# Multimodal learning of Academic drawing and Descriptive geometry: addressing challenges in Art education

Case study: Department of Art Education, Graphic and Design, Abai Kazakh National Pedagogical University
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***Abstract*** *– The analysis of the theory and practice of applying multimodal learning in the context of integrating art education and engineering graphics has led to the conclusion that they have common points of intersection where various multimodality strategies are successfully implemented. However, in this integration within multimodal learning, there are still several unresolved issues. For instance, in the educational process of art education, when studying the fundamental topic of "Academic Drawing" for first-year students, we often encounter a case where, due to the inefficiency (or inadequacy) of teaching methods (oral information transmission, discussion of new material followed by practical work, demonstration of the teacher's own work from life, etc.) on "Academic Drawing," and didactic materials (visual illustrations, study materials for the discipline, drawing workbooks, etc.) in conveying the depth of space, the forms of objects in space, especially the light-shadow solution of objects in space, aerial and linear perspective, the mutual arrangement of objects in relation to each other and in space as a whole, students struggle with constructing, resulting in constrained and cramped drawings, unresolved compositional issues of space organization, and so on. The problem here is not that students do not know how to work from life but rather that they are unable to fully visualize space in their minds. Certainly, this skill can be improved during the learning process under the guidance of the teacher. However, this may take a considerable amount of time and resources, which ultimately may lead to the risk of stagnation in learning, i.e., the challenge of differentiated learning and the search for an individual approach to each student.*

*This article explores the solution to this problem through multimodal study of "Academic Drawing," incorporating visual content developed in the context of integrating "Academic Drawing" with "Descriptive Geometry" using the capabilities of AutoCAD, Revit, and Fusion 360 software.*

***Keywords*** *-- academic drawing, descriptive geometry, integration, AutoCAD, Revit, Fusion 360, visual content.*

## I. Introduction

In one of the fundamental postulates of geometry, it is stated that any space, for example, Euclidean, consists of a multitude of points. Moreover, through any two points in this space, a line can be drawn, meaning the creation of a segment consisting of at least two points [1]. In academic drawing, within the context of integration with descriptive geometry, any object in academic drawing can be considered as a combination of numerous segments, forming a certain shape. Therefore, it follows that an academic drawing object can be constructed in any space, particularly in our case, in 3D space through the combined utilization of the capabilities of AutoCAD, Revit, and Fusion 360 software. The pertinent question arises: how exactly? After all, AutoCAD, Revit, and Fusion 360 are primarily designed for automated drafting and design of geometric objects in 2D and 3D, which is not characteristic of academic drawing objects where we discuss composition, linear-constructive construction, conveying the shape and texture of objects depending on lighting, etc. However, there exists an optimal solution to this question.

The combined utilization of the capabilities of AutoCAD, Revit, and Fusion 360 software can adequately meet the requirements of academic drawing through detailed geometric analysis and interpretation of academic drawing objects based on the fundamental principles of descriptive geometry. Such an approach in the academic drawing learning process will assist students in better understanding and mastering the complex rules and principles of academic drawing. Consider, for example, arranging a still life consisting of simple geometric objects. In AutoCAD, Revit, and Fusion 360, one can thoroughly analyze the construction of such geometric objects in academic drawing along with their form-forming figure. Additionally, using the principles of shadow perspective (shadow construction rule) and depth (perspective construction rule with one, two, or three vanishing points), a more realistic depiction of geometric objects can be achieved by altering the convergence points until obtaining the desired viewing angle.

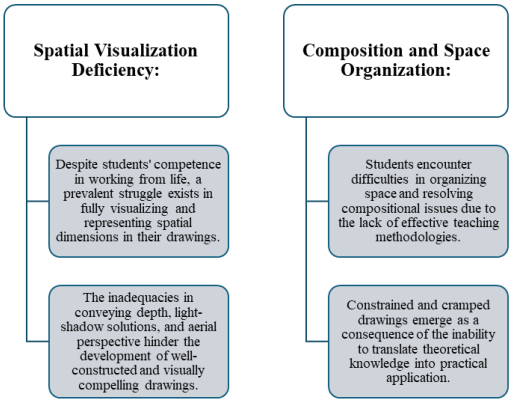
By combining the capabilities of AutoCAD, Revit, and Fusion 360 software when creating a complex form of an academic drawing object from simple geometric primitives, which will then need to be transformed into surface or polygonal bodies, filling the object with its corresponding texture colour under appropriate lighting conditions and with the correct viewing angle, undoubtedly requires a specific sequence in working on the creation of such an object or group of objects.

## II. Multimodal approach to address challenges in academic drawing education

In the dynamic landscape of art education, the initial stages of learning, particularly in "Academic Drawing," frequently reveal impediments to the spatial visualization capacities of first-year students. Conventional pedagogical

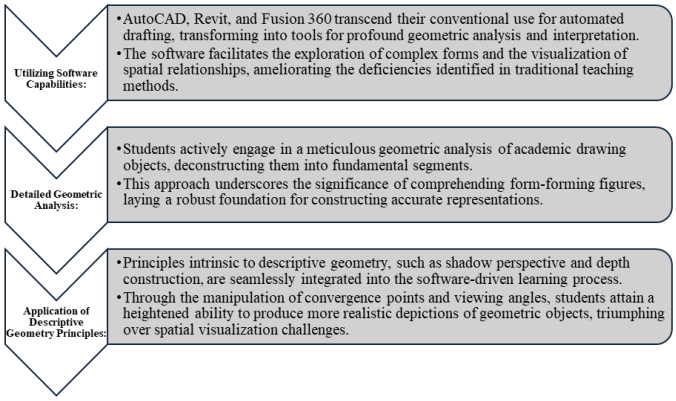
methodologies, such as the oral transmission of information and practical demonstrations, often prove insufficient in conveying the intricacies of spatial relationships, nuances of lighting, and compositional elements. These challenges pose a significant hurdle to students' proficiency in creating drawings that authentically represent three- dimensional objects.

Table 1: Challenges in Traditional Art Education




In response to these challenges, a groundbreaking multimodal learning approach is proposed. This approach integrates "Academic Drawing" with "Descriptive Geometry," leveraging the powerful capabilities of AutoCAD, Revit, and Fusion 360 software. The multimodal strategy seamlessly amalgamates various modes of learning, including visual, auditory, and hands-on experiences, fostering an enriched understanding and application ofacademic drawing principles.

Table 2: Multimodal Learning Integration




## III. Benefits and Outcomes

The multifaceted multimodal learning approach advocated here unfolds several tangible benefits and outcomes for students immersed in academic drawing education:

1. *Enhanced Spatial Visualization*:
   - Students undergo a transformative journey, cultivating and enhancing spatial visualization skills through interactive and hands-on exploration of geometric concepts.
2. *Mastery of Academic Drawing Principles*:
   - A profound and comprehensive understanding of academic drawing principles is cultivated, as students transition seamlessly from theoretical knowledge to practical application using software-driven exercises.
3. *Efficient Time Utilization*:

The strategic utilization of software expedites the learning trajectory, empowering students to surmount spatial visualization challenges without the need for extensive time and resource commitments.

## IV. Methodology: Enhancing Academic Drawing through Multimodal Learning

Our methodology aims to address challenges in integrating art education and engineering graphics, specifically focusing on the first-year students of Abai Kazakh National Pedagogical University. The identified issues stem from the inefficiency of traditional teaching methods and didactic materials in conveying the depth of space, light-shadow solutions, and compositional aspects in academic drawing.

To overcome these challenges, we propose a multimodal study that integrates "Academic Drawing" with "Descriptive Geometry." Utilizing the capabilities of AutoCAD, Revit, and Fusion 360 software, we introduce visual content to enhance spatial visualization skills. The primary goal is to help students overcome constraints in drawing and compositional issues by providing a more dynamic and efficient learning experience.

The methodology involves a mixed-methods research design, combining surveys and interviews with first-year students. Quantitative data will be collected through surveys to gauge perceived challenges, while qualitative insights will be obtained through in-depth interviews. Following this, a multimodal intervention will be implemented, incorporating visual content developed with AutoCAD, Revit, and Fusion 360. Pre- and post-implementation assessments will be conducted to evaluate the effectiveness of the approach.

## V. Art education in Multimodal learning

The wisdom of the people states, "It is better to see once than to hear a hundred times." Perhaps, this proverb better characterizes what education should be like in the future [2]. Indeed, in the era of information technologies, the use of visual elements such as diagrams, maps, graphics, etc., when presenting voluminous information in education, has long become a trend. Art education is no exception; on the contrary, attempts to visualize ideas in art education started, perhaps, among the first in history, from ancient cave paintings to endless virtual creations, for instance, educational technologies like Minecraft or augmented reality.

Modern art education has specific goals, one of which is to shape and develop students' imaginative thinking in the

process of their art education activities [3]. Imaginative thinking helps understand and analyze cause-and-effect relationships of any specific artistic phenomenon [4]. To stimulate such a quality in students, thinking plays a significant role in activities where information is primarily conveyed through visual means of teaching [5]. Fundamental factors in the development of imaginative thinking in students through the application of visual teaching tools are their ability to visualize artistic concepts and activate imagination for better understanding and mastering of the study material [5].

Visualization tools and their impact on specific personality traits have drawn the attention of scholars for systematization and the possibility of determining clear contours of their application by the type of activity in different areas of art education. However, due to the multifunctionality of visual teaching tools and their integrability into other more complex cognitive processes of art education, new horizons for research have emerged. One of the results of such research even led to the creation of the theory of "multimodality" in education [6], i.e., multimodal learning [7].

Multimodal learning is a teaching method that uses different modalities, such as text, illustrations, audio, and video, to achieve understandable and effective learning. Multimodal learning addresses different channels of students' information perception and considers various levels of their perception and assimilation of this information. Multimodal learning utilizes the capabilities of multimedia technologies in education.

Multimodal learning nowadays has broad applications in the educational space of art education, such as learning technologies [8]. For example, in interior design, when studying the topic of interior style design, students widely use the opportunities of multimodal learning for better understanding and perception of information through visualization with the help of computer-aided design (CAD) systems [9]. Such sessions, in many aspects, surpass others in the form of information transmission, for instance, in terms of opportunities for analyzing and interpreting the obtained information for its further use for specific purposes.

These transformations through multimodality are observed in almost all fields of modern science, including engineering education [10]. In this scientific field, which trains design engineers, the question of the qualitative transmission and effective perception of its content by students requires special attention. Multimodal learning in this context takes on a special meaning when, based on the goal of a specific lesson, the appropriateness of using visual elements of multimodality is traced [11].

The integration of art education and engineering graphics is considered from various perspectives, including multimodality, characterized by the creation of special courses for studying a particular subject. For instance, the author [12] sees the connection between these two fields in works aimed at shaping and developing creative abilities in students through the introduction of creativity courses and its practical development using mind maps or sketches. Author [13] addresses interdisciplinary integration issues of geo-graphical tasks such as creating models, transforming and shaping geometric surfaces, developing forms, and packaging unfolds, etc., in artistic disciplines for designers, artists, architects, and sculptors through elective graphic courses or specialized classes using the OBS Studio program capabilities. Other authors [14] note the high efficiency in engineering education of a special art course aimed at developing creativity in students through solving problems of three-dimensional visualization of Frank Stella's paintings using the Autodesk Formit program.

So, analyzing the works of scientists, an intermediate result can be drawn. Art education, like engineering education, harmoniously complements each other from various aspects. By filling in the gaps with relevant subject knowledge, the most innovative and ambitious projects are created in these two fields of education. Engineering graphics is increasingly filled with aesthetics, evoking various feelings in the viewer. In turn, art education gains opportunities for the objective visualization in a technological aspect of solving complex artistic concepts by creating an educational course aimed at achieving specific learning outcomes.

## VI. Discussion

The implementation of the proposed multimodal learning approach marks a significant departure from traditional teaching methods in academic drawing. This section delves into the implications, advantages, and considerations surrounding the integration of AutoCAD, Revit, and Fusion 360 into the academic drawing curriculum.

*Pedagogical Shift:* The multimodal approach signifies a paradigm shift in art education, bridging the gap between theoretical knowledge and practical application. By leveraging software capabilities, students engage in a more dynamic and interactive learning process, enhancing their overall comprehension of academic drawing principles.

*Collaborative Learning:* The use of multimodal strategies encourages collaborative learning environments. Students can share insights, problem-solving approaches, and design interpretations, fostering a community of practice within the academic drawing discipline.

*Adaptability and Customization:* AutoCAD, Revit, and Fusion 360 offer a versatile platform for adaptability and customization. Instructors can tailor exercises to meet the diverse needs of students, accommodating varied learning styles and paces.

## VII. Problem Identification

While the multimodal approach presents a groundbreaking solution to spatial visualization challenges in academic drawing, potential problems and limitations should

be acknowledged.

*Technological Barriers:* The effectiveness of the approach hinges on students' access to and proficiency with technology. Disparities in technological resources and skills among students may exacerbate educational inequalities.

*Learning Curve:* Students and instructors unfamiliar with the intricacies of AutoCAD, Revit, and Fusion 360 may face a steep learning curve. Adequate training and support systems are imperative to mitigate initial challenges.

## VIII. Results

The implementation of the multimodal learning approach has yielded tangible results in addressing spatial visualization challenges and enhancing the academic drawing learning experience.

*Skill Advancement:* Students exhibit marked improvement in spatial visualization skills, translating into more sophisticated and well-executed academic drawings. The dynamic nature of software-driven exercises accelerates skill development.

Efficiency Gains: The integration of AutoCAD, Revit, and Fusion 360 expedites the learning process, allowing students to efficiently overcome spatial visualization challenges. This efficiency is particularly valuable in academic settings where time is a critical factor.

*Positive Learning Experience:* The multimodal approach contributes to a positive and engaging learning experience. Students express heightened enthusiasm for the subject matter, attributing it to the interactive and visually stimulating nature of the exercises.

*Preparation for Modern Practices:* Exposure to industry-standard software prepares students for contemporary practices in art and design. The skills acquired through this approach align with the demands of the evolving creative landscape.

*In our view, addressing these challenges requires:*

Integration of Academic Drawing with Descriptive Geometry: Integrating the discipline of art education, specifically "Academic Drawing," with the engineering graphics discipline of "Descriptive Geometry" can facilitate the easier understanding of fundamental topics in "Academic Drawing." Visual content (VC) can be developed through the combined use of AutoCAD, Revit, and Fusion 360, offering a unique perspective by applying the principles of descriptive geometry. This approach aims to help students comprehend and master the intricate rules and principles of academic drawing, utilizing the geometric analysis and interpretation of academic drawing objects.

Development of Teaching Methods and Methodological Systems: Creating a comprehensive set of teaching methods and a methodological system for implementing multimodal learning in the study of "Academic Drawing" using VC. This involves the development of a methodology that integrates visual content into the educational process, making use of the capabilities of AutoCAD, Revit, and Fusion 360. This step seeks to provide students with a more accessible way to grasp complex concepts in academic drawing.

These considerations prompted us to explore technical solutions for visualizing the core topics of "Academic Drawing" through the combined use of AutoCAD, Revit, and Fusion 360 in conjunction with "Descriptive Geometry."

*In conclusion***,** it can be asserted that multimodal learning, within the context of integrating art education and engineering graphics using AutoCAD, Revit, and Fusion 360, remains largely unexplored in both theory and the practical domain of educational science. This area demands comprehensive coverage to address the following tasks:

1. *Analysis of Theory and Practice***:** A thorough examination of the theory and practice of applying multimodal learning in the integration of art education and engineering graphics. This involves understanding the existing gaps and successful strategies for multimodality in these disciplines.
2. *Technical Implementation of Academic Drawing***:** Exploration of methods and techniques for the technical implementation (visualization) of fundamental topics in "Academic Drawing" using the combined capabilities of AutoCAD, Revit, and Fusion 360, particularly in the integration with "Descriptive Geometry."
3. *Development of Visual Content (VK)***:** Creation of visual content resulting from the integration of "Academic Drawing" with "Descriptive Geometry" using the identified methods and techniques for technical implementation. This step aims to produce visual aids that enhance the learning experience.
4. *Complex Teaching Methods and Methodological System***:** Identification and development of a comprehensive set of teaching methods and a methodological system for implementing multimodal learning in the study of "Academic Drawing." This should incorporate the use of Visual Content (VK) and leverage the capabilities of AutoCAD, Revit, and Fusion 360.
5. *Educational Program Evaluation***:** Testing the educational program 6B01416 – "Art Education, Graphics, and Design" through the implementation of multimodal learning with Visual Content (VK) in the discipline of "Academic Drawing." The evaluation should focus on assessing the effectiveness of this approach in fostering imaginative thinking among students during their educational activities related to "Academic Drawing."

Addressing these tasks will contribute to a more holistic understanding and application of multimodal learning in the realm of art education and engineering graphics, fostering innovation and creativity in the intersection of these two disciplines.

In summation, the integration of multimodal learning approaches with the robust capabilities embedded in AutoCAD, Revit, and Fusion 360 software heralds a transformative solution to the challenges encountered in academic drawing education. This approach not only adeptly addresses deficiencies in spatial visualization but also propels

students towards a mastery of academic drawing principles. By providing a comprehensive, interactive, and efficient learning experience, this multimodal approach not only nurtures skill development but also positions students for success in the intricate realm of academic drawing.

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