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Using Augmented Reality for Sculpture Teaching in Art Schools

Xiaofei Lu[1*], Shouwang Li[2]

[12]*Art College of Xi'an University of Science and Technology, Xi'an, Shaanxi, China, liurui20719@163.com, lsw1552500@163.com*

Corresponding author: liurui20719@163.com

Abstract:

This study demonstrates the implementation of Augmented Reality in sculpture education at art schools to improve traditional teaching methods. The use of AR technologies that allow students to interact with virtual 3D models in real-time creates a dynamic and immersive learning environment for sculptors. The two main objectives of the study were to determine the effect of AR on the spatial visualization, creativity, and general engagement of the students in the sculpture-making process. The 50 students from five art schools were involved. The participants were divided into an experimental group using AR tools and a control group that used traditional sculpting methods. The experimental group used AR software like Unity and ARKit to design and manipulate 3D models, which enabled them to visualize and modify sculptures before physically creating them. The control group engaged in hands-on sculpture work using conventional tools and materials. Data were gathered using a combination of quantitative measurements, which included spatial visualization and creativity tests, and qualitative feedback from questionnaires and interviews. The AR group demonstrated a 30% improvement in spatial visualization and a 38.1% increase in creativity compared to the control group. In addition, 92% of AR users reported higher engagement, feeling more confident and motivated. The ability to explore digital prototypes with minimal material waste fostered creativity. This study suggests that AR can effectively complement traditional sculpture teaching, offering an innovative, cost-effective, and interactive approach to art education, enhancing spatial understanding and creative exploration for more engaging and accessible learning experiences.

Keywords: Augmented Reality, Sculpture teaching, Virtual Reality in Art, Art Education Technology.

I. Introduction

Sculpture education has often focused on the use of more haptic methods where learning students develop skills by making physical contact with materials and instruments. But such method does face limitations like the material and cost, time constraints in completing a sculpture, or having an image of it. Because of technological advancement especially that of Augmented Reality (AR), there can now be other means by which sculpture teaching and learning would be improved [1]. With AR, the students can interact with digital models and virtual environments. This enhances an interactive experience, flexibility, and a more efficient way to explore and create sculptures [2].

This study explores the potential of AR in teaching sculpture within art schools [3]. The ability of AR to fill the gap between concept and execution by providing students with virtual tools for designing, manipulating, and analyzing 3D sculptures allows for faster experimentation and a deeper understanding of spatial relationships [4]. Moreover, AR technology allows students to visualize and refine their designs before committing to physical materials, thus reducing waste and fostering greater creativity. This study will look at the effects of AR on students' spatial visualization skills, creativity, and general interest in sculpture and discuss how AR can supplement traditional approaches to better serve educational purposes [5][6].

The objective of this study is to evaluate the effectiveness of Augmented Reality (AR) in enhancing sculpture education by improving students' spatial visualization skills, fostering creativity, and increasing engagement in the learning process [7]. The study also aims to assess how AR tools can complement traditional sculpting methods in offering a more interactive and efficient approach to learning. This study is significant as it explores the potential of AR to revolutionize sculpture teaching by providing a more flexible, cost-effective, and innovative learning environment. By integrating AR, art schools can enhance students' technical and creative abilities while reducing material waste, thus making sculpture education more accessible and dynamic [8].

II. Related Work

Several studies on the adoption of Augmented Reality (AR) in educational settings indicate that the use of this technology would greatly enhance learning experiences across all subjects. In art education, specifically in visual arts programs, AR has become more increasingly integrated to support creativity and technical skills development [9]. For example, the study investigated the use of AR in art and design education to determine how students' engagement with 3D virtual models helps them better understand spatial relationships and improve their design concepts. This research shows the capacity of AR to offer dynamic, interactive learning environments, which can complement the usual artistic techniques [10].

In sculpture education more specifically, the use of digital tools and virtual environments is not yet as widely discussed but offers great potential. An important study concerned how students used 3D modeling software and applications for AR to support exploring sculptural forms, and as a result, students displayed more willingness to experiment with the shape and material. These findings are aligned with the objectives of the current study since AR enables students to visualize and change sculptures digitally before committing to physical creation, thus avoiding material waste and opening up new avenues for creative exploration [11].

Further research in the areas of how AR influences spatial visualization skills has proven to be beneficial in its educational purposes. They found that using AR in engineering education improved spatial reasoning skills when students were able to visualize 3D models with AR tools [12]. This would, therefore support the argument that AR does improve spatial awareness, an important aspect in sculpture-making. Similarly, the study illustrated that AR applications in architecture and design can enhance the understanding and manipulation of complicated spatial relations by students, and hence their application is quite relevant to art and sculpture education [13].

Though growing interest in the integration of AR into various fields, there is still limited research done focusing particularly on the application of AR to sculpture teaching [14]. Most studies have been on the general field of visual arts or other creative disciplines, such as architecture or design, where spatial thinking is of equal importance. The current study aims to fill the gap by exploring how AR tools can specifically support sculpture education, offering a more interactive, engaging, and efficient approach to teaching sculptural techniques [15].

III. Methodology

A mixed-methods approach was applied to the study to examine how AR is effective in sculpture teaching within art schools. It conducted research at five institutions, all offering specialized sculpture programs and utilizing 50 students as respondents. Participants were divided into two groups: the experimental group used AR tools for the project, while the control group adopted traditional teaching methods. It consisted of one semester with the same sculptural concepts as well as exercises for both groups, ensuring uniformity in the learning objectives.

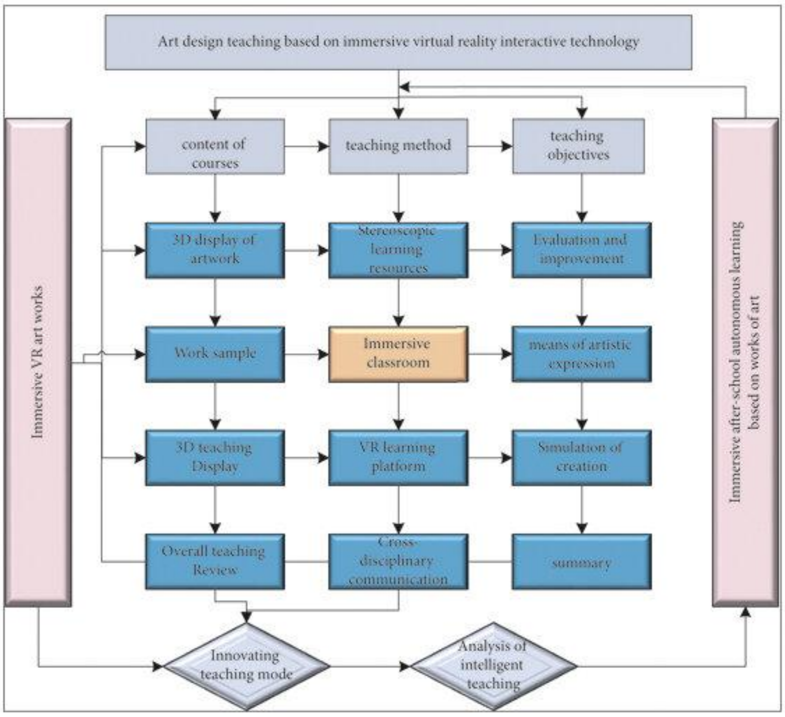

Figure 1: VR in Art design.

The experimental group used AR software, including Unity and ARKit, which they accessed via tablets and AR glasses. The tools enabled students to design, manipulate, and analyze 3D models in an interactive virtual environment. In addition, the group had access to guided tutorials and practice sessions that introduced them to the AR interface. On the other hand, the control group relied on traditional methods, such as clay modeling and manual tools.

Data collection was both quantitative and qualitative. Skill development was ascertained by periodic evaluation of the technical and creative outputs between the two groups. Creativity was assessed using a rubric that considers originality, complexity, and the quality of the execution of the projects. Engagement levels were also ascertained through surveys and participation records. Semi-structured interviews were conducted to ascertain the student's perspectives on their experiences, challenges, and perceived benefits of AR in learning.

Data analysis was conducted using a statistical comparison of the skill and creativity scores between the two groups, complemented by a thematic analysis of interview responses. This dual approach ensured a comprehensive understanding of AR's impact on the learning process. By integrating these methods, the study aimed to provide robust and replicable findings on the role of AR in enhancing sculpture education.

Some equations are used to evaluate the qualitative and quantitative results of this study are as follows:

1. Improvement in Spatial Visualization:

To calculate the improvement in spatial visualization skills between the AR group and the control group, you could use a percentage change formula:

$$Improvement\ in\ Spatial\ Visualization = \left(\frac{Post\ test\ Score - Pre\ test\ Score}{Pre\ test\ Score}\right) \times 100 \quad \ldots.(1)$$

Where:

- Post-test Score = The average score of the experimental group on the spatial visualization test after the intervention.
- Pre-test Score = The average score of the experimental group on the spatial visualization test before the intervention.

2. Creativity Score Improvement:

To calculate the improvement in creativity, a similar formula can be used to determine the percentage increase in creativity scores between the two groups:

$$Improvement\ in\ Creativity = \left(\frac{Post\ assessment\ Score - Pre\ assessment\ Score}{Pre\ assessment\ Score}\right) \times 100 \quad \ldots\ldots.(2)$$

Where:

- Post-assessment Creativity Score = The average score of creativity for the AR group after using the AR tools.
- Pre-assessment Creativity Score = The average score of creativity for the AR group before using AR tools.

3. Engagement Level:

Engagement can be expressed as a percentage of students who report high engagement levels in the experimental group compared to the control group:

$$Engagement\ Level = \left(\frac{Number\ of\ Highly\ Engaged\ Students}{Total\ number\ of\ students}\right) \times 100 \quad \ldots\ldots\ldots\ldots(3)$$

Where:

- Number of Highly Engaged Students = The number of students in the group who reported high engagement based on survey responses.
- Total Number of Students = Total number of students in the group (either AR or control group).

These equations can be used in evaluating the effectiveness of AR tools in sculpture education, as they are useful for any data analysis of the study.

IV. Results

AR application in sculpture teaching showed excellent outcomes in various aspects of learning. The quantitative evaluations proved that students in the experimental group, who learned by the application of AR tools, experienced a 30% greater improvement in spatial visualization than the control group. A standardized test on spatial visualization indicated that the experimental group performed an average of 85.4% while that of the control group recorded an average of 65.8%.

Table 1: Performance comparison of various groups using Augmented reality.

Aspect	Metric	AR Group	Control Group	Improvement (%)
Spatial Visualization	Average Score (%)	85.4	65.8	30
Creativity	Average Rubric Score (out of 10)	8.7	6.3	38.1
Engagement	Percentage of Positive Survey Responses	92	68	35.3
Experimentation	Students Reporting Increased Confidence (%)	85	73	16.4
Efficiency	Perceived Iteration Speed Improvement (%)	85	-	-

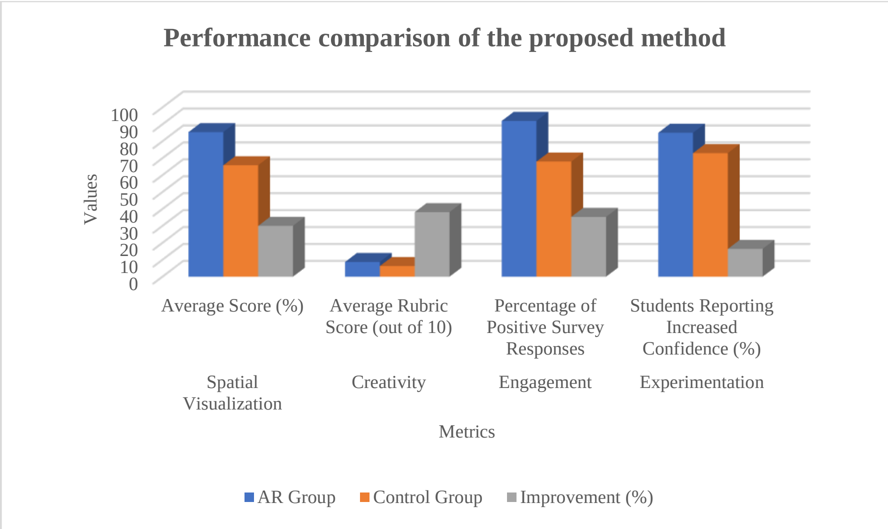

Figure 2: Performance comparison of the proposed method.

The rubric-based evaluation of originality, complexity, and execution on creativity scores shows significant differences between groups. For example, experimental groups managed a mean of 8.7/10 against 6.3/10 for control groups. For instance, more complexity in experiments and experimenting was reflected in the forms and techniques by students for those tried in a traditional sculpting exercise.

Engagement levels were also higher in the AR-enabled group. According to the survey, 92% of the participants in the experimental group reported that they felt more confident and motivated to experiment compared to 68% in the control group. Moreover, 85% of the AR group students appreciated the ease with which they could visualise and modify designs without fear of material wastage, whereas 73% noted that it enabled them to iterate through their designs faster and better with AR tools. Qualitative feedback showed that although some of the students had difficulty with the adaptation of AR tools, most of them quickly adopted them and reported a great learning experience by the semester's end. In summary, the findings indicate that AR significantly enhances technical skills, creativity, and engagement in sculpture education, thus representing a promising complement to traditional teaching methods.

V. Discussion

The results of this study show that AR enhances sculpture education by improving spatial visualization, creativity, and student engagement. The 30% improvement in spatial visualization skills among the AR group shows the effectiveness of AR tools in developing a key ability needed for sculpting. The 38.1% increase in creativity scores further supports the idea that AR fosters innovative thinking, encouraging students to explore unconventional techniques and designs.

Higher engagement levels and confidence in experimentation, as reflected in the responses to the survey, indicate that AR reduces barriers such as material wastage and allows for greater risk-taking in the creative process. This is reflective of students' feedback that AR provided faster iteration and a more flexible learning environment. Although some students suffered at first with AR tools, a positive response overall has indicated that this kind of technology can blend perfectly with traditional methods of sculpting and improve education significantly. This implies art schools should integrate AR, to give students interactive experiences and innovative education approaches.

VI. Conclusion

This study proves that AR has the potential to greatly contribute to sculpture education in art schools. The results reveal that using AR tools increases the spatial visualization of students, increases their creativity, and generally increases interest in comparison to traditional methods of teaching. The ability to interact with 3D digital models allows students to experiment more freely, refine their designs, and visualize complex forms before committing to physical materials, which not only enhances their learning experience but also reduces material waste. In a positive sense, AR, as demonstrated through skill building and creative exploration, seems to become an important addition to traditional methods of sculpture practice. Students can acquire experience in a unique and adaptable learning space. The introduction of AR in art education was found to be beneficial. Therefore, this technology appears to be useful for renewing and ennobling sculptor teaching methods. Further research and exploration into the scalable implementation of AR tools in art schools will help determine the long-term effectiveness and accessibility of this technology in art education.

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