# Team-based learning in online education: the development of students' creative thinking skills in digital art

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## Abstract

A person cultivates their creative skills influenced by various types of activities. The purpose of the work is to study the peculiarities of the development of students' creative thinking skills, which are interrelated with the development of appropriate stages of team teaching, as well as to determine the impact of creative thinking on the indicators of academic performance and motivation to learn. The authors used the methods of sociological survey, which allowed them to determine that the largest number of students had mastered the skills of discipline (27%) and emotionality (21%) to a greater extent at the initial stage of the study. The results showed that 11% of the students in creative subjects (painting, digital art) and 7% of students in general disciplines (history, sociology, pedagogy, mathematics, physics, Chinese, cultural studies) had their academic performance at a high level before the start of online learning. The process of online teaching to paint was based on teamwork using the technologies of online education through educational online platform in the context of digital art. The results of the survey showed that the students had developed their creative skills significantly after training. The development of creative manner (29%) and analytical thinking (28%) were most popular. The authors determined that 88% of the students had received high grades in creative disciplines and 83% of the students in general academic disciplines after training. Most students were characterized by a high level of knowledge. The results are valuable for researchers who study the relationship between the development of creative skills and knowledge in general academic subjects, as well as strive to develop new curricula.

**Keywords** Artistic consciousness · Creativity · Digital art · Online education · Painting · Team approach

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# 1 Introduction

With the rapid development and rise of the economic level, people's aesthetic needs also increase, they have a deeper emotional understanding of art and culture. Every year the number of young people who strive for a comprehensive study of fine arts increases (Kupers et al., 2019; Li et al., 2021). Teaching fine arts is a universal approach based on cultural characteristics, using pieces of Western and Eastern art as the main educational resources (Suson et al., 2020). Painting is an independent type of artistic creativity, which draws the attention of teachers and students with its unique charm and is an important part of art education in colleges and universities (Burde et al., 2017; Tsankov, 2021).

In China, painting is not only an artistic, but also a literary style. Artists' values result in the expressiveness inherent in Chinese art. Each artist attaches great importance to the choice of their professional instruments and artistic style and takes full responsibility for this (Lee & Portillo, 2022; Yang, 2021). Chinese painting is one of the outstanding traditional culture elements of the country; it embodies the long history and intellectual wisdom of the Chinese nation (Bian & Shen, 2021). In the era of big data information technologies, the task is to find a new universal method suitable for the modern field of art education, changing the original traditional approach to teaching based on teaching previously developed educational materials (Draper et al., 2021). With the continuous development of society and information technologies (applications, online platforms, etc.), society pays much attention to innovative artistic consciousness based on the solid mastery of professional knowledge. This is one of the main qualities of highly qualified people (Wang, 2020).

Team-based learning contributes to solving this problem and training highly qualified professionals (López-Martín et al., 2022). Team-based learning is based on the interaction of groups of students, educators among themselves, which is manifested in the development of learning mechanisms aimed at unlocking the potential of students (Martínez-Maireles et al., 2022). The rapid popularization of team-based learning has been seen since 1994 at the University of Oklahoma, and it has also previously been used in business companies and partially in medical specialties (Hasan et al., 2022). The level of role assignment among the participants in the process depends on the professionalism of an instructor, their personal qualities and the ability to work in a team (Hasan et al., 2022). The success of team-based learning, including the development of creative skills, is evident in the design of lessons that are based on joint planning, as well as the orientation of not only methodical material, but also practical. In a team-based learning environment, the process is most often built on a dual perception of information, where some participants explain theoretical material, and others teach practical approaches to implementation. Working through the practical material affects the development of students' thinking (Wu et al., 2020).

The modern world requires specialists with creative thinking who can show flexibility and originality in solving complex and extraordinary tasks. However, it is impossible to acquire creative thinking skills without training (Suyundikova et al., 2021). The ability to solve problems, creative and critical thinking, communication skills and teamwork are now those fundamental factors which determine professional success (Guo et al., 2021a). Higher education must provide students with the oppor-

tunity to master these qualities (Gordon et al., 2022). Studying to paint is one of the simplest and most economical means of educating visual intelligence in students of art schools (Riley, 2021). Painting visuality is of fundamental importance for human culture, apart from professional practice in fine arts and design (Kocak et al., 2021).

Team teaching is aimed at introducing active work of students in the learning process, which affects the development of creative skills as a result of the rapid search for approaches to solving problems (Chen & Chen, 2019). The development of dynamics in learning also has a direct correlation with students' motivation to acquire new knowledge and skills (Hasan et al., 2022). Group learning is based on the elimination of passive perception of information and is aimed at finding new opportunities in solving problems as a result of discussion with other group members and teachers (Cheng & Ou, 2017). Therefore, the value of team-based learning in developing creative skills is great, which manifests itself in responsible learning.

Team training is of great importance for developing creative skills, as it allows interprofessional education to develop a culture of cooperation between students (Burgess et al., 2020). Teamwork is a process when team members collaborate to achieve set goals (Driskell et al., 2018). The ability to solve problems, creative and critical thinking, communication skills and teamwork are now fundamental factors determining professional success (Berghout, 2021). Higher education should aim at providing students with the opportunity to master these qualities. The authors chose visual arts to study the features of team training, since it contributes to the artistic taste of students to determine color schemes, compositions, techniques, etc.

Scientific education currently focuses on encouraging students to comprehend through multimodal representations. They should pay particular attention to the development of their creative thinking, as many researchers seek to enrich the theories of creativity with socio-cultural approaches (Sun, 2021). The development of creative thinking, sense making, logical implementation of formal and informal processes, constant hypotheses, communication with peers and teachers positively affect students' academic performance and their motivation to learn, since the presented elements focus directly on a certain group of students (Ferguson, 2022). In the field of fine arts, teachers need to abandon the traditional method of teaching and outdated educational materials not adapted to the modern stage of student development and technology. In the process of teaching fine arts, it is necessary to recreate more unique and independent concepts of artistic creativity, such as projection, photography, and copying (Border et al., 2021).

## 1.1 Literature review

The authors analyzed various literary sources to study approaches that affect the academic performance of students and contribute to the development of creative skills. The advantages of the Learning through Art Project are about linking the cultural heritage of students from different backgrounds with the main goals of school education. The program involves teaching both physically and psychologically developed people and those who have various psychophysiological problems. The results of the study provide an interdisciplinary and inclusive teaching methodology that promotes the development of cognitive and socio-affective competencies necessary for lifelong

learning. The learning approach includes a systematic practical study of the elements of painting, since art therapy affects the development of creative thinking (Alvarez et al., 2021; Huei-Chun, 2022).

Based on innovative approaches to information visualization (for example, interactive multimedia boards), the author's methodology, which involves using professional, psychological, pedagogical and artistic online technologies, aims at developing digital learning technologies, professional tools when teachers interact with students. These tools include systematic control by teachers of completed tasks (Goryacheva & Kartavtseva, 2021; Nolan, 2022).

Determining the influence of inter-curricular communication on the holistic visual development (cognitive, affective and psychomotor) of students when teaching art allows motivating them to study artistic disciplines related to painting. The author revealed that the students achieved a better understanding of art and professional terms if they took part in the learning process with interdisciplinary communication than the control group (there was no significant difference found in one week in the first and fifth grades). The students of the experimental group achieved significantly better knowledge transfer, the level of motivation, sensitivity to artistic materials and techniques, the level of originality and individuality, the level of critical and aesthetic evaluation. This resulted from a systematic interaction between students and teachers (Huzjak, 2016). Having studied higher educational institutions, the authors concluded that teachers were considering the possibility of introducing online feedback systems together with teamwork in curricula. Peer feedback turns out to be effective for developing teamwork skills, which is valuable for students (Donia et al., 2022).

The part of art education that demands attention to the elements of art technology also requires constant cooperation between teachers and students to transfer and assimilate the skills necessary for further professional activity. The authors have developed the structure and criteria for evaluating the process of remote artistic activity of students and its results. An analysis of theoretical philosophical aspects, psychological, sociological, pedagogical, and cultural concepts of personality development through art allowed identifying promising approaches based on the creation of psychological and pedagogical conditions (through communication with psychologists) for the productive socialization of children in difficult life situations using art education (Wagner et al., 2021). The authors developed a concept of pedagogical support for the productive socialization of children in difficult life situations using art. This concept includes a theoretical model of children's socialization and their integration into the socio-cultural space through active artistic and creative activity.

Based on the theories of aesthetics and aesthetic psychology, the evolution of popular aesthetic psychology was considered under the influence of the study of painting in three dimensions: aesthetic feeling, pleasure and tenderness (Hai, 2020). The author invited students who had not studied painting and students studying painting to participate in a comparative experiment. The results of the experiment show that the duration of professional training in the visual arts has a positive effect on the love of painting, the sharpness of the aesthetic sense, the pleasure of perceiving painting.

Using the methods of analyzing the literature on the research problem (art history, theory, and methodology of teaching fine arts, etc.), the students worked in OpenAir. This made it possible to establish the dependence of the format of practical tasks

and stages of the work on a pictorial sketch on the goals and objectives of teaching to paint in OpenAir (Soriano-Colchero & López-Vílchez, 2019; Zinchenko, 2021). Imaginative thinking is an important part of the educational process, since it affects the expression of students' thoughts and feelings and depends on the level of organization of educational and methodological work. Motivational aspects of students of art education were studied; a number of specific tasks aimed at clarifying the evolution of interest in fine art were set; a case study was used as a methodology; information was collected; documents, observations, and interviews were analyzed; and discussion groups were used as a strategy. The authors could see the improvement of the students' abilities to systematize the processes of artistic creativity, influenced by the group learning environment, the students' motivation and understanding of the importance of their learning. Group learning included teamwork, which allowed students to participate actively in the discussion of topics, ask questions to teachers and other students, thereby forming interest in the subject and dedication to learning (Leal et al., 2022; Li et al., 2021; Vallecillo, 2022). Team processes in higher education are directly related to the interaction of students. During the study, the authors noted that universities tended to proactive approaches to teaching students. Students who have been through the learning process in a team generate new ideas, synthesize, initiate better and more innovative proposals (Witherspoon, 2022).

Interprofessional training should aim at studying the strategy of team learning, students' perception of communication skills and teamwork. Group learning is a valid strategy to encourage communication and teamwork skills. However, there is a lack of interprofessional knowledge sharing during the course. Students reported that classroom activities should require the professional knowledge of all participating groups to prevent a negative shift in attitudes towards interprofessional learning in the later years of their studies. The introduction of team learning in the field of fundamental sciences can stimulate communication between students and their teamwork. Mixed classes can contribute to the socialization of students of different professional groups, although they carry the risk of a negative attitude towards interprofessional education (Lochner et al., 2020).

Focused on small groups, group training is directly related to achieving the necessary level of knowledge for each student. Students see the value of their interaction with other students to be able to solve problems together and find different approaches to learning (Burgess et al., 2020). Nowadays, teamwork and project management skills are especially relevant in conditions of uncertainty (Soboleva & Karavaev, 2020). Due to the insufficient methodological base to train future specialists, students with creative thinking and capable of productive teamwork rise to the fore in the modern educational environment.

## 1.2　Problem statement

Today's students expect the integration of innovative learning technologies, especially educational online platforms, using digital art in online education. Among the innovative technologies, it is supposed to use multimedia whiteboards, online applications, various available online platforms, for example, analogues of Zoom, which affect the involvement of students in the educational process and its modernization.

Teachers and students adapt quickly to the creative use of new applications and software, integrating them into their workflow for taking notes and tutorials. One of the main tasks of this work is to discover new methods for the art education industry, which allows achieving significant success in this field. Regulatory pedagogy should be based on two fundamental theoretical foundations of visual perception and visual communication, developing students' creative thinking skills using digital art and increasing motivation and desire to receive a comprehensive harmonious education. The paper aims to study approaches that affect the development of students' creative thinking skills using digital art in online education (on the example of educational online platform "Corel Painter 2022"), as well as academic performance and motivations to study. The authors set themselves the tasks of:

— determining what skills the students acquired before the study, indicating the grades received in creative (painting, digital art) and general academic disciplines (history, sociology, pedagogy, mathematics, physics, Chinese, cultural studies), which was possible by the use of a sociological survey;

— developing elements of teaching painting that include the principles of teamwork and inspiring the students' interest, which were developed based on the personal experience of the authors of the article;

— identifying the students' skills acquired after the training and comparing students' skill levels in creative subjects and general academic disciplines using Student's t-test.

## 2 Materials and methods

### 2.1 Study design

The authors studied the development of students' creative thinking skills using digital art in online education (on the example of educational online platform "Corel Painter 2022") in several stages. The first step was to identify the skills they had learned through the previous curriculum in painting. A sociological survey of teachers determined the skills (Chinn & Hart, 2022). Eighteen teachers from Russia and China determined the skills. The authors conducted the sociological survey remotely using a Google form. Therefore, they sent by e-mail a closed questionnaire that was presented during the study. To answer the questions, the teachers had to have a computer, laptop, tablet, or smartphone with an Internet connection. The teachers had 12 h to give their answers. In this area, the method of questioning is also often used, but the authors concluded that the sociological survey does not require additional preparation in the detailed answers provided by respondents, which will more accurately contribute to obtaining the necessary information. Sociological questioning can also be conducted for an unlimited number of respondents, which in our study affects the correctness of the data provided. At this stage, the authors determined the students' academic performance in creative (painting, digital art) and academic subjects (history, sociology, pedagogy, mathematics, physics, Chinese, cultural studies) before the study. To compare the indicators, they used the Student's t-test (Medstatistic, 2019). The results were consolidated into a single table based on an analysis of their semes-

ter grades, excluding additional calculations. At the second stage of the study, based on the data obtained, they developed some elements of a training program using digital art in online education (on the example of educational online platform "Corel Painter 2022"). The elements were designed for online training, which was becoming more common due to the COVID-19 pandemic. They selected the educational online platform "Corel Painter 2022" and the technological applications of digital art based on the study of various publicly available information and recommendations from other teachers. To implement the training, the authors needed to identify the most adequate interactive technologies, as well as access to the Internet to connect students to the educational process. The 18 teachers conducted classes under the direct supervision of the authors of the paper.

The third stage was to determine the skills that students had acquired after the training. This included their level of academic general and creative performance. Determining the level of academic performance was sufficient to identify the effectiveness of research and achieve the ultimate goal. Academic grades were selected as the basis of the study. The grades enabled comparing the results of efficiency since they reflected students' academic performance over a semester of study, rather than a short period of time. The authors surveyed the students in the same way that at the first stage. This stage also included the methods of the sociological survey and the calculation of the Student's t-test. The study took place in the 2021–2022 academic year.

## 2.2 Sampling and participants

The study involved 184 first-year students of creative specialties in Russia and China who studied painting. The authors chose painting as the basis of training because it is a type of fine art that has been developing in China since ancient times, in Russia since the XVII century. It contributes to the transmission of cultural traditions and historical epochs displayed on the canvases of various artists. Based on previously analyzed literature sources, it can be seen that the introduction of modern technologies of digital art into the educational process is not common for painting subjects. It pays much attention to mathematical and musical subjects, as well as language. Based on the obtained results, the authors selected creative specialties for the study, which were interrelated with painting.

A prerequisite for the sample was the affiliation of the first-year students to creative specialties. They chose the first year because students studied both specialized disciplines (painting, digital art) and general ones (history, sociology, pedagogy, mathematics, physics, Chinese, cultural studies) at this stage. For this reason, they excluded 30 s-year students from the research part. To correlate the necessary data, the students were familiarized with the research program and gave their written consent to participate. An important point of the consent was the confirmation of information about participation in the research program until its completion, which contributed to obtaining up-to-date data before and after the experiment.

### 2.3 Data analysis

Initially, the study determined what skills the students had gained because of the previous program. To determine this indicator, the authors used the method of sociological survey, which made it possible to detail the necessary data. The answers provided were as follows:

— formation of spatial imagination;
— development of creative individuality;
— development of analytical thinking;
— development of imagination;
— development of emotionality;
— discipline.

The Results Section contains all the questions put to the respondents as well as the answers. They evaluated the students' academic performance by comparing the provided grades for a semester of study with mandatory graduation into creative disciplines and general educational subjects. The authors used the calculation of the Student's t-test according to Formula 1 to compare the obtained dependencies between different disciplines.

$$t = \frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}} \tag{1}$$

where, $M_1$, $M_2$ are the average discrepancies of the indicators;
$m_1$, $m_2$ are the mean square deviations of the indicators.

The t-test is compared with tabular data, which is its important peculiarity. If a calculated indicator is lower than a tabular one, there is a relationship between the presented values; higher – the values do not have similar qualities. The next stage of training included the development of a training program, which included the following stages:

— formation of teamwork using the MOOC platform and digital art on the educational online platform "Corel Painter 2022";
— creating elements of colorfulness, contrast, decorativeness using the ArtFlow application;
— training and improvement of skills through the use of the Fresko Paint Light and Pro application;
— cultivation of immediacy skills using computer graphics;
— use of technological devices (multimedia whiteboards, Fresko Paint Light and Pro and ArtFlow applications).

The learning environment was created using a Team-Based Learning. This approach contributes to more intense involvement of students in the learning process. Team training promotes the activation of students' mental activity as a result of discussing the tasks set. The advantages of a team approach can also be associated with the development of communication skills, students' interaction with each other to understand the specifics of the studied issue. One of the disadvantages of a team approach to learning is the need to track the participation of all students in the

discussion. Additionally, the group members are not equally engaged in the training activity: some students fulfill the tasks to achieve high scores while others do not.

Development of the stages of training took place based on the personal experience of the authors of the article. To this end, the advantages and disadvantages of more than 200 modern computer applications that are more conducive to the formation of learning in a teamwork environment were studied. During the analysis of modern technologies, the possibility of their adaptation to teaching painting was identified, which will not only contribute to the possibility of receiving assignments from teachers, but also the development of creative thinking as a result of using self-study approaches. The third stage of the study was to determine the skills that the students acquired in the second semester of the curriculum, after training. The answers were as follows:

— formation of spatial imagination;
— development of creative individuality;
— development of analytical thinking;
— development of writing skills.

The students' academic performance was determined in various disciplines after the painting skills training according to the program developed by the authors with the same principles as before the training. The implementation of the third stage of learning was possible as a result of a sociological survey, as well as a comparison of grades before and after learning with the help of a control cross-section of knowledge in creative and general academic subjects. The percentages of the obtained levels of achievement are indicated by the total annual grades.

The rationale for the study validity and the data used is presented in the results of the study.

### 2.4  Statistical processing

Data processing took place using Microsoft Excel, which allowed saving and processing the obtained data, as well as building the necessary graphs. The authors chose the application because it allowed them to tabulate and analyze the data.

### 2.5  Ethical issues

The study was conducted in compliance with all ethical standards and in accordance with the Guidelines for Research Ethics in Science and Technology (Norwegian National Committee for Research Ethics in Science and Technology, 2016). The authors confirm that the data presented are up-to-date and reliable. The study was conducted in accordance with the previously designated stages for the respondents, which contributed to the absence of indicators that could violate the rights of students.

### 2.6  Research limitations

The limitations of the paper are associated with a limited period, since the study took place within one year of study. However, the authors provided data that confirmed the effectiveness of training, arising from the results before and after the study.

## 3 Results

The first stage of the study to determine the opportunities for the development of the students' creative skills, which further influence academic activity, comprised determining the skills that the students learned because of previously acquired knowledge (Fig. 1).

At the first stage, the results showed that the students developed mostly physiological than creative skills. For 27% of the students, their discipline is the most common skill to perform consistent actions over a long period of time. Discipline is also important for the formation of the educational process and the motivation of students for performing educational tasks and homework. About 23% of the students developed self-expression, which allowed them to select the necessary colors and additional elements for their artistic compositions. Self-expression also contributes to the formation of an individual style of a student studying painting. Approx. 13% of the students started developing their analytical thinking, which allowed both determining further approaches to painting and contributing to high grades in other subjects. Only 7% of the students have a creative personality, which allows them to do unique paintings. The data obtained indicate the need to develop creative skills that allow applying non-standard approaches to solving problems, not only within the framework of curricula. After determining the skills gained in the work, the students' performance in creative and other academic disciplines was determined. These data were necessary to establish the relationship between the development of creative skills and the academic performance of the respondents. The first-year students were involved, who studied both narrowly focused subjects and general academic disciplines (Table 1).

At each level, the average performance indicators were not calculated, because it is important to determine the number of students at this stage, and the grades obtained within a certain level do not play a significant role in developing the necessary skills. The presented results showed that there was a relationship between the grades in cre-
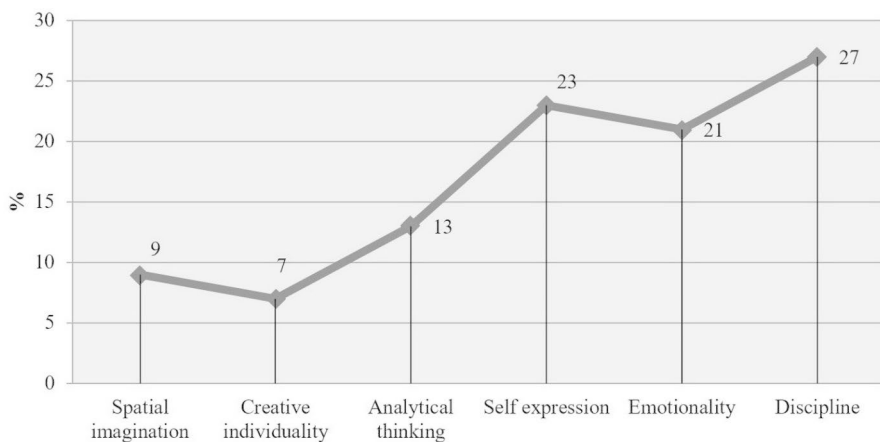


**Fig. 1** Skills acquired by the students at the start of the study

**Table 1** The students' academic performance in creative and general academic subjects before the study

| Academic performance level | Percentage of the students | | Comparison of the results using Student's t-test |
|---|---|---|---|
| | Creative academic subjects | General academic subjects | |
| High (from 85–100 points) | 11% | 7% | 1.263 |
| Sufficient (from 70 to 84 points) | 69% | 81% | 2.431 |
| Low (from 55 to 69 points) | 18% | 12% | 1.325 |
| Unacceptable level (below 54 points) | 2% | 1% | 0.127 |

ative subjects and general educational subjects. Approx. 11% of the students gained a high level of knowledge in creative disciplines and 7% in general academic disciplines. These results are related to previously defined skills that were acquired before the start of the study. The formation of a high level of knowledge was mainly influenced by discipline and self-expression. The largest number of the students gained a sufficient level, both in creative subjects (69%) and in general disciplines (81%), since creative individuality was insufficiently developed. About 2% of the students gained an unacceptable level in creative subjects and 1% in general disciplines, which resulted from the lack of the students' motivation and completion of necessary tasks. Comparison of the results with the Student's t-criterion showed that the obtained data correlated with each other, since they did not exceed the tabular value (2.447).

Determining the skills that students have and their performance at the start of the study was determined to understand the upcoming work with students and the development of program elements that are more focused on the development of students' creative individuality, spatial imagination, analytical thinking, which has a relationship with creative thinking. Having identified the existing situation, the authors have developed elements of the curriculum of teaching to paint, considering the elements of creative thinking that are necessary to develop general academic performance:

— training should be based on teamwork, which allows developing communication skills and creative thinking. To implement these elements, the educational process was based on additional subgroups of 8 people. This made it possible to pay attention to each group, discuss the information studied by students, and identify gaps in knowledge during the exchange of studied materials. For the development of creative thinking, communication skills were developed during the discussion between the students. The discussion included the definition of the painting concept, its color palette, the combination of details, etc. To exchange information, the authors used MOOC platform, which allowed communication both in the classroom and during homework, since it also facilitated online classes. This element plays an important role in the further process of obtaining creative skills, since teamwork forms an idea of the future artistic composition. It allows creating established concepts in a combination of colors and lines that affect the holistic artistic composition, based on the discussion of theoretical material between the students.

Colorfulness, decorativeness, and contrasts are important elements of teaching to paint. At this stage, the students must combine various elements within the frame-

work of the assigned tasks. This is an element of rehearsal and skill improvement, accumulating the complexity of performing compositions with each lesson. The training took place based on teamwork, which allowed applying the studied theoretical knowledge in the process of communication. At this stage, the formation of an imaginative vision takes place in the process of communication of students, which forms an aesthetic value. To implement this stage, the ArtFlow application and educational online platform for digital art "Corel Painter 2022" were used, which allow working with various drawings and layers. ArtFlow and educational online platform for digital art "Corel Painter 2022" can process electronic images in the form of impressionism, which contributes to the teamwork both to transfer the drawing to paper "blindly" and analyze which artistic elements were created correctly by the application and which required correction. The disadvantage of this program is a long period to process the provided drawings. The benefits of the Corel Painter platform in the development of creative skills are associated with the ability to perform the tasks. The solution to finding ways to implement them requires its own developed approach, which helps to activate thinking. The development of creative skills occurs as a result of transferring the drawing on paper, which contributes to the selection of the most harmonious artistic elements;

— ArtFlow and the online digital art education platform "Corel Painter 2022" can process electronic images in an impressionistic way, which promotes collaboration both to transfer the drawing to paper "blindly" and to analyze what artistic elements were created correctly by the application and what needed to be corrected. The disadvantage of this program is the long processing time of the provided drawings;

— the Fresko Paint Light and Pro application was used to train skills, which contributed to more complex sketches of painting and different layers. Using this application, it is possible to determine the necessary watercolors and oily paints. The disadvantages of this application contain minor errors resulted from the wrong combination of color elements. The development of skills in electronic form contributes to their transfer to paper, which affects logical thinking and spatial imagination. At this stage, the authors also used teamwork, which included transferring the same drawing to paper by different groups of the students. This approach contributed both to the development of communication skills and motivation, since teachers assessed the sketch of the highest quality;

— developing skills of spontaneity and creating a unique style. At this stage, they offered a group of the students to do paintings based on some compositions and certain lighting. The students had to use computer graphics, which allows them to train coloristic skills and aesthetic education. Each student did paintings in the group individually based on the designated tasks. However, group communication allowed them to interact with other group members and provide the most correct composition;

- also during the training, they used various technological devices (multimedia whiteboards, Fresko Paint Light and Pro and ArtFlow applications), which allow them to present images and paintings. They used various video lectures, contributing to the formation of the artistic worldview of the students.

The next stage of the study aimed to determine the skills acquired in the learning process, considering the elements of the developed program. This aspect was
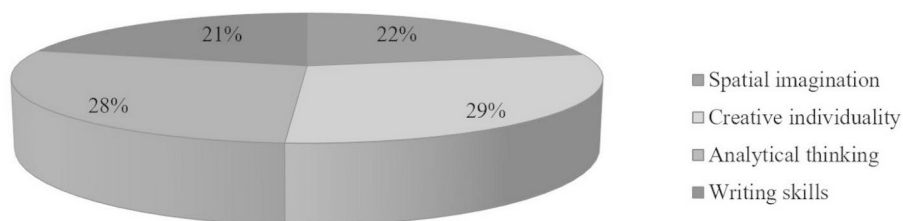
**Fig. 2** Skills acquired by the students after the training

**Table 2** Students' academic performance in various disciplines after training according to the program developed by the authors

| Academic performance level | Percentage of the students | | Comparison of the results using Student's t-test |
|---|---|---|---|
| | Creative academic subjects | General academic subjects | |
| High (from 85–100 points) | 88% | 83% | 0.834 |
| Sufficient (from 70 to 84 points) | 12% | 16% | 0.652 |
| Low (from 55 to 69 points) | - | 1% | - |
| Unacceptable level (below 54 points) | - | - | - |

included in the work to determine the increase in skills obtained, which were presented before the development of the steps presented (Fig. 2).

Based on the results in Fig. 2, the students did not even choose the answers related to psychological and physiological characteristics. They focused on the formation of creative skills mainly. The students had to choose one of the most appropriate answers from those provided. The results showed that many of the respondents preferred the development of creative individuality (29%), which allowed them to choose the concept of a work of art independently. This also influenced the use of creative approaches within other disciplines. For example, spatial imagination (22%) contributed to determining the accuracy of lines of sketches and allowed solving complex mathematical problems based on spherical geometry. Approx. 21% of the students developed their writing skills, and they could write short texts.

To compare the data on academic performance after training, the authors also determined the students' academic performance in various subjects that were included in the first-year curriculum (painting, painting technology, history, sociology, pedagogy, mathematics, physics, Chinese, cultural studies). The results, which are presented in Table 2, are significant in determining the need for the presented study phases, as the results allow one to compare performance with the first phase of the study.

The results showed that the authors managed to motivate the students to attend classes, since there was no unacceptable level of knowledge in various disciplines. However, 1% of the students received low grades in general academic subjects. There were no low grades in creative ones. The results confirm that it is necessary to improve the educational process in other disciplines, based on modern approaches,

including online platforms and applications, based on the pace of technology development. Due to a creative approach to solving educational problems, most of the students gained a high level of knowledge, both in creative disciplines (88%) and in general academic disciplines (83%). Few students with a high level in general academic subjects are associated with many subjects out of creative disciplines. The authors confirmed the results of the data comparison using the Student's t-test, since the calculated data did not exceed the tabular ones (2.571). They did not calculate the Student's t-test for a low level of knowledge, since there were no students with low grades in creative academic subjects.

The results of the work confirm the validity of the experimental data in accordance with the methodology chosen by the authors. The results obtained made it possible to achieve the goal of the work. The results of internal validity are presented in Table 2, which were obtained on the basis of the experiment. The results of external validity confirm the obtaining of reliable data, based on the experimental data, which were obtained by calculating Student's t-criterion. The present research achieved the study validity, which corresponds to the set aim. The impeccable result was due to determining students' academic performance in various disciplines after completing painting skills training according to the program developed within the framework of the research. Consequently, the effectiveness of the developed training elements was determined. At the same time, the research data confirmed the internal validity of the study, which made it possible to test the effectiveness of the team approach in training. The obtained academic grades were sufficient to indicate the study validity, since they included the level of knowledge and skills acquired. The grades obtained reflected the results of the whole study semester. Therefore, focus on the control section of knowledge excluded incorrect assessment. In this case, since the grades reflected the totality of knowledge and skills acquired, the assessment was not influence by side effects, such as the psychological and physiological state of the respondents. The results obtained showed that the effectiveness of the developed curriculum elements is at a high level. This is due to the teaching of knowledge in creative subjects and general academic disciplines.

## 4 Discussion

To determine the elements that affect academic activity, the authors analyzed various scientific papers. The development of students' creative thinking is important when studying the art of digital images using sensory technologies, because currently digitalization covers many areas of life. The combination of technology and art makes the idea of painting more peculiar. Using advanced sensor technologies in the field of art for research (sensors that perceive and recognize elements of the environment), turns boring and complex technical data into an interesting art form, making human-computer interaction compact and humane. This contributes to higher-quality pieces of art, allowing more people to use scientific and technical achievements (Gao & Fu, 2022). Based on gamification, various innovative approaches contribute to improving the quality of education and increase overall academic performance after their introduction into the educational process. To improve the educational process,

the paper includes some gamification elements in 4 subjects from various fields of knowledge. The results showed that this approach contributed to improving communication between students and increased the number of achievements in creative tasks. This was due to the game form, which allowed the students to interact with each other and motivated them to get higher grades (de la Peña et al., 2021). The authors indicate that the development of elements of non-standard problem-solving and creative skills contributes to the removal of barriers in learning, especially for solving mathematical problems (Supandi et al., 2021). The results showed that this approach promotes the use of improvisation skills in solving various tasks, even for students with disabilities. In our work, on the other hand, it is substantiated that an integrated approach to learning contributed to the development of creative skills (spatial imagination, creative individuality, analytical thinking, writing skills), which positively affected further educational activities. The results were obtained after one academic year.

Students should accept and assimilate the difficulties or possible failures of the creative process as an integral and inevitable phase of their artistic training (González-García & Gómez-Isla, 2021). The methodology of two pedagogical experiments included watching several documentaries containing the reflections of famous artists in the first person during their work and their doubts about the steps they take during their work. The authors concluded that joint reflection on various situations of frustration in artistic creativity was necessary for students. Thoughtful reflection and awareness of failures that arise during the creative process are important to overcome difficulties, providing the necessary training and research of such failures. The authors determined the structural relationship between self-effectiveness, independent learning, and creative thinking of adolescents (Lew & Park, 2019). Our work excluded the rationale for the difficulties that students encounter during learning but identified the skills that have been acquired during the process of learning. Also, the work identified statistical relationship between grades for creative disciplines and general academic subjects. The data were compared using the Student's t-test.

Based on the results of the master's program, a group of students and their adaptation to teaching fine arts in Chinese cultural context were studied. Then, a comparative analysis was carried out of the effectiveness of teaching fine arts considering cultural characteristics in comparison with traditional teaching (Guo et al., 2021b). The authors divided 106 students into 2 groups, who received a traditional art education. In addition, an intervention group was trained in additional fine arts (including a visit to the museum with observation and summing up of Chinese oil paintings (four training hours)). After 3 months of training, the authors analyzed the data and concluded that the results of the intervention group were much higher than those of the control group. Teaching fine arts is effective, acceptable and feasible considering cultural characteristics.

The traditional process of teaching fine art depends on the use of textbooks, slides, presentations, and additional video materials. However, this approach does not contribute to the subtle perception of artworks, the accurate evaluation of them, and critical thinking development. The solution to this issue requires the use of virtual reality technologies in training (EL-SVVR). This approach facilitates the development of experimental learning, thereby providing access to a variety of artworks and

improving students' abilities to create them. The process of creating digital paintings motivated students and allowed them to develop critical thinking (Chiu et al., 2023).

The use of modern technologies in teaching form self-expression in students. This affects artistic taste development as well as the process of expressing emotions through the visualization of paintings. Information technologies facilitate the creation of high-quality works of art in a shorter time and with less effort. Digital technologies contribute to the accuracy of emotion transmission and the improvement of artistic design (Wenjing & Cai, 2023). The use of modern technologies shapes the learning process due to communication elements and means of expression. Modern technologies can be used to demonstrate educational materials and teach drawing techniques (Chatzara et al., 2019).

Analysis of scientific papers has shown that many studies are related to the development of creative skills and their impact on academic performance in a particular subject, for example, academic performance in mathematics. This paper focuses on the relationship between the development of creative skills and improvement of academic performance in general educational disciplines. The authors compared the results using the Student's t-test. The value of our work lies in the possibility of using the presented stages of training in the conditions of a wider classroom, because the effectiveness of the developed stages and used technologies has been tested experimentally. To develop creative thinking, the authors recommend using a team approach to learning. The teaching of painting requires an emphasis on colorfulness, decorativeness, and contrasting combinations. Fine art courses should improve skills in forming complex art sketches as well as develop a unique style. At the same time, the use of modern technologies allows for a more comprehensive approach to learning and saves time in mastering a particular element.

## 5 Conclusions

The paper aimed to develop a training curriculum for future artists to determine the relationship between the development of creative skills and their impact on academic disciplines. The authors determined that the students had mastered discipline to a greater extent (27%) and self-expression to choose colors (23%) before training. To a lesser extent, the students mastered creative skills associated with creative individuality (7%), analytical thinking (13%), and spatial imagination (9%). The results showed that the level of the students' academic performance was at a sufficient level at the initial stage of the development of creative skills. However, 69% of the students reached it within the framework of creative disciplines and 81% of general academic disciplines. The authors confirmed the presented results using the Student's t-test, the tabular value of which was higher (2.447) than that obtained during the calculation for all the levels.

The presented data contributed to the definition of curriculum elements that affected the development of artists' skills:

- implementation of teamwork to develop communication skills and logical thinking using the MOOC platform and educational online platform "Corel Painter 2022";
- creating colorfulness and decorativeness using systematic repetitions, based on the ArtFlow application and educational online platform "Corel Painter 2022";
- development of more complex painting sketches using Fresko Paint Light and Pro, which allows developing logical thinking and spatial imagination as a result of transferring elements to paper;
- development of a direct and unique style using elements of computer graphics;
- introduction of various technological devices that contribute to students' world view.

After the training, it was found that the students had developed creative skills better, which included creative individuality for 29% of the students and analytical thinking for 28% of them. In addition, 21% of the students have developed creative skills in writing various texts. The results of their academic performance after training showed that 88% of the students received high and 12% of them sufficient academic grades in creative disciplines. Approx. 83% of the students received high grades and 16% of them sufficient ones in general academic subjects. The results of the paper are of scientific value for teachers who develop new training programs that affect the acquisition of high knowledge not only within a limited number of subjects. The study of the advantages and disadvantages of a team approach to training are the prospects of further research. This will contribute to a more effective implementation of the training program.

The authors believe that one of the best creativity drivers, in addition to the presented elements of the training program, is the elaboration of artworks from different sides. This approach may form a profound understanding of combining colors, lines, and artistic forms. Creative skills can also be stimulated under the influence of famous artists and their works. In this case, it is essential to study their work and the peculiarities of creating paintings. Additional development also requires attention and implementation using innovative technologies. To this end, it is necessary to study the possibility of using various programs. Programs affect the development of artistic skills, thereby complicating the quality of the created works. At the same time, participation in various competitions allows students to improve their skills and compare progress over a certain period.

**Data Availability** Data will be available on request.

## Statements and Declarations

**Conflict of interests** This research has no conflict of interests.

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