PAYKAREH
Volume 13 Issue 37 Autumn 2024 Pages 76-91

Original Research Article

Investigating Effective Multimedia Elements in Science-Education Illustration (with Emphasis on Holographic Technology)

Seyed Mohammad Taheri Qomi[1]

1. Assistant Professor, Department of Visual Communication, Faculty of Visual Arts, Isfahan Art University, Isfahan, Iran.
E-mail: sm.taheri@aui.ac.ir

Received: 5 February 2024 Revised: 10 August 2024 Accepted: 15 August 2024

Abstract

Introduction: Science-education illustration is important and influential in simplifying complex concepts and making them visually attractive for learners. Multimedia elements, such as pictures, diagrams, and animations, along with sounds and music, increase the effectiveness of educational images. These elements provide a comprehensive visual presentation package that can support and enhance textual information. In other words, multimedia is a new branch of illustration that has found a special status in our era based on contemporary technological achievements and has also entered fields composed of art and computer elements. Learners can visualize abstract concepts, understand processes, and easily connect different ideas. In addition, multimedia elements can present actual samples and case studies, making the learning experience more relevant and practical. With the advancement of technology and new arts, instructors now have access to various multimedia elements to create more comprehensive educational illustrations. One of these technologies that has attracted a lot of attention is holographic technology. This research examines and explains the role and status of science-education illustrators in creating multimedia visual-education material based on modern holographic technology. The current study is conducted to answer this question: «What is the impact quality of multimedia elements in science-education illustration based on holographic technology?»

Research Method: Using a descriptive-analytical method, the current theoretical research aims to investigate the degree and quality of multimedia elements that impact science-education illustration, mainly based on holographic technology. The data collection is conducted using a library and electronic documents method.

Findings: Using the power of multimedia illustration and relying on holographic technology and the combination of visual, auditory, and tactile stimuli, the audience can experience more inclusive learning by understanding a more concrete space and multi-faceted study of the material at will, which increases comprehension, retention, and critical thinking skills even more.

Conclusion: Integrating multimedia elements with platforms based on modern learning systems enables seamless access and collaboration in different devices and places. Multimedia, especially the holographic type, includes endless resources, and illustrators can revolutionize the quantitative and qualitative mechanisms of education by adding their creative approaches and innovative ideas to these modern media.

Keywords

Education, Scientific Illustration-Graphics, Multimedia Art, Holographic, Interaction

How to cite this article: Taheri Qomi, S.M. (2024). Investigating Effective Multimedia Elements in Science-Education Illustration (with Emphasis on Holographic Technology). *Paykareh*, 13 (37), 76-91.
DOI: https://doi.org/10.22055/PYK.2024.19358

Introduction and Problem Definition

The integration of multimedia elements into the classroom has transformed the traditional teacher-centered approach into a learner-centered learning environment. Multimedia tools provide opportunities for active participation, collaboration, and exploration. Learners can engage with interactive simulations, virtual reality experiences, and online resources to deepen their understanding of complex concepts. In addition, multimedia elements enhance their creativity and imagination by allowing learners to express their ideas through visual and audio media. Accordingly, the classroom becomes a dynamic and interactive space, promoting a deeper level of interaction and motivation among learners. Multimedia elements have revolutionized the field of education, transforming traditional teaching methods into dynamic and interactive experiences. With the advancement of technology, teachers now have access to a wide range of multimedia tools that enhance the learning process. These elements, from videos and audio clips to animations and interactive simulations, have the power to engage learners and facilitate better understanding. Educational illustration is a powerful tool that helps understand and retain complex concepts. Research has shown that incorporating multimedia elements into educational tools leads to improved understanding, engagement, and retention of knowledge among learners. One of the latest developments in multimedia technology is the use of holographic technology in education. Holograms are three-dimensional images that can be projected into space, creating a realistic and pervasive learning experience. Holographic technology has the potential to revolutionize education by providing learners with interactive and realistic illustrations of complex concepts. In this regard, the present study is conducted to answer this question: «What is the impact quality of multimedia elements in science-education illustration based on holographic technology?»

Research Method

The present study aims to investigate the extent and quality of the impact of multimedia elements in scientific-educational illustration, relying on holographic technology and using a descriptive-analytical method. The data collection is conducted using a library and electronic documents method. In this research, while trying to answer the aforementioned question, the benefits of multimedia learning, the impact of multimedia in the classroom, and the role of multimedia elements in educational illustration will be examined.

Research Background

«Craik and Collings» (2022), in their article "A Preliminary Study on the Impact of Using 3D Models in Learning and Teaching Forensic Anthropology", found that learners who experienced 3D models performed better than those who only used 2D images. These results have been consistent across different educational environments, indicating that 3D models enhance learners' understanding and confidence. A study by «Mayer, Adams, and Cook» (2002) entitled «A comparison of two multimedia learning packages on the anatomy of the eye», showed that motion graphics explaining scientific phenomena led to higher knowledge retention than text or still images. «Mayer and Moreno's» (2003) study, entitled «Nine ways to reduce cognitive load in multimedia learning», shows that multimedia presentations with narration perform better than purely visual presentations in terms of

knowledge acquisition and transfer. «Yu, Li, Min, and Wang» (2022), in an analytical study titled "The Effectiveness of 3D Holography Technology on Students' Learning Performance: A Meta-Analysis", reported a significant positive impact of 3D holography technology[15] on students' learning performance across various subjects. A study conducted by «Akçayir and Yalçın» (2020) entitled «The effect of three-dimensional holographic technology on students' achievement and engagement in anatomy education» shows that holographic-based anatomy lessons lead to greater student engagement and much higher knowledge acquisition compared to traditional methods. However, some studies, such as «Hendrix, Klop, Paas, and Van Merrienboer» (2022) entitled «The effectiveness of naked-eye 3D holograms in science education: A meta-analysis», warns that effectiveness can be influenced by factors such as class size, duration, and type of holographic display, suggesting that further optimization is required. While traditional multimedia elements offer valuable benefits, holographic technology suggests a promising way to enhance science education. Continuous research and development is crucial to activate its full potential and effectively integrate it into educational practices. So far, no research in Persian has been found in line with the topic of this research. In the present study, in addition to utilizing the aforementioned research and other studies that have directly or indirectly addressed areas related to the discussion, an attempt is made to analyze effective multimedia elements in scientific-educational illustration, with an emphasis on holographic technology, in order to obtain accurate and practical results.

Illustration

Illustration is a field of visual arts that deals with the visual representation, interpretation, or explanation of texts, concepts, or stories and is used in communication media such as posters, advertisements, magazines, books, educational tools, animation, video games, and films. Illustration is done using a variety of tools such as watercolor, colored pencil, acrylic, metal pen, 2D and 3D digital software for different age groups. This field includes various sub-disciplines such as scientific-educational, imaginative, technical-engineering, natural science, historical, and science-fiction illustration.

Scientific-Educational Illustration

Scientific illustration is a field of visual arts that depicts the visual aspects of scientific concepts, especially observations of the natural world. This type of illustration not only reflects cultural issues but also depicts the findings and advances of science and technology. These images may reveal details that are not visible to the untrained eye, from the molecular level and viruses to the galactic hierarchy and the universe at large. The language of images depicts information and concepts that cannot be conveyed with words. The applications of this type of illustration are very wide and include the production of specialized magazines and books in the fields of natural sciences and technical engineering, textbooks, guides, displays in museums, websites, and scientific research articles (Hojat, 1999, 11). In fact, scientific illustrators are artists in the service of science, who use informed scientific observations, combined with technical and aesthetic skills, to depict scientific materials with great accuracy. Unlike aesthetic artists who prioritize the principles of beauty, these scientific illustrators emphasize adherence to valid scientific principles and findings in

scientific illustration. This type of illustration actually acts as a bridge between scientists' theories and discoveries and scientific audiences.

Branches of Scientific Illustration

Scientific illustration, from a common perspective, is mainly divided into three main branches of natural, technical, and historical sciences:

1. Natural Sciences Illustration: Natural science illustration focuses on topics and events that have arisen completely naturally, without the intervention of man-made industry and technologies. This branch includes the disciplines of biology, medicine, botany, zoology, physiography, anthropology (physical evolution), astronomy, and paleontology (Sumida & Jefcoat, 2018) (Fig 1).

Fig 1. An example of natural science illustration in biology material. Source: https://studentartguide.com.

2. Technical Illustration: Technical illustration includes topography, archaeology, architecture, mechanics, aerospace, electricity, and electronics (Figs 2 & 3).

Fig 2. An example of technical illustration in electronic material. Source: Haqqani, 2017.

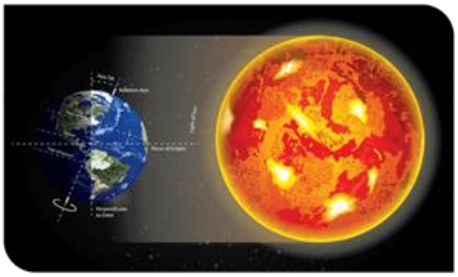

Fig 3. An example of technical illustration in astronomical material. Source: Haqqani, 2017.

3. Historical Illustration: Historical illustration refers to the depiction of texts in which the historian or author, in addition to describing historical events, also examines those events. This type of illustration actually analyzes the causes of historical events and even points out their positive and negative consequences (Fig 4).

Fig 4. An example of historical illustration. Source: Haqqani, 2017.

Scientific illustration is the application of images and drawings in the presentation of scientific material to facilitate understanding and learning of concepts. This method uses images, drawings, maps, and other graphic tools to explain the material and enhance the understanding of students and audiences. As mentioned, scientific-educational illustration can improve the learning process and create a better understanding of complex concepts. By using explanatory images, scientific concepts are presented in a more graphic and fluent form. This method is widely used, especially in the fields of natural sciences, mathematics, physics, and biology.

Advantages of Using Scientific-Educational Illustration

Among the advantages of scientific-educational illustration are the following:

1. Ease of Understanding: Images and diagrams can visually represent complex concepts and help in better understanding the material.

2. Retention and Recall: Images can improve memory and facilitate information recall.

3. Combining Skills: This method allows learners to understand information more harmonically and combine different skills.

4. Diversity in the Presentation of Material: Using diverse and attractive images allows for the presentation of educational material with beauty and high utility. This diversity allows students to look at the material in different ways and strengthen their understanding.

5. More Interaction: Motion images, interaction diagrams, and educational videos can lead to more interaction with the audience. This allows students to engage in hands-on activities and become more actively familiar with the concepts.

6. Use in Cyberspace: Scientific-educational illustration can be used in online educational platforms and social networks as an effective tool for knowledge transfer. This method helps to exchange ideas and share more information.

7. Technological Advancement: With the advancement of technology, graphic and visual capabilities have also improved, making it possible to depict scientific material more beautifully and effectively.

Educational illustration not only helps students better understand the material but also makes the learning process more appealing and dynamic. Intelligent use of these tools can help improve the quality of teaching and learning and, from various perspectives, allow learners to be more interactive and creative in their learning journey. Science illustration artists depict scientific materials in a detailed manner. The artist must have the technical skills and aesthetic taste to be able to combine scientific observations and research and accurately depict the material. Using images, models, and videos to explain something can make it more appealing and accessible to an audience. In addition to explaining complex topics in a simple way for the general public, scientific illustration can also help educate scientists and medical professionals (Fig 5 & 6).

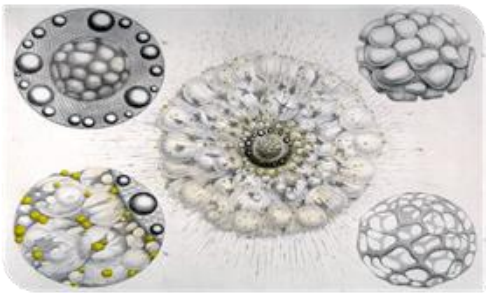

Fig 5. An example of medical illustration. Source: Tehran Illustrators, 2023.

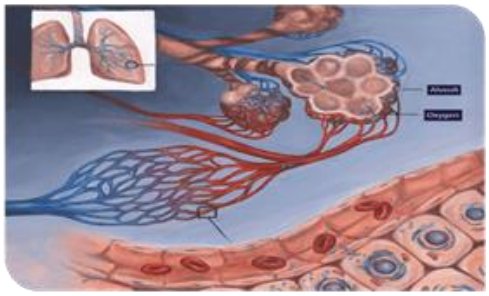

Fig 6. An example of medical illustration. Source: Tehran Illustrators, 2023.

Scientific images allow us to see things that are not visible to the naked eye, such as molecules and viruses, the internal anatomy of humans, animals, and plants, the layers inside the Earth, and even creatures that are now extinct.

Multimedia Illustration

Multimedia illustration refers to the use of various combinations of visual and audio media to present diverse and engaging materials to audiences. This method uses a combination of various elements such as images, videos, sounds, texts, and graphics to enhance the communication and learning experience. Multimedia illustration has a greater impact on attracting attention and understanding concepts by producing diverse and dynamic materials. This method provides the ability to create an interactive and diverse experience for the audience. Elements used in multimedia illustration include videos, diagrams, maps, animations, sounds, and still images (Roth, Clunie, Vining & Berkowitz, 2021) (Fig 7).

Fig 7. Part of a multimedia illustration in motion graphics format. Source: Henderson, 2018.

Some of the advantages of multimedia illustration include:

1. Variety of Materials: This method helps present information in a variety of ways and through different elements, which allows people to understand the information from different perspectives.

2. Attract More Attention: Using images, videos, and sounds attracts more attention from the audience and enhances their experience.

3. Active Interaction: Creating an interactive experience using different elements enhances the possibility of greater audience activity.
4. Effective Education: In the field of education, multimedia illustration helps students by enhancing the learning experience.
5. Conveying Emotions and Measuring Effectiveness: Multimedia illustration provides materials that contain emotions and motivation. This tool allows for the transmission of emotions and creating emotional experiences in the audience with the help of videos, music, and sounds. Also, measuring the effectiveness of the information presented is improved through audience interactions and feedback in this method.
6. Use in Advertising and Marketing: In the field of advertising and marketing, multimedia illustration using attractive images, promotional videos, and mixed sounds has a greater impact on attracting customers and promoting products.
7. Virtual and Augmented Reality Experience: Combining multimedia images with virtual and augmented reality technologies provides a more comprehensive experience of materials and concepts. This integration allows audiences to engage with material in a more interactive and realistic environment.
8. Adaptability to Different Audiences: Given that people differ in their lifestyles, needs, and priorities, multimedia illustration can present its materials in multiple ways that are suitable for different people.
As a result, multimedia illustration, as a wide-spreading tool with diverse capabilities, is influential in improving communication processes and effective information transfer in the fields of education, entertainment, advertising, and industry.

Holographic Technology

Holographic technology is an advanced innovation that allows for the display of three-dimensional images in a real environment. Unlike traditional two-dimensional images, holographic technology creates realistic, interactive, and comprehensive experiences. Using light diffraction, holographic displays can create depth, motion, and realism that captivate learners' attention and enhance their understanding of complex concepts. Holographic images are an advanced imaging technology that creates high-quality three-dimensional images. This technology uses the principles of light and laser waves to provide images that are more realistic and actual than 2D images. In holographic images, objects appear as if they are present in space and the viewer feels as if they are interacting with those objects. In this technology, optical information from an object is received and accurately reflected to the eyes and combined to provide a three-dimensional image. Since holographic images are physically created in space, they can be viewed from any angle, allowing the user to experience spatial information and augmented reality (Sugimoto, Shiga, Abe, Kameyama & Azuma, 2016) (Fig 8). The use of holographic images demonstrates the development of advanced imaging technology that enhances the visual experience of users and has wide applications in various fields, including experimental sciences, medicine, and industry.

Fig 8. Holographic light emission and formation of the final image. Source: https://pinterest.com

The technical mechanism of holographic image formation

Holographic images are created by using differences in light waves to create three-dimensional images. A hologram is created when a laser beam is split into two separate beams. The first beam bounces back when it hits the object from which the image will be created. The second beam then hits the reflection of the light from the first beam, creating an interference pattern that can be recorded (Talbot, 2019, 20). The mechanism of this process is as follows:

1. Monochromatic Light Source: First, a monochromatic light source such as a laser is used to produce light of a specific wavelength. This light is used with high precision and special properties to create precise differences in light waves.

2. Irreversible Division of Light: The light produced is split into two parts. One part is sent as reference light (direct light) towards the desired object and the collision with the object causes changes in the light waves.

3. Formation of Edges of Waves: Another part of the light is reflected towards the source as a vanishing edge. These edges are spaced at different levels and provide phase information about the relative position of the object and the source.

4. Hologram Recording: The reference light and the edge light are recorded on a light-sensitive film (hologram). This film contains precise patterns of phase and intensity differences at each point.

5. Image Reconstruction: When the hologram is illuminated with a similar monochromatic light source such as a laser, the light waves are recovered from the photosensitive film. This reconstruction is done by the patterns stored in the hologram and results in the creation of the appropriate 3D holographic image (Nyamsuren, 2021) (Fig 9).

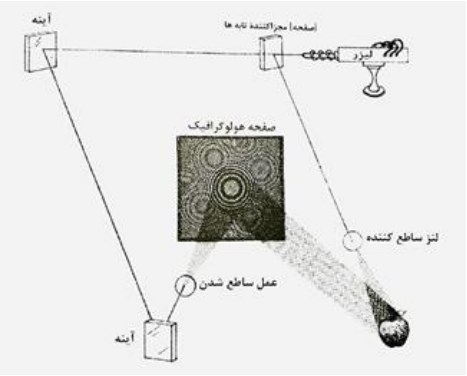

Fig 9. Diagram of the process of forming a holographic image. Source: Talbot, 2019, 20.

Fig 10. Salvador Dali with his holographic artwork, photo by Paul Perry. Source: Lawson-Tancred, 2023.

Holography and Art

Holography has developed as a highly effective method for creating high-quality three-dimensional images. In this context, a new field called «artistic holography» has emerged, which is recognized as an important style in the field of holography. The first artist to exploit the amazing properties of holograms was Salvador Dali. He always sought to use the physics of light as a macro tool to create the illusion of volume. Before the invention of the

laser and its use in holography, Dali used «stereoscopic[1]» vision for specific purposes. The first phase of this research took place in 1964 when he obtained transparent plastic panels from New York. These panels were combined to create an outstanding effect. He then used angled mirrors to project small double images showing Gala (his wife) in the Port Lligat workshop. This initiative led Dalí to begin working with stereoscopic images, which he created by reflecting light off two angled mirrors. When American scientist Dennis Gabor[2] won the Nobel Prize for his invention of holography, Dalí realized that holography was the best way to improve his images. In early 1972, on Gabor's advice, he composed three songs that were exhibited at the Nadler's Gallery in New York. In the introduction to the exhibition catalog, Dalí explained what holographic art meant to him and how this technology emerged as a new tool for artistic expression (Lissack, 2014) (Fig 10). After the emergence of artistic holography, with the development of new opportunities, this technology has become one of the important representation technologies. Artists in holographic studios work on projects that require new equipment and technologies, opening up new possibilities for artistic direction. Holography represents a fusion of knowledge of the physics of light and artistic creativity that requires collaboration between scientists, designers, and artists.

Holographic Technology Components in Education

Several educational institutions and organizations have already embraced holographic technology to enhance the learning experience. For example, medical schools are using holograms to train future doctors, allowing them to perform surgical procedures in a virtual reality environment. Similarly, museums are using holographic displays to bring historical artifacts to life, enabling visitors to interact with ancient objects and characters. Holograms have also found their way into the field of architecture and design, where learners can visualize and explore 3D building models. These examples demonstrate the enormous capacity of holographic technology in education and its ability to change the way learning and teaching are done (Dolega-Dolegowski & Proniewska, 2022) (Fig 11). Multimedia learning combines different modes of communication, such as visual and auditory, to present information more attractively and memorably. Research has consistently shown that multimedia learning is effective in improving learners' understanding and retention of information (Fenesi & Kim, 2014). By presenting information through multiple channels, multimedia elements cater to different learning styles and ensure that learners with diverse needs can understand materials more effectively. Moreover, multimedia learning stimulates critical thinking and problem-solving skills because learners are encouraged to analyze and interpret information presented in different formats. Holograms offer a unique learning experience that moves beyond traditional multimedia elements. They provide a sense of presence and immersion that captures learners' attention and stimulates their curiosity. With holograms, learners can interact with virtual objects and explore them from different perspectives, fostering a deeper understanding of the material. Holographic technology also promotes active learning, as learners are encouraged to manipulate and engage with the holographic materials. This hands-on approach enhances learners' spatial awareness, problem-solving skills, and critical thinking abilities. By incorporating holograms into the

curriculum, teachers can create a transformative learning environment that inspires and empowers learners (Fig 12).

Fig 11. Traditional classroom, with the addition of advanced 3D hologram technology that aids in education. Source: Businessner editorial team, 2023.

Fig 12. A representation of the future holographic virtual reality integrated into the learning experience. Source: Businessner editorial team, 2023.

The most important components of holographic technology in education are:
1. Advanced Spatial Understanding: Holographic technology allows learners to interact with 3D objects and environments, providing a deeper understanding of spatial relationships. This is especially useful in materials like anatomy, chemistry, and engineering, where spatial awareness plays a critical role in understanding and problem-solving.
2. Comprehensive Learning Experiences: Holographic technology creates comprehensive learning environments by bringing virtual objects into the real world. Learners can explore and manipulate virtual models, allowing for hands-on experiences that facilitate knowledge retention and critical thinking.
3. Visualize Abstract Concepts: Visualizing abstract or complex concepts using traditional 2D methods is often challenging. Holographic technology offers a unique solution by representing abstract concepts in a tangible and visually appealing way. Learners can view and interact with holographic visualizations, making abstract ideas more tangible and easier to understand.

Effective Use of Multimedia Elements with Holographic Technology

To maximize the benefits of holographic technology in educational visualization, effective use of multimedia elements is essential. By combining different sensory inputs, teachers can create comprehensive and engaging learning experiences. Here are some strategies for effectively integrating multimedia elements with holographic technology:
1. Visual and Auditory Stimulation: Holographic displays provide attractive visual stimuli, but combining them with relevant audio enhances the overall learning experience. By synchronizing visual and auditory information, teachers can reinforce key concepts and engage learners on multiple sensory levels.

2. Haptic Interactions: While holographic technology primarily focuses on visual and auditory elements, incorporating haptic interactions alongside visual elements can enhance the learning experience. By allowing learners to physically interact with virtual objects or use haptic feedback devices, teachers can provide a more comprehensive learning environment.

3. Gamification[3] and Interactive Simulations: Gamification and interactive simulations use holographic technology to create attractive learning experiences. By incorporating game-like elements and interactive scenarios, teachers can foster active participation, problem-solving, and knowledge application among learners (Garrison, Colin, Lemberger & Lugod, 2021).

4. Personalized Learning Experiences: Holographic technology allows for the customization of educational material to meet the needs and preferences of learners. By adapting images, audio, and interactions, teachers can create personalized learning experiences that cater to diverse learning styles and abilities.

5. Collaboration and Social Interactions: Holographic technology can facilitate collaboration and social interactions in educational environments. By enabling multiple users to interact with holographic visualizations simultaneously, learners can participate in group activities, discussions, and problem-solving exercises, strengthening teamwork and communication skills.

Challenges and Limitations of Using Holographic Illustration in Education

While holographic technology holds great promise for education, there are still challenges and limitations that need to be addressed. One of the main challenges is the cost of implementing holographic systems in classrooms. Holographic displays and equipment can be expensive, making the technology difficult for schools with limited resources to use. Moreover, developing high-quality educational holographic material requires specialized skills and resources. Teachers and material creators need training and support to effectively use holograms in the classroom. In addition, there may be technical limitations, such as the need for a controlled environment and limited viewing angles, that can impact the overall user experience. Overcoming these challenges will be crucial for the widespread adoption of holographic technology in education. The components of scientific-educational illustration, in terms of the form of production and presentation in three formats of traditional, multimedia, and holographic illustration can be seen and compared in Table 1 (Table 1).

Table 1. Comparison of scientific-educational components in types of illustration according to presentation type. Source: Author.

	Traditional illustration	**Multimedia illustration**	**Holographic illustration**
Audience range	All age and social groups	All age and social groups	All age and social groups, especially students
Material relevance	All types of scientific and educational materials	All types of scientific and educational materials	All types of scientific and educational materials, especially medical and biological materials
Variety in presentation	Technical, color, and print variety	Ability to be played on a variety of electronic displays	Merely presenting with the help of special holographic projectors in suitable environmental conditions
Accuracy in presentation	Depending on the size of the work and the details of the image	Depending on the format, resolution, and quality of production and playback	Depending on the format, resolution, and quality of production and playback
Attracting attention and focus	Focal focus on a two-dimensional surface	Multifaceted focus on audio, video, and motion in video displays	Focusing on multi-dimensional images and space based on laser light radiation
Interaction degree	Questions and answers without the possibility of interfering with the image	Questions and Answers - the possibility of interfering with the Structure of material presentation in interactive media	Questions and Answers - possibility to change the view and angle and explore space without physical limitations
Information persistence	Depending on the maintenance of physical and chemical materials, such as paper, canvas, and paint, and control of light and environment temperature - durability in the form of conversion to a computer file	Persistence in the form of conversion to computer files and archiving in physical digital storage and cloud space	Recording files on film - computer memories - cloud memories - recording on sensitive surfaces for continuous display
Production and maintenance costs	Costs related to considering and controlling the conditions of the physical environment - Costs of maintaining digital copies	The cost of producing multimedia materials - the costs of maintaining digital copies in physical and cloud storage	Costs related to considering and controlling the conditions of the physical environment - costs of maintaining digital copies and cloud space
Production tools	Hand-drawn painting and illustration tools such as various paints, canvases, mediums, etc.	Computer hardware and software, video cameras	Computer hardware and software - video cameras - light physics laboratory equipment

Conclusion

Multimedia elements have revolutionized education by providing dynamic, interactive, and attractive learning experiences. From films and animations to interactive simulations and virtual reality, these elements respond to different learning styles and enhance learners' understanding and retention of information. In particular, holographic technology-based illustration has the potential to transform education by creating comprehensive and realistic learning environments. Holograms offer a unique learning experience that enhances critical thinking, problem-solving, and spatial awareness. With continued advancements and innovations, the full transformative potential of multimedia and holographic image creation can be activated in educational illustration. The effective use of multimedia elements, especially in conjunction with holographic technology, has the potential to revolutionize educational visualization. Applying the power of holographic displays and combining visual, auditory, and tactile stimuli, teachers can create comprehensive and engaging learning experiences that enhance comprehension, retention, and critical thinking skills. Holographic illustration, as an advanced tool in education, requires a combination of artistic and technological skills, in which visual artists play a critical role. The role of visual artists in this field is not limited to creating images, but as pioneers in the integration of art and science, they can help develop and advance this field. By teaching and sharing their experiences, they can train a new generation of artists and professionals who have a thorough understanding of the field. As holographic technology continues to evolve, it holds great promise for transforming the way we teach and learn. As technology advances, we can expect more sophisticated multimedia tools that provide more interactive and immersive experiences. Holographic illustration as an educational medium has several advantages over other educational illustration techniques. Holography can provide interactive and comprehensive educational experiences. Students can physically and visually interact with educational material, which can provide a deeper understanding of complex concepts. It also allows for accurate and realistic 3D visualization of educational topics. This technique can provide more detail than 2D images or videos, helping learners better understand complex concepts. Using innovative technologies such as holography can increase the motivation and attention of learners. These techniques are usually more engaging and can encourage learners to learn actively. Another advantage of holographic illustration is the possibility of virtual representation of objects and processes that are not physically accessible; for example, it provides microscopic structures or complex chemical processes. This can help to better and more accurately understand the topics. Furthermore, in many cases, the use of holography can reduce the costs and risks associated with physical experiments and demonstrations. Holographic material can be distributed and accessed digitally, allowing learners and teachers to access educational material anytime, anywhere; this visual material can also be easily updated and modified. Overall, the use of holographic illustrations in education can provide innovative and effective solutions to educational challenges and help improve the quality and effectiveness of the learning process. Multimedia, especially holography, has endless possibilities, and illustrators can transform

the quantitative and qualitative mechanisms of education by adding their creative aspects and innovative ideas to these new media.

Author Contributions
Not Participation

Acknowledgment
Not Appreciation

Conflict of Interest
The author (s) declare that there are no potential conflicts of interest related to this research, in writing, and publication of this article

Research Funding
The author (s) did not receive any financial support for conducting the research, writing up, and publication of this article.

Appendix
1.Stereoscopic vision is a method of creating a three-dimensional image in the viewer through binocular vision. In most stereoscopic vision methods, two ordinary two-dimensional images, slightly different in size, are placed in front of the right and left eyes. These two two-dimensional images are combined in the brain, giving the viewer the impression of seeing a three-dimensional image (Dornaika & Hammoudi, 2009).
2. Dennis Gabor (1900-1979) was a Polish inventor and electrical engineer best known for his invention of holography, for which he later received the Nobel Prize in Physics in 1971 (Merriam-Webster Encyclopedia).
3. Gamification is an approach that uses elements and ideas from computer games in non-game environments or activities to increase motivation, participation, and interaction. In fact, gamification attempts to capture attention and stimulate motivation by using game elements such as points, competitions, logos, prizes, and challenges (Author).

References

- Akçayır, M. & Yalçın, N. (2020). The effect of three-dimensional holographic technology on students' achievement and engagement in anatomy education. *Medical Science Educator*, 33(1), 223-231.
- Businessner editorial team. (2023). *Holographic displays in education: Revolutionizing learning experiences.* https://businessner.com/holographic-displays-in-education-revolutionizing-learning-experiences/ Jan 2024.
- Craik, K. & Collings, A J. (2022). A preliminary study into the impact of using three-dimensional models in forensic anthropology learning and teaching. *Science & Justice*, 6(62), 814-821. Doi: https://doi.org/10.1016/j.scijus.2022.04.006.
- Darkhanbaatar, N, Erdenebat, M, Shin, C-W, Kwon, K-C, Lee, K-Y, Baasantseren, G, & Kim, N. (2021). Three-dimensional see-through augmented-reality display system using a holographic micromirror array. *Applied optics*, 60(25), 7545-7551. Doi: https://doi.org/10.1364/AO.428364
- Dolega-Dolegowski, D, Proniewska, K, & Dolega-Dolegowska, M. (2022). Application of holography and augmented reality based technology to visualize the internal structure of the dental root- a proof of concept. *Head Face Med*, 18(12).Doi: https://doi.org/10.1186/s13005-022-00307-4.
- Dornaika, F. & Hammoudi, K. (2009). *Extracting 3D polyhedral building models from aerial images using a featureless and direct approach*. Machine Vision Applications.
- Fenesi, B, & Kim, J A. (2014). Learners misperceive the benefits of redundant text in multimedia learning. *Frontiers in psychology*, (5), 710. Doi: https://doi.org/10.3389/fpsyg.2014.00710.
- Garrison, E, Colin, S, Lemberger, O, & Lugod, M. (2021). Interactive learning for nurses through gamification, *The Journal of nursing administration*, 51(2), 95-100.
- Haqqani, M. (2017). *Historical illustration.* https://www.scienceart.ir/article-reading-10.html. Access date: January 2023. **[In Persian]**
- Haqqani, M. (2017). *Technical illustration.* https://www.scienceart.ir/article-reading-5.html. Access date: January 2023. **[In Persian]**
- Hendrix, R. H, Klop, E., Paas, F. & Van Merrienboer, J. J. (2022). The effectiveness of naked-eye 3D holograms in science education: A meta-analysis. *Interactive Learning Environments.* 32(5), 1629–1641.
- Henderson, P. (2018). *Siemens*. https://www.behance.net/gallery/61547667/Peter-Henderson-Siemens/modules/361477687 .Jan 2024
- Hojat, M. (1999). *Scientific illustration and modeling* (M. A. Keshavarz, Ed.). Tehran: Borhan School Cultural Institute. **[In Persian]**
- Lawson-Tancred, Jo. (2023). *How Dalí became one of the first artist pioneers in the field of holographics*. https://news.artnet.com/art-world-archives/dali-holographics-2357911 May 2024.
- Lissack, S. (2014). *Dali in holographic space.* https://spie.org/news/spie-professional-magazine-archive/2014-january/dali-in-holographic-space#_=_ Jan 2024.
- Mayer, R. E, Adams, W. K. & Cook, S. (2002). A comparison of two multimedia learning packages on the anatomy of the eye. *Learning and Instruction*, 2(20), 95-99.
- Mayer, R. E. & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *EDUCATIONAL PSYCHOLOGIST*, 38(1), 43–52. Doi: https://doi.org/10.1207/S15326985EP3801_6.
- Roth, C, Clunie, D, Vining, D; Berkowitz, S, Berlin, A, Bissonnette, J, Clark, S, Cornish, T, Eid, M, Gaskin, C, Goel, A, Jacobs, G, Kwan, D, Luviano, D, McBee, M, Miller, K, Hafiz, A, Obcemea, C, Parwani, A, Rotemberg, V, Silver, E, Storm E, Tcheng, J, Thullner, K, & Folio, L. (2021). Multispecialty Enterprise imaging workgroup consensus on interactive multimedia reporting current state and road to the future: HIMSS-SIIM Collaborative White Paper. J. *Digit Imaging*, 34(3), 495-522.
- Sugimoto, M, Shiga, Y, Abe, M, Kameyama, S, & Azuma, T. (2016). Immersive surgical navigation using spatial interactive virtual reality and holographic augmented reality. *National Library of Medicine*, 117(5), 387-94. Doi: https://doi.org/10.1016/j.jbi.2015.04.003

- Sumida, S, & Jefcoat, B. (2018). Anatomy, animation, and visual effects: The reciprocal tools of biology and film-making. *Integrative and comparative biology*, 58(6), 1269-1278.
- Talbot, M. (2019). *The holographic universe (A theory to explain the supernatural abilities of the mind and the unknown mysteries of the brain and body)* (D. Mehrjuei, Trans.). Tehran: Hermes. **[In Persian]**
- Tehran Illustrators. (2023). *What is scientific and educational illustration?* https://tasvirsazi.ir/Accessed: January 2023. **[In Persian]**
- Yu, Q., Li, B. min, & Wang, Q. yun. (2022). The effectiveness of 3D holographic technology on students' learning performance: a meta-analysis. *Interactive Learning Environments*, 32(5), 1629–1641. Doi: https://doi.org/10.1080/10494820.2022.2124424.