding of their strengths and weaknesses. As a result, the educational process becomes more flexible and goal-orientated. These findings concurred with this study, which also emphasised the prospect of using big data to personalise learning, especially in the context of arts education. However, the present study added to the theme by including an analysis of additional technologies, such as VR and 3D printing, that offer new opportunities for creative and interactive learning.

Online learning formats in art were considered by Liu,[50] who analysed the impact of distance methods on the educational process. The author concluded that these approaches enhance student engagement by enabling students to participate in educational activities from any location and cultivate professional skills. The researcher also noted that distance learning methods create opportunities to better utilise educational resources, including unique lectures, master classes, and digital libraries. These findings are consistent with this study, which also discussed the importance of online platforms for increasing access to educational programmes, especially for students from remote regions.

The use of digital tools for teaching drawing skills was analysed by Xie.[51] The author noted that digital technologies have a significant impact on the learning process, helping students to learn complex artistic techniques faster and develop creativity. The study emphasised that digital tools greatly simplify the process of conceptualising ideas and allow students to experiment with different styles without incurring the expense of physical materials. In addition, the researcher pointed out that such technologies facilitate individualised learning by allowing students to work at their own pace and teachers to tailor assignments to each student's needs. These findings coincide with the results of this study, which also emphasised that the use of digital technology not only facilitates the technical side of art production but also opens up new opportunities for creative expression.

The application of VR and AI in the creation of digital media art was analysed in detail by Gong.[52] The author focused on how VR and AI enhance teaching and stimulate the development of creativity in students. The study found that these technologies improve the quality of art projects and increase opportunities to experiment with new art forms. These findings are consistent with this study, which also emphasised the importance of VR and AI technologies for enriching education. However, the present study focused more on the practical aspects of applying these technologies in the context of Chinese universities and colleges, including the use of VR to study art history and create interactive exhibitions.

AI in contemporary art teaching has been the object of study in Kong.[53] The author focused on the potential for AI to personalise learning and improve communication between students and teachers. The researcher revealed that AI helps tailor educational programmes to meet the individual needs of students by analysing their progress and offering customised recommendations. In addition, the technology can automate the process of grading student work, which speeds up feedback and relieves instructors of routine workload. The researcher's findings correlate with this study, which also emphasises the role of AI in adaptive learning and increased student engagement.

The results of this study are largely consistent with the findings of other authors, confirming the importance of digital technologies for modernising teaching methods, developing professional competencies, and ensuring accessibility in art education. At the same time, this study has supplemented the existing work by focusing on the specifics of technology implementation in Chinese universities and analysing its impact on the educational process in the context of art education.

There are several limitations of this study. The lack of student viewpoints restricts our comprehension of how students view and interact with digital technologies. Student input should be incorporated into future studies to paint a more complete picture. Furthermore, the tools and platforms presented may soon become obsolete due to the swift speed of technological change, which compromises the findings' long-term applicability. When analysing the results, these aspects should be considered.

Conclusions

This study focuses on the integration of digital technologies in art education within Chinese higher education institutions, specifically examining courses and platforms at leading universities in Beijing and Zhengzhou. It focuses on how tools like VR, AI, and 3D modelling enhance creativity, technical skills, and accessibility. The development of courses in digital painting, animation, and 3D modelling has received particular attention for its contribution to modernising teaching methods. Such courses were found to have enabled students to learn skills in demand in both creative and commercial fields, integrating traditional and innovative approaches into the learning process.

The study of students' digital skills development showed that the use of modern technologies has significantly expanded their professional opportunities. Courses aimed at mastering such tools as Adobe Photoshop, After Effects, and Unity have demonstrated their effectiveness in developing skills related to video editing, creating animations, and developing interactive projects. It was found that these educational programmes develop not only technical competencies but also creative thinking, critical problem solving, and

project management skills, which increases the competitiveness of graduates in the labour market.

A study on expanding the accessibility of art education has revealed the significant potential of online platforms such as Tencent Classroom, DingTalk, and XuetangX. These platforms have proven to be useful in providing equal access to educational resources for students from remote regions. The analysis found that they facilitated interactive classes, provided access to lecture recordings, and created opportunities to participate in virtual exhibitions. This confirms that digital technologies play an important role in democratising art education. The study of existing problems, limitations, and prospects for technology implementation showed that the digitisation process faces a number of challenges. The study revealed that insufficient training, limited access to modern equipment and programmes, and organisational barriers pose significant challenges for teachers and students. However, the possibility of integrating technologies, such as virtual and augmented reality, AI and 3D printing, offers prospects for improving the quality of education and making it more accessible.

The limitation of this study was mainly the focus on educational institutions in China, which may not provide a complete picture of the application of its findings to other countries with different educational and technical conditions. In addition, potential cultural bias, the absence of student perspectives, and the fast-evolving nature of digital technologies may limit the generalisability and timeliness of the findings. A promising direction for future work is to investigate the impact of digital technologies on arts education in other countries, which will allow for the comparison of results and the identification of universal approaches to technology integration. Additionally, conducting interviews with educators and industry professionals could offer helpful observations about the practical challenges and successes of digital technology integration in arts education.

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