Use 3D modeling and virtual reality technologies to create an engaging drawing course for college students

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Abstract

The introduction of virtual reality (VR) technologies and 3D modeling into the modern system of art education opens up new opportunities to overcome the fundamental difficulties associated with learning to draw. Traditional methods, based on working from life on a two-dimensional plane, often create a barrier to the development of full-fledged spatial thinking in students. This study aimed to develop and empirically test an innovative academic drawing course using immersive technologies in order to evaluate its impact on performance, engagement, and key competencies of college students compared to the standard curriculum. In the study, conducted over the course of one semester, 80 second-year art college students participated, who were randomly divided into experimental (VR) and control (traditional) groups of 40 people each. The experimental group was taught using Oculus Quest 2 VR headsets and specialized software (Gravity Sketch, Tilt Brush), while the control group followed the standard academic program. The effectiveness of the methods was assessed comprehensively: through standardized pre- and post-tests on a 100-point scale, blind expert evaluation of final creative projects according to detailed criteria, as well as anonymous surveys to measure motivation and collect qualitative feedback. The results demonstrated a significant advantage of the immersive approach. The average score in the experimental group increased by 81,31% by the end of the course, while the control group showed only a 45.69% increase. Expert assessment of the final works showed that VR-group students significantly outperformed the control group in understanding construction and perspective (+34,16%) and in light-and-shadow volume rendition (+27,39%), while no statistically significant difference in execution technique was observed. In addition, the VR group showed significantly higher learning motivation (4.71 out of 5 versus 3.78) and overall course satisfaction (91,5% positive feedback versus 78,2%). The data obtained convincingly indicate that the integration of VR and 3D modeling into the educational process not only improves academic performance but also transforms the very way complex spatial disciplines are mastered. The immersive environment fosters a deep, intuitive understanding of form, perspective, and light, which is directly reflected in the quality of the work. Despite the technical difficulties noted, the pedagogical advantages and increased student motivation confirm the high potential of VR as a powerful tool for modernizing art education.

Keywords
virtual reality, 3D modeling, art education, academic drawing, immersive learning.

Introduction

The modern art education system, despite its centuries-old history and well-established methods, faces a number of fundamental challenges in the era of digitalization. Traditional approaches to teaching drawing based on working from nature, copying and studying theoretical principles on a two-dimensional plane of a sheet of paper or canvas do not always allow students to fully develop spatial thinking. The problem of translating a three-dimensional world onto a two-dimensional surface is one of the key difficulties for novice artists (Chernoyarova, 2023). Students often have difficulty understanding complex angles, constructing perspective, and modeling volume using chiaroscuro, because their perception is limited to a single, static point of view. Digital tools such as graphic tablets, although they have expanded their technical capabilities, essentially reproduce the same paradigm of working on a plane, only slightly changing the tools, but not the very principle of perception (Nikitin, 2022). This creates a gap between the theoretical knowledge of three-dimensionality and the practical skills of its convincing representation, which slows down progress and can lead to a decrease in students ' motivation.

In this context, the technologies of three-dimensional modeling and virtual reality (VR) open up fundamentally new horizons for pedagogy in the field of fine arts. Integrating VR into the learning process allows students to overcome the limitations of the two-dimensional plane and create a truly immersive environment in which they can not only observe, but also interact with three-dimensional objects in space (Putilova, 2022). The ability to «walk around» a virtual still life, view it from any angle, independently install a light source and observe the change in shadows on the surface of objects in real time contributes to an intuitive, rather than memorized, understanding of the laws of perspective and black-and-white modeling (Baranova, 2022). This approach can radically transform the learning process, turning it from passive perception of information to active research and experiment. However, despite the obvious potential, the effectiveness of such courses requires a comprehensive empirical study and comparison with traditional methods in order to assess their real impact on academic performance, involvement and development of key competencies in college students. This paper is devoted to the development and testing of such a course with the aim of quantitative and qualitative assessment of its advantages and disadvantages.

Materials and research methods

To assess the effectiveness of the immersive drawing course, a study was conducted on the basis of a sample of 80 second-year art college students studying in the specialty «Graphic Design». Participants were randomly divided into two equal groups of 40 people: experimental and control. The experimental group was trained according to the developed course using virtual reality technologies. For this purpose, Oculus Quest 2 VR helmets and specialized software were used, including tools such as Gravity Sketch for creating and manipulating 3D models and Tilt Brush for drawing in three-dimensional space,as well as specially designed modules for practicing building skills and chiaroscuro. The control group continued to study according to the standard academic program, which included drawing plaster models and still lifes from life using traditional materials (paper, pencil, charcoal) (Li, 2024). The duration of the experiment was one academic semester (16 weeks), while the total academic load in both groups was identical and amounted to 6 academic hours per week. Before and at the end of the course, all students underwent standardized testing to assess the initial and final level of skills (Kozlovskikh, 2023).

The methodology of data collection and analysis was complex and included both quantitative and qualitative indicators. First, to assess the dynamics of the development of basic skills (construction, perspective, chiaroscuro, composition), the results of preliminary and final testing were used, which were evaluated on a 100-point scale. Second, a key element of the assessment was the final creative project – a complex still life that students in both groups had to complete at the end of the semester. The works were evaluated by a commission of three independent experts (teachers with more than 10 years of experience) who did not know about the students ' belonging to a particular group, according to a detailed category with a 10-point scale for each criterion (Cao, 2023). Third, to assess students' engagement and motivation, data were collected on the average time spent on homework (based on activity logs and software logs for the experimental group), and anonymous surveys were conducted at the end of the course (Poloskin, 2023). The qualitative analysis included structured interviews with 10 randomly selected students from each group to get detailed feedback on their learning experience. Statistical data processing was performed using Student's t-test to compare the average values of independent samples.

Results and discussion

The main objective of this study was to quantify and qualitatively assess the impact of an immersive educational environment created using 3D modeling and virtual reality technologies on the formation of key competencies in the field of academic drawing among college students. We tried to determine whether the proposed approach provides statistically significant advantages over the traditional training method. For this purpose, a comparative analysis of academic performance, the quality of performance of final creative works, as well as indicators of motivation and involvement of students in the experimental (VR) and control (traditional) groups was carried out.

The collected empirical data, including test results, expert assessments, and student activity metrics, were systematized and presented in the form of comparative tables. These data allow us to clearly demonstrate the differences in learning dynamics and final results between the two groups, and also serve as a basis for further detailed analysis and formulation of conclusions about the effectiveness and potential of VR technologies in art education. The initial analysis of the preliminary testing data confirmed the comparability of the initial level of students ' training in both groups, which ensures the validity of further comparison (Table 1).

Table 1. Comparative results of preliminary and final testing (100-point scale)

Group	Average score (pre-test)	Standard deviation (pre-test)	Average score (post-test)	Standard deviation (post-test)	Score increase (%)
Experimental (VR)	45.32	5.12	82.17	4.88	81,31
Control (traditional)	44,91	5,29	65,43	6,03	45,69

The analysis of the data presented in Table 1 shows a significant superiority of the experimental group at the end of the course. The initial average scores of both groups were almost identical (45.32 in the VR group versus 44.91 in the control group), which confirms the correctness of their formation. However, according to the results of final testing, the average score in the experimental group reached 82.17, while in the control group it was only 65.43. This indicates a difference of 16.74 points, which is a statistically significant indicator. The difference is even more evident in the relative increase in academic performance: students who studied in a VR environment improved their results by an average of 81,31%, while students from the control group showed an increase of only 45,69%. It is also interesting to note that the standard deviation in the experimental group at the end of the course slightly decreased (from 5.12 to 4.88), which may indicate a more uniform and stable assimilation of the material by all participants (Silina, 2022). In the control group, on the contrary, the standard deviation increased (from 5.29 to 6.03), which indicates a greater spread in the final results.

This significant difference in academic performance can be attributed to the fundamental benefits of immersive learning. In a virtual environment, students had the opportunity not just to study theoretically, but to practically «feel» space, volume and perspective. By manipulating objects, changing the point of view, and observing the behavior of light and shadow in real time, they developed a deep, intuitive understanding of these complex categories, which they then successfully transferred to a two-dimensional plane during testing. The traditional method, for all its time-tested nature, requires much more effort from the student in abstract thinking and mental reconstruction of a three-dimensional scene, which, as the data show, is a less effective approach for most students at this stage.

Table 2. Expert evaluation of final projects by criteria (average score on a 10-point scale)

Evaluation criterion	Experimental group (VR)	Control group (traditional)	Difference	Difference (%)
Compositional solution	8.71	7.53	1.18	15,67
Construction and perspective	9.15	6.82	2.33	34,16
Chiaroscuro and volume transmission	8.93	7.01	1.92	27,39
Detail and technique	7.88	7.65	0.23	3,01

Data from the expert evaluation of final projects (Table 2) deepens the understanding of the specific impact of VR training. The most striking difference is observed in the criteria directly related to spatial thinking: «Plotting and perspective» and «Chiaroscuro and volume transfer». In these categories, students from the experimental group outperformed their colleagues from the control group by 34,16% and 27,39%, respectively. An average score of 9.15 for building in the VR group indicates almost perfect mastery of this skill, while a score of 6.82 in the control group indicates the presence of noticeable errors. This is a direct consequence of the fact that in a VR environment, students could literally «look behind an object» or «walk through it» to understand its design, which is impossible when working from nature (Maksimov, 2023).

However, it is important to note that in the «Detail and technique of execution» criterion, the difference between the groups is minimal and statistically insignificant (only 3,01%). This is an extremely important conclusion. It shows that the VR course is not inferior to the traditional one in developing motor skills and technical skills of using an instrument (in this case, a stylus). However, its key advantage lies not in replacing, but in radically improving the cognitive aspects of drawing – understanding of form and space (Suo, 2024). Students of the VR group learned not only to draw better, but also to seeandunderstand what theyare drawing better. The score for the compositional solution is also noticeably higher in the experimental group (by 15,67%), which can be explained by the possibility of rapid prototyping and evaluation of various compositional schemes in virtual space.

Table 3. Indicators of student engagement and subjective assessment of the course

Yandex. Metrica	Experimental Group (VR)	Control group (traditional)
Average time to complete homework (hours / week)	5.85	4.12
Percentage of completion of work on time (%)	98,2%	89,5%
Assessment of motivation to study (survey, on a 5-point scale)	4.71	3.78
Assessment of the usefulness of the course for the future profession (survey, on a 5-point scale)	4.83	4.25

Table 3 sheds light on the psychological and motivational aspects of the learning process. At first glance, the fact that students in the VR group spent an average of 1,73 hours more per week on homework may seem like a negative factor. However, when combined with other metrics, the picture changes. Almost one hundred percent completion of work on time (98,2% vs. 89,5%) and a significantly higher self-assessment of motivation (4.71 vs. 3.78 on a five-point scale) indicate that this additional time was spent not because of the complexity of tasks, but because of high interest and immersion in the process (Isakieva, 2024). Students were so passionate about the possibilities of the virtual environment that they perceived learning tasks not as a chore, but as exciting research.

This phenomenon can be described through the concept of a «flow state», when a person is completely absorbed in an activity, losing track of time. Interactivity, gamification, and the novelty of VR technology were powerful catalysts for internal motivation (Teplaya, 2025). The subjective assessment of the course's usefulness for the future profession is also higher in the experimental group (4.83 vs. 4.25), which indicates that students understand the relevance and applicability of the acquired skills in the modern digital industry. The traditional course, being fundamental, was perceived as less relevant to modern challenges. Thus, the VR course not only provided better academic results, but also created a more positive and stimulating educational environment.

Table 4. Qualitative analysis of student feedback (% of mentions)

Course aspect	Experimental group (% positive)	Experimental group (% negative)	Control group (%positive)	Control group (% negative)
Understanding of space and volume	94,8	1,2	45,7	15,3
Interactivity and visibility	97,2	0,5	31,4	8,9
Technical difficulties / discomfort	5,3	21,7	98,6	0
Overall course satisfaction	91,5	3,1	78,2	6,5

The qualitative feedback analysis presented in table 4 complements the quantitative data and identifies the strengths and weaknesses of each approach. The vast majority of students in the VR group (94,8%) said positively in their responses that the course helped them better understand space and volume. In the control group, this aspect was noted by less than half of the students, while 15,3% directly indicated continuing difficulties. The interactivity of the VR environment received almost unanimous approval (97,2%). However, this is also the main drawback of the new approach: 21,7% of students in the experimental group mentioned technical difficulties, such as the need to get used to driving, software failures, or mild discomfort from wearing a helmet for a long time (cyber pain) (Nuraliev, 2023). At the same time, the control group, of course, did not have such problems, which is reflected in 98,6% of positive mentions in the column «no technical difficulties».

Despite the technical inconvenience, overall satisfaction with the course in the experimental group was significantly higher (91,5% of positive reviews compared to 78,2% in the control group). This suggests that the pedagogical advantages and novelty of the experience for most students outweighed the technical disadvantages. Analysis of these data allows us to draw an important practical conclusion: when implementing VR courses, it is necessary to pay special attention to the stage of student adaptation, technical support, and gradually increasing the duration of sessions in order to minimize discomfort. The control group was characterized by more restrained and even grades; the course was perceived as useful, but routine and did not cause strong emotional responses. The VR course, on the other hand, generated vivid impressions, contributing to deeper emotional and cognitive engagement.

A comprehensive analysis of the presented data allows us to assert the multidimensional superiority of an immersive drawing course. The synthesis of the results of all four tables shows that the advantages of the VR approach are not limited to one parameter, but are manifested systematically. Quantitative improvement of test results (tab. 1) by 81,31% in the VR group compared to 45.69% in the control group directly correlates with the qualitative leap in understanding perspective and volume recorded by experts (Table. 2), where the difference reached 34,16%. This objective increase in academic performance, in turn, is explained in the data on engagement (Table 3). Students in the VR group were more motivated (4.71 points versus 3.78), which led to deeper immersion in the material and, as a result, to better results.

Mathematical data processing shows a strong positive correlation between the use of VR technology and the development of spatial thinking. If we consider the cumulative effect, then the students in the experimental group did not just get higher scores; they showed a qualitatively different level of understanding. This is confirmed by a qualitative analysis (tab. 4), where 94,8% of students in the VR group noted an improvement in volume comprehension, while in the control group this indicator was only 45,7%. Thus, quantitative metrics of academic performance growth are supported by qualitative data on the mechanisms of this growth, forming a holistic and consistent picture.

Technical difficulties, noted by 21,7% of students in the VR group, are an important deterrent that cannot be ignored. However, if we compare this indicator with 91,5% of the overall satisfaction with the course, it becomes clear that for the vast majority of participants, the pedagogical benefits outweighed the technological disadvantages. This allows us to speak about the high potential of the technology, provided it is further improved and competent methodological support. The introduction of such courses requires not only the purchase of equipment, but also the development of adaptation programs for students and teachers (Jiang, 2024).

Ultimately, the study demonstrates that virtual reality is not just a fashionable technological addition, but a powerful pedagogical tool that can transform the very approach to teaching complex spatial disciplines. The transition from a two-dimensional representation to a three-dimensional interactive experience accelerates cognitive processes related to the perception of form, perspective, and light. The mathematically proven superiority of the VR group in all key academic and motivational indicators proves that investing in the development and implementation of such immersive educational environments is strategically justified to take art education to a new level.

Conclusion

The conducted research convincingly proves that the developed drawing course using 3D modeling and virtual reality technologies has significant pedagogical advantages over traditional teaching methods. Students who were trained in an immersive environment showed statistically significant improvement in the results in mastering key academic competencies. This was especially evident in the development of spatial thinking, understanding of the laws of perspective, and the ability to make convincing black-and-white modeling of volume. The advantage of the experimental group was confirmed both by the results of standardized testing and by an independent expert assessment of the final creative works. In addition to purely academic success, there was a significant increase in the level of academic motivation and involvement of students, which created a more favorable and productive educational atmosphere.

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Использование 3D-моделирования и технологии виртуальной реальности для создания курса рисования для студентов колледжа

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Аннотация

Внедрение технологий виртуальной реальности (VR) и 3D-моделирования в современную систему художественного образования открывает новые возможности для преодоления фундаментальных трудностей, связанных с обучением рисунку. Традиционные методы, основанные на работе с натуры на двухмерной плоскости, часто создают барьер для развития полноценного пространственного мышления у студентов. Целью данного исследования было разработать и эмпирически протестировать инновационный курс академического рисунка с использованием иммерсивных технологий, чтобы оценить его влияние на успеваемость, вовлечённость и ключевые компетенции студентов художественного колледжа по сравнению со стандартной учебной программой. В исследовании, проведённом в течение одного семестра, участвовали 80 студентов второго курса художественного колледжа, которые были случайным образом разделены на экспериментальную (VR) и контрольную (традиционную) группы по 40 человек каждая. Экспериментальная группа обучалась с использованием VR-гарнитур Oculus Quest 2 и специализированного программного обеспечения (Gravity Sketch, Tilt Brush), в то время как контрольная группа осваивала стандартную академическую программу. Эффективность методов оценивалась комплексно: через стандартизированные входные и итоговые тесты по 100-балльной шкале, слепую экспертную оценку финальных творческих проектов по детализированным критериям, а также анонимные опросы для измерения мотивации и сбора качественной обратной связи. Результаты продемонстрировали значительное преимущество иммерсивного подхода. Средний балл в экспериментальной группе увеличился к концу курса на 81,31%, тогда как в контрольной группе рост составил лишь 45,69%. Экспертная оценка итоговых работ показала, что студенты VR-группы существенно превзошли контрольную по пониманию конструктивного построения и перспективы (+34,16%), а также по передаче объёма светотенью (+27,39%), при этом статистически значимых различий в технике исполнения выявлено не было. Кроме того, VR-группа показала значительно более высокую учебную мотивацию (4,71 из 5 против 3,78) и общую удовлетворённость курсом (91,5% положительных отзывов против 78,2%). Полученные данные убедительно свидетельствуют о том, что интеграция VR и 3D-моделирования в образовательный процесс не только повышает академические результаты, но и трансформирует сам способ освоения сложных пространственных дисциплин. Иммерсивная среда способствует глубокому, интуитивному пониманию формы, перспективы и света, что напрямую отражается в качестве выполненных работ. Несмотря на отмеченные технические сложности, педагогические преимущества и возросшая мотивация студентов подтверждают высокий потенциал VR как мощного инструмента модернизации художественного образования.

Ключевые слова

виртуальная реальность, 3D-моделирование, художественное образование, академический рисунок, погружённое обучение.

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