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Using Hologram Technique in Educational Environment: The Case of Perspective Module

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Abstract

3D imaging systems have given rise to concepts such as holograms and virtual and augmented reality. One of the areas of use of holograms, which we encounter in various fields in our daily lives, is education. Hologram technology shortens and even accelerates the learning and perception processes by supporting them with visual elements, turning holograms into useful educational technology. Although there have been many studies on hologram technology to date, there are very few studies on using this technology as a course material and its contribution to the educational environment. This study aims to examine how hologram technology as a type of visual communication can be used in the educational environment and what its benefits might be. For this purpose, a hologram application was prepared for the Perspective module taught in the Basic Art Education course offered at the high school level and was used as a course material. Throughout the research, perspective as a topic was taught to tenth-grade high school students taking the Basic Art Education course using the hologram application prepared as a course material. As a result, it was observed that the experimental group, which was taught the module using the hologram application, demonstrated a higher success rate and a better understanding of the module. In conclusion, it can be inferred that using a technological method, such as a hologram, leads to more effective outcomes in comparison with traditional teaching methods.

Key words: *education; hologram technology; three-dimensional (3D); two-dimensional (2D); visual communication.*

Introduction

Technology is the public knowledge of producing goods or services (Atabek, 2001). As a combination of technical purposes and methods developed by people to dominate nature using science, technology shows us what the ever-evolving human brain and imagination can do. As their needs increase, people develop their knowledge and skills in line with their own needs, and at the same time, they change and develop technology with the purpose of finding something different and new. Nowadays, technology has long surpassed the point of meeting all the needs necessary for people to continue their daily lives and has become a way to find a new world to live in (Kulzhanova et al., 2020; Roztokci et al. 2019).

Techniques and technologies developed in line with needs have led to the rapid advancement of communication and information technologies. Moreover, with the development of computer technology, various technologies which we can use in our daily lives have emerged. While this situation has accelerated the fulfillment of needs, it has also contributed to the development of technology itself. Today, the 3D rendering of computer-generated media and the use of 3D technologies in this direction help increase the effect of visual elements and strengthen the visuals (Chibaca & Crespo, 2019). These technologies include augmented reality, virtual reality, mixed reality, and hologram techniques and technologies. With such technologies, the events and facts to be told have become much easier to explain and understand.

The word hologram combines the Greek words *holos* (the whole image) and *gram* (written). The basis of a hologram, which is also defined as the display technology that allows the 3D image of an object to be viewed spatially from the bottom, top, and sides (TRT, 2015), relies on simple optical principles. The trick of the hologram is to use a unique method to record the optical information of the scene (Kasper & Feller, 1987). A hologram, which can be thought of as a picture made of laser light, contains all the optical information on any object that even the eye has difficulty distinguishing. In this context, the difference between a hologram and a photograph is that the hologram plate does not record the image of the objects but the information necessary to obtain that image (Arıtan, 1990).

The hologram is based on the mixed pattern theory of Nobel laureate Dennis Gabor. In 1947, Gabor, trying to find a way to eliminate the magnetic errors of electron microscopes, wanted to record the shape of electron waves and correct it with optical waves obtained from a special glass, as the lenses distort the shape of spherical electron waves coming from point objects (Ecevit, 2009). In 1962, Yuri Nikolayevich Denisyuk, a Soviet physicist, combined Lippman's color photography technique with Gabor's holography to discover the "white-light reflection hologram", also known as the "Lippman hologram", which was recorded with a laser and visible at standard white light for the first time (Toal, 2012). In 1968, Dr. Stephen Anthony Benton invented a type of transparent hologram known as the "rainbow hologram" or "Benton hologram", which is still used in credit cards today. In 1971, McDonnell Douglas produced a hologram portrait of Gabor with a red-colored fine pulsed laser beam (<20 nanoseconds) (Hariharan, 2002). Furthermore, in 1972, Lloyd Cross succeeded in making 3D motion cinema by combining "white-light transmission holography" and the already known cinema recording technique (Ecevit, 2009).

Holograms are produced from precision optics and unique photosensitive materials exposed to laser light (Chibaca & Crespo, 2019; Mawardani et al., 2021; Ramlie et al., 2020). After the first hologram is produced in the laboratory, the "master" is reproduced in many formats according to the designed application areas and the quantities needed. The object to be photographed is first developed in a laser beam to produce a hologram. The laser beam is split in two; while one part illuminates the object, then bounces off and hits the film or a plate in front of the object, the other part, called the reference beam, is directed by mirrors and lenses to illuminate the film. When the hologram is developed, it looks like a meaningless swirl of light and dark lines. However, as soon as another laser beam illuminates the developed film, a 3D image of the original object appears. The holographic film is then developed into a black-and-white photograph. Once the process is completed and dried, the hologram is ready to be seen. This series of processes results in a laser-imaged "master" hologram.

Hologram technology is used in many different areas of daily life, from bank cards, security solutions, passports, textile products, concert and show tickets, ID cards, pictures, product and brand documents, CD, cassettes, and visual shows (Hwang et al., 2014). In fact, the hologram is now an advanced technology used in airplane instrument panels as holographic data storage, optical pattern recognition, and the digital camera focusing systems (Donnelly, 2007). Hologram, made inimitable by today's technological possibilities, has become the most preferred technique in terms of security.

This technology, which is also used in the education process that is in a different position from all fields stated above, causes information to be transferred quickly, enables us to use the knowledge and skills efficiently, and thus affects learning in a positive way. Its importance is indisputable, especially for visual communication design education, where visuality is at the forefront.

Holograms as educational technology

In his book "Eğitim Teknolojisi ve Öğretim" (1994), Çilenti states that the more sensory organs are involved in the learning process, the better we learn and the better knowledge retention is, based on Edgar Dale's Cone of Experience. Considering that 83 % of what we learn is perceived through sight, 10 % through hearing, 4 % through smell, 2 % through touch, and 1 % through taste, the importance of the sense of sight in education for both instructors and students cannot be denied (Birkeland Wilhelmsen & Felder, 2021; Shabiralyani et al., 2015; Strazdina, 2021). In this context, using computers and computer-generated media as educational technology increases its importance.

This once again demonstrates the importance of educational technology. Tas (2011) explains educational technology as follows:

"Educational technology is a dynamic process focused on the systematic design, implementation, evaluation, and development of teaching-learning processes in order to enrich every stage of education, to encourage individuals in education to learn and teach, to facilitate learning and to motivate students based on the results of educational theory and research with the aim of providing a more efficient teaching-learning environment" (p. 10).

Today, the hologram is a technology included in educational technologies. It is seen that 3D techniques, which visually strengthen the power of learning, are also used in different courses in the educational environment, apart from being used while teaching students.

In 2000, the image of Catharine Darnton, a Math teacher, was teleported at a short distance. The teleportation was carried out by Edex, the largest internet company in the UK, in the exhibition hall of a school in South London (BBC, 2000).

Sudeep Upadhye, a faculty member at the Vidya Vikas Institute of Technology in India, emphasized the importance of using 3D hologram technology in the educational environment in a study conducted with 200 participants in 2012 (Upadhye, 2018). In his study, Upadhye investigated whether hologram technology is an effective tool for teachers. His aim was to identify the challenges that would make it difficult to use holograms in a 3D learning environment. In the study, 68 % of the teachers argued that the 3D hologram was an effective tool, while 32 % said that it would not change education but could be helpful for teaching (Upadhye, 2018). On the other hand, Aslan and Erdoğan (2017) found that hologram technology contributes to students' rapid learning and that it supports permanent learning. Another study stated that the hologram provides an ideal learning environment for face-to-face education and effectively corrects various conceptual errors (Chen & Wang, 2015).

In addition to all these, a hologram also has disadvantages. While Upadhye (2018) mentioned the high cost of holograms and the need for a fast Internet connection in his study, Lee (2013) found that although it has excellent visual impact, the hologram causes problems such as creating a high-quality 3D image, visual fatigue, and application planning.

As in many educational and training environments, hologram technology can be used as a course material in institutions for arts education. Unlike the standard educational materials, hologram technology is thought to improve students' readiness, motivation, and understanding of the lecture as it has visual content (Shabiralyani et al., 2015; Strazdina, 2021). The hologram, which can be perceived in 3D due to its technology, allows an object or artistic work to be seen and examined in detail. In this respect, a hologram is a much more effective technique than a photograph. In photography, the image is obtained in 2D with the help of light, while it is obtained in 3D in holograms with the help of a laser.

Moreover, the hologram is a very suitable technique for examining works of art, as well as making them accessible. A person who wants to see and examine the Aphrodite sculpture in the Louvre Museum must go there, which is quite challenging in terms of time and money. Yet, an Aphrodite sculpture created with the hologram technique will be very useful for various purposes. For instance, hologram technology will eliminate the financial and temporal requirements of traveling to the location of the sculpture. Besides, the sculpture created with hologram technology will also provide the opportunity to be stored and used at any time. Hologram technology, which increases the accessibility of such works of art, should be considered a new and suitable technique to be used in educational environments, as it offers many opportunities, such as indefinite examination, observation, and reproduction.

Methodology

Output is one of the key elements of the education system. Although the output is expected to be consistent with the aims of the education system, there may be occasional inconsistencies with the aims. Therefore, it is necessary to determine whether the output is consistent with the aims, which can be done with educational measurement (Gelbal, 2013).

This section presents the research model and processes of identifying the study group, the preparation of measurement instruments, and data collection and analysis. This study used quantitative research methods in accordance with its aims. The quantitative research method was employed to determine the effect of visuals produced by hologram technology on graphic students' learning of the Perspective module. Holographic visuals used as a course material consisted of samples photographed with laser and included the depth of field and vanishing points necessary to explain the perspective. This study hypothesizes that students who are taught the course using the hologram technique should comprehend the topic more comprehensively than those taught using traditional teaching methods.

Procedure

This study used a quasi-experimental research design with a pretest and posttest with a control group to collect data (Karasar, 1984). It aimed to determine the effect of holographic visuals on graphic students' learning process and *retention*. Before the experiment, pretests were given to the experimental and control groups of students in the first week of the Perspective module of the Basic Art Education course. By taking into consideration the opinions of the course teacher, the Perspective module was prepared and taught with traditional methods in the control group. However, holographic visuals were used as a course material in the Perspective module lecture in the experimental group. Both groups were taught by the same teacher, who was acquainted with holographic visuals, in order to minimize the potential differences caused by the involvement of different teachers. After the experiment, posttests were administered to students.

The author's decision for choosing the Perspective module of the Basic Art Education course is that, as stated by Yakar (2008), this course aims to provide students with the common language of art/design, methods/techniques, knowledge of materials, and most importantly, skills of "seeing," "perceiving" and "problem-solving." In addition, the course with the highest number of hours and credits in design education programs is the Basic Art Education course. Moreover, the author examined the modules and the content of the Basic Art Education course in the curriculum. The module in which holographic visuals could be used as a course material was identified. In addition, the opinions of teachers teaching Basic Art Education in high schools and art professors from Gazi University Faculty of Vocational Education were obtained. As a result, it was determined to use the hologram as course material in the Perspective module. While teaching the Perspective module, technical concepts related to the subject were explained to the experimental group using printed holograms (Figure 1). A total of 12 printed hologram visuals were used during the teaching process. Then, the author prepared a preliminary test consisting of 52 questions to determine the reliability of the pretest questions in the experiment. This preliminary test was prepared to determine the knowledge level of students who had not been taught the Perspective module before. Before the experiment, this preliminary test was given to 104 10th-grade students at Zübeyde Hanım Girls' Anatolian Technical and Vocational High School and Etimesgut Girls' Anatolian Technical and Vocational High School.

It should be noted that although the name of these schools indicates that the schools comprise only female students, these types of schools in Turkey provide education to both male and female students. After the test, the results were analyzed, and 28 questions with a mean score below 0.5 were eliminated. Consequently, a pretest with 24 questions was obtained (the examples of the questions are provided in Annex 1). The students were graded from 0 to 100 points.

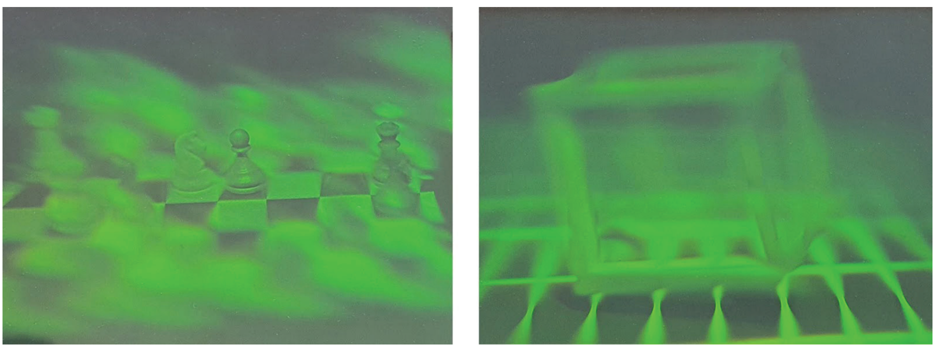

Figure 1. Examples from the hologram visuals used in the study

Since these images are exposed using a laser, they cannot be seen clearly when photographed. However, when viewed with the naked eye in the printed form, it is possible to see the depth of field and objects clearly.

This study's control and experimental groups consisted of 10th-grade students from the Department of Graphics and Photography at Gaziosmanpaşa Girls' Anatolian Technical and Vocational High School in Ankara, Turkey. As mentioned earlier, the study group included male and female students, despite the school's name, with an average age of 15-16. Students from this department were selected because they took the Perspective module of the Basic Art Education course for the first time. According to the class sizes, 20 (twenty) students from the 10-AG Class were designated as the experimental group, while 19 (nineteen) students from the 10-MG Class were designated as the control group in this study.

Instruments

Following the designation of the groups, the pretest was given to 10-AG and 10-MG students at Gaziosmanpaşa Girls' Anatolian Technical and Vocational High School. For the analysis of the test, the t-test was used. The t-test is a statistical test that compares the means of two groups in a study (Kim, 2015). After the pretest, a t-test for the independent group was applied to check whether there was a difference between the pretest scores of the groups. Once the education period was completed, a posttest was given to both groups to measure the outcomes. A t-test for the difference between the mean values in dependent groups was applied to understand whether the experimental and control groups' achievement scores obtained from the pretest and posttests differed. Also, the dependent samples t-test was used to analyze whether there was a significant difference between the groups' pretest and posttest scores.

Results and discussion

In this section, the findings obtained from the analyzed data are presented. Explanations are made by showing the data in tables, and the results are interpreted. However, it should be noted that since these experimental and control groups, who were learning the Perspective module for the first time, were randomly selected classes from the school selected for the study, there is a difference in the number of students in the groups, which constitutes a limitation for the study. Furthermore, the fact that the multiple t-test has a margin of Type-I error of 5 % should be considered.

The result of the comparison for the t-test for independent group pretest scores analysis is presented in Table 1. In the pretest, the control and experimental groups answered 24 questions with mean scores of 14.18 and 18.09, respectively.

Table 1
Comparison of pretest scores of students in experimental and control group

Pretest	Group	N	Mean	SD	t	df	p
Achievement Score	Experimental	20	18.79	3.10	4.033	37	0.000*
	Control	19	14.18	2.88			

*p<0.05

It is understood from Table 1 that there was a significant difference between the pretest scores of the groups at the 0.05 level. The fact that the difference in pretest scores was significant means that the experimental and control groups were different in terms of the measured property. In addition, Cohen's D test was applied to the pretest scores of both groups, and the value of 1.54 was obtained.

The results of the dependent samples t-test to show the difference between the pretest and posttest achievement scores in the experimental group are presented in Table 2.

Table 2
Difference between the pretest and posttest scores of the students in the experimental group

Group	Test	N	Mean	SD	t	df	p
Experimental	Pretest	20	18.79	2.88	-7.260	16	0.000*
	Posttest	20	20.68	0.94			

*p < 0.05

It is seen that posttest achievement scores of the experimental group students (M=20.68) were higher than their pretest achievement scores (M=18.79). Also, a statistically significant difference was found between their pretest and posttest achievement scores ($p<0.05$). This difference militates in favor of the posttest achievement scores of the experimental group students. In other words, it can be inferred that students' success increased in lectures in which holographic visuals were used.

The results of the dependent samples t-test used to analyze whether there was a significant difference between the control group's pretest and posttest achievement scores are demonstrated in Table 3.

Table 3
Comparison of pretest and posttest achievement scores of control group students

Group	Test	N	Mean	SD	t	df	p
Control	Pretest	19	14.18	1.90	-3.229	18	0.005*
	Posttest	19	19.53	2.75			

*p < 0.05

It is seen that posttest achievement scores of the control group students (M=19.53) were higher than their pretest achievement scores (M=14.18). In addition, a statistically significant difference was found between their pretest and posttest achievement scores ($p<0.05$). This difference militates in favor of the posttest achievement scores of the control group students. In other words, it can be inferred that the use of traditional methods in the lecture also positively affected students' success.

As can be seen in Table 1, there was a significant difference in favor of the control group between the pretest achievement scores of the experimental group students in which the lecture was delivered using 3D and hologram technologies and those of the control group students in which the lecture was delivered using the traditional method.

It was observed that the pretest achievement scores of the experimental group students (M=18.79), in which the lecture was delivered using 3D and hologram technologies, were higher than those of the control group students (M=14.18), in which the lecture was delivered using the traditional method. A statistically significant difference was found between the mean pretest achievement scores of the experimental and control group students ($p<0.05$).

Whether the experiment to be applied to the experimental group would eliminate this difference was decided by comparing the posttest scores. The posttest and retention scores of the groups were also analyzed with independent samples t-test. After the pretest was administered to the students in the experimental group, the Perspective module was taught for the first time with course materials, including holograms and hologram technologies, and the posttest was applied after the lectures were over.

Whether there was a significant difference between the posttest achievement scores of the students in the experimental and control groups was analyzed by t-test for independent samples, and the results are shown in Table 4.

Table 4
Posttest achievement scores of experimental and control group students

Posttest	Group	N	Mean	SD	t	df	p
Achievement Score	Experimental	20	20.,68	2.75	1.645	34	0.109
	Control	19	19.53	0.94			

*p<0.05

It was observed that the posttest achievement scores of the control group (M=19.53) were lower than those of the experimental group students (M=20.68). However, there was no statistically significant difference between the mean posttest achievement scores of the experimental and control groups (p>0.05). In addition, Cohen's D test was applied to the posttest scores of both groups, and the value of 0.56 was obtained. Although the experimental group students had better pretest achievement scores than the control group students, the fact that there was no significant difference between the posttest achievement scores of both groups after the education program was implemented indicates that the education program improved the students' knowledge. Therefore, it can be stated that using 3D and hologram techniques in the lecture was an important factor in increasing students' success.

Furthermore, the students and teachers involved in the study expressed positive opinions about the use of hologram technology as a course material. It was observed that the use of a technological material in addition to traditional course materials additionally motivated the students.

Conclusion

In this study, both groups were taught the Perspective module of the Basic Art Education course. While the course material with hologram and hologram technology examples was used in the experimental group, traditional teaching methods (e.g., overhead projector, ruler, caliper, miter, etc.) were used in the control group.

A pretest was given to the groups before the experiment. After the implementation of the education programme, a posttest was administered to both groups to assess their knowledge of the module. As a result of the posttest, a statistically significant difference was not found between the groups. The control group answered the questions with a mean score of 19.53, while the mean score of the experimental group was 20.68. The experimental group's pretest and posttest achievement scores were measured at 18.79 and 20.68, successively, which indicates a slight increase. On the other hand, the control group's scores were 14.18 and 19.53, successively, which shows a higher increase.

The posttest success average of the groups was significantly remarkable. This situation shows a subject mastery rate in both groups, and it can be observed that the hologram technologies used with a new understanding of course material increased the success rate.

Based on the results of this study, 3D and hologram technology can be used to reinforce teaching methods for students to understand the theoretical and practical information in art education courses. 3D and hologram technology can be used as a course material and included in textbooks and curricula as it is seen that it enables students to comprehend subjects effectively in a visual way. Also, more source material and visuals supported with 3D visuals and holograms can be included in modules and courses to enrich the theoretical subjects. However, the hologram is a technological application produced with various scientific methods, so it is necessary to include technical information on this technology in the lectures. 3D and hologram technologies may also be used in other branches of art education as a course material to strengthen the visual elements. However, it should be considered that the creation and use of holographic material require technical hardware, which can be expensive. In addition, not everyone may produce holographic material anywhere. The process requires qualified persons with appropriate media to create and present the holographic material.

References

Arıtan, A. (1990). Hologram nedir? Nasıl işler? [What is a hologram? How does it work?]. *Bilim ve Teknik Dergisi, 268,* 25.

Atabek, Ü. (2001). *İletişim ve teknoloji [Communication and Technology]*. Seçkin Yayıncılık.

Aslan, R., & Erdoğan, S. (2017). 21. Yüzyılda hekimlik eğitimi: Sanal gerçeklik, artırılmış gerçeklik,

Hologram [21st century medical education: Virtual reality, augmented reality, hologram]. *Kocatepe Veterinary Journal, 10*(3), 204-212. https://doi.org/10.5578/kvj.57308

Birkeland Wilhelmsen, G., & Felder, M. (2021). Learning is visual: Why teachers need to know about vision. *Education at the Intersection of Globalization and Technology.* https://doi.org/10.5772/intechopen.93546

British Broadcasting Corporation. (2000). *Meet the hologram teacher*. http://news.bbc.co.uk/2/hi/in_depth/education/2000/bett2000/600667.stm

Chen, Cp., & Wang, CH. (2015). Employing augmented reality embedded instruction to disperse the imparities of individual differences in earth science learning. *Journal of Science Education and Technology, 24(*6), 835-847. https://doi.org/10.1007/s10956-015-9567-3

Chicaba, J. C., & Crespo, H. (2019). Development and application of laser hologram production techniques for the teaching of physics and the public awareness of science. *Proc. SPIE 11207, Fourth International Conference on Applications of Optics and Photonics, 1120732, (3 October 2019).* https://doi.org/10.1117/12.2531266

Çilenti, K. (1994). *Eğitim teknolojisi ve öğretim [Educational technology and teaching]*. Kadıoğlu Matbaası.

Donnelly, J., & Massa, N. (2007). *Light: Introduction to optics and photonics.* New England Board of Higher Education.

Ecevit, N. (2009). *Holografi ve uygulamaları [Holography and applications]* [Seminar notes]. Ankara, Turkey.

Gelbal, S. (2013). *Ölçme ve değerlendirme [Measurement and evaluation].* Anadolu Üniversitesi Yayınları.

Hariharan, P. (2002). *Basics of holography.* Cambridge University Press.

Hwang, W., Chan, H., & Cheng, C. (2014). Hologram authentication based on a secure watermarking algorithm using cellular automata. *Applied Optics, 53*(27), G64-G73. https://doi.org/10.1364/AO.53.000G64

Karasar, N. (1984). *Bilimsel araştırma yöntemi [Scientific research method].* Ankara Üniversitesi İletişim Yayınları.

Kasper, E. J., & Feller, A. S. (1987). *The complete book of holograms: How they work and how to make them.* Dover Publications.

Kim, T. K. (2015). T test as a parametric statistic. *Korean Journal of Anesthesiology, 68*(6), 540. https://doi.org/10.4097/kjae.2015.68.6.540

Kulzhanova, Z., Kulzhanova, G. T., Mukhanbetkaliyev, Y. Y., Kakimzhanova, M. K., & Abdildina, K. S. (2020). Impact of technology on modern society – a philosophical analysis of the formation of technogenic environment. *Media Watch, 11*(3), 537-549. https://doi.org/10.15655/mw/2020/13082020

Lee, H. (2013). 3D holographic technology and its educational potential. *TechTrends, 57*(4), 34-39. https://doi.org/10.1007/s11528-013-0675-8

Mawardani, A., Dwandaru, W. S., Nugroho, M. P., & Surtini, S. (2021). Multimedia learning module (MLM) with hologram simulation to improve students' mathematical representation ability. *Advances in Social Science, Education and Humanities Research, 541.* https://doi.org/10.2991/assehr.k.210326.075

Ramlie, M. K., Ali, A. Z. M., & Rokeman, M. I. (2020). Design approach of hologram tutor: a conceptual framework. *International Journal of Information and Education Technology, 10*(1), 37-41. https://doi.org/10.18178/ijiet.2020.10.1.1336

Roztocki, M., Soja, P., & Wiestroffer, H. R. (2019). The role of information and communication Technologies in socioeconomic development: towards a multi-dimensional framework. *Information Technology for Development, 25*(2), 171-183. https://doi.org/10.1080/02681102.2019.1596654

Shabiralyani, G., Hasan, K. S., Hamad, N., & Iqbal, N. (2015). Impact of visual aids in enhancing the learning process case research: District Dear Ghazi Khan. *Journal of Education and Practice, 6*(19), 226-233.

Strazdina, E. (2021). Visual literacy in the context of digital education transformation. *Human, Technologies and Quality of Education.* https://doi.org/10.22364/htqe.2021.82

Tas, Ş. (2011). *Sınıf Öğretmenlerinin Kaynaştırma Eğitiminde Eğitim Teknolojileri Kullanım Durumları [Classroom Teacher's Use of Educational Technologies in Inclusive Education Status].* [Master's thesis, Ege Üniversitesi]. YÖK Ulusal Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=E6NWQJYxOo90QNK5QaeguA&no=mESXpl1jOYPCoNSTEv3q_g

Toal, V. (2012). *Introduction to holography.* CRC Press.

TRT Eğitim Dairesi Başkanlığı. (2015). *Yayıncılık ve medya sözlüğü [Publishing and media dictionary].* Kayıhan Ajans.

Upadhye, S. (2018). Use of 3D hologram technology in engineering education. *IOSR Journal of Mechanical and Civil Engineering,* 62-67. https://www.researchgate.net/publication/329208987_Use_Of_3D_Holographic_Technology_In_Engineering_Education

Yakar, G. (2008). *Temel sanat eğitimi dersi programının yürütülmesine ilişkin görüşlerin incelenmesi ve doku modülü için örnek cd-rom tasarımı [Examination of opinions on the execution of the basic art education course program and sample cd-rom design for texture module].* [Master's Thesis, Gazi Üniversitesi]. YÖK Ulusal Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

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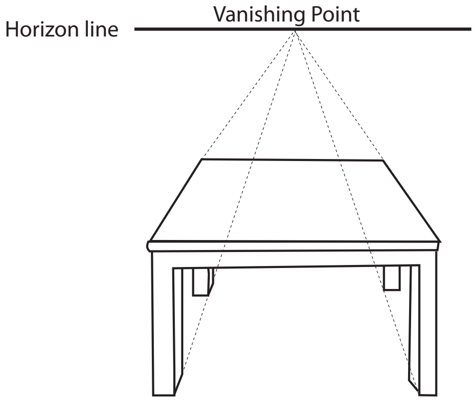
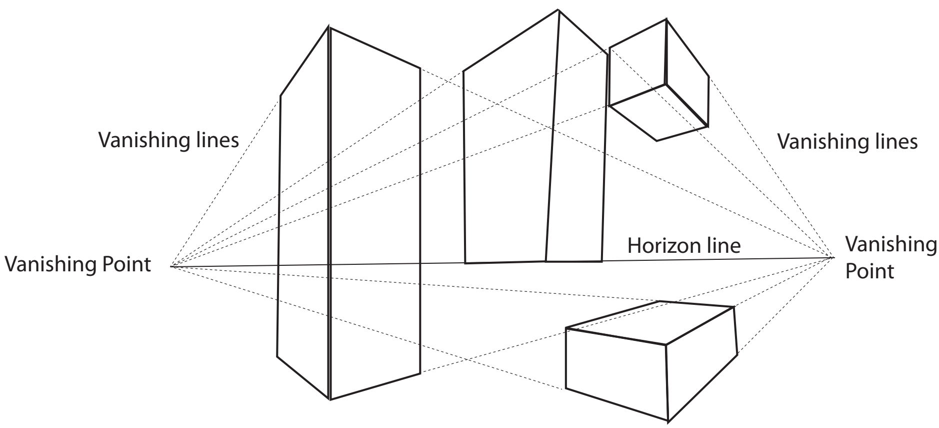
Appendix



Question 1. The table image shown above is an example of which of the following types of perspective?

a) Single vanishing point perspective
b) Perspective with four vanishing points
c) Circular perspective
d) Air perspective
e) Perspective with double vanishing point



Question 2. The picture given above is an example of which of the following types of perspective?

a) Air perspective
b) Single vanishing point perspective
c) Circular perspective
d) Perspective without vanishing point
e) Two vanishing points perspective

Korištenje hologramske tehnike u obrazovnom okružju: obrada nastavnoga modula Perspektiva

Sažetak

Sustavi za 3D slike omogućili su rasprostranjenost pojmova kao što su hologram te virtualna i proširena stvarnost. Hologrami su postali našom svakodnevnicom, a jedno od područja njihove primjene jest i obrazovanje. Hologramska tehnologija skraćuje i ubrzava procese učenja i percepcije pomoću vizualnih elemenata te tako hologrami postaju obrazovna tehnologija. Iako su do sada provedena mnogobrojna istraživanja o hologramskoj tehnologiji, tek se mali broj njih bavi korištenjem te tehnologije kao nastavnoga materijala i njezinom važnošću u obrazovnom okružju. Cilj je ovoga istraživanja utvrditi kako se hologramska tehnologija kao vrsta vizualne komunikacije može koristiti u obrazovnom okružju te koje su njezine moguće dobrobiti. S tim ciljem na umu, izrađena je hologramska aplikacija za modul Perspektiva, koji je dio predmeta Osnove umjetnosti na srednjoškolskoj razini. Aplikacija je korištena kao nastavni materijal. Tijekom istraživanja, perspektiva kao tema obrađena je s učenicima desetoga razreda koji su odabrali predmet Osnove umjetnosti, a hologramska aplikacija korištena je kao nastavni materijal. Rezultati su pokazali da je eksperimentalna skupina, s kojom je modul Perspektiva obrađen pomoću hologramske aplikacije, ostvarila bolji uspjeh i bolje razumjela modul. Može se zaključiti da primjena tehnologije kao što je hologram vodi k boljem ostvarenju ishoda nego što je slučaj s primjenom tradicionalnih nastavnih metoda.

Ključne riječi: *dvodimenzionalni (2D); hologramska tehnologija; obrazovanje; trodimenzionalni (3D); vizualna komunikacija.*

Uvod

Tehnologija podrazumijeva znanje javnosti o proizvodnji dobara i usluga (Atabek, 2001). Kao kombinacija tehničkih rješenja i metoda koje su razvili ljudi kako bi dominirali prirodom pomoću znanosti, tehnologija nam pokazuje što sve ljudska mašta i mozak, koji neprestano raste i razvija se, mogu napraviti. Kako se ljudske potrebe povećavaju, tako se u skladu s njima razvijaju i ljudske vještine i znanja, a istovremeno se razvija i mijenja tehnologija u potrazi za nečim drugačijim i novim. U današnje je vrijeme tehnologija uvelike nadmašila puko zadovoljenje svakodnevnih, jednostavnih potreba ljudi te postala način pronalaženja novoga svijeta u kojem ćemo živjeti (Kulzhanova i sur., 2020; Roztokci i sur. 2019).

Tehnike i tehnologije koje su se razvijale u skladu s potrebama dovele su do brzoga napretka u komunikacijskoj i informatičkoj tehnologiji. Štoviše, kroz razvoj računalne tehnologije pojavile su se i razne druge tehnologije koje možemo koristiti u svakodnevnom životu. Takva je situacija ubrzala zadovoljenje potreba i doprinijela razvoju same tehnologije. U današnje vrijeme 3D prikazi medija izrađenih pomoću računala i upotreba 3D tehnologija pomažu pojačati učinak vizualnih elemenata i ojačati vizualnu komponentu (Chibaca i Crespo, 2019). Te tehnologije obuhvaćaju proširenu stvarnost, virtualnu stvarnost, mješovitu stvarnost te hologramske tehnike i tehnologije, uz koje je lakše objasniti i razumjeti događaje i činjenice koje treba prezentirati.

Riječ hologram kombinacija je grčkih riječi *holos* (cijela slika) i *gram* (zapis). Hologram se zasniva na jednostavnim optičkim principima, a može se definirati kao tehnologija prikaza koja nam omogućava pogled na 3D sliku nekoga predmeta u prostoru s njegove donje, gornje i bočne strane (TRT, 2015). Ono što je bitno jest da se pri snimanju holograma koristi jedinstvena metoda za snimanje optičkih podataka prizora (Kasper i Feller, 1987). Hologram, koji možemo zamisliti kao sliku koja se sastoji od laserskoga svjetla, sadrži sve optičke informacije o bilo kojem predmetu koje je teško razaznati golim okom. U tom kontekstu, razlika između holograma i fotografije jest u tome što pločica holograma ne snima sliku predmeta nego informacije koje su potrebne da bi se ta slika dobila (Arıtan, 1990).

Hologram se temelji na teoriji miješanoga uzorka čiji je autor dobitnik Nobelove nagrade, Dennis Gabor. Godine 1947. Gabor je, tražeći način eliminacije magnetskih pogrešaka u elektronskim mikroskopima, želio zabilježiti oblik elektronskih valova i ispraviti ga optičkim valovima dobivenima pomoću posebnoga stakla, jer leće iskreću oblik sfernih elektronskih valova koji dolaze od zašiljenih predmeta (Ecevit, 2009). Godine 1962. sovjetski fizičar Yuri Nikolayevich Denisyuk kombinirao je Lippmanovu tehniku fotografije u boji s Gaborovom holografijom te tako otkrio „hologram s refleksijom bijeloga svjetla". Taj se hologram još naziva Lippmanovim hologramom, a snimljen je laserom i prvi je put bio vidljiv pri običnom bijelom svjetlu (Toal, 2012). Godine 1968. dr. Stephen Anthony Benton izumio je vrstu transparentnoga holograma koji se naziva „duginim hologramom" ili Bentonovim hologramom, a još uvijek se koristi u kreditnim karticama. Godine 1971. McDonnell Douglas izradio je Gaborov hologramski portret s crvenom pulsirajućom laserskom zrakom (<20 nanosekundi) (Hariharan, 2002). Nadalje, 1972. godine Lloydu Crossu pošlo je za rukom izraditi 3D pokretni holografski film kombinirajući „holografiju prijenosa bijeloga svjetla" s već poznatom tehnikom snimanja filmova (Ecevit, 2009).

Hologrami se izrađuju pomoću precizne optike i jedinstvenih fotoosjetljivih materijala koji se izlažu laserskom svjetlu (Chibaca i Crespo, 2019; Mawardani i sur., 2021; Ramlie i sur., 2020). Nakon što se u laboratoriju izradi prvi hologram, taj se original reproducira u mnogim formatima, ovisno o područjima primjene i potrebnim količinama. Predmet koji će biti fotografiran prvo se izrađuje u laserskoj zraci kako bi se izradio hologram. Nakon toga laserska zraka dijeli se na dva dijela – dok jedan dio osvjetljava predmet, a zatim se odbija i odlazi na film ili pločicu ispred predmeta, drugi dio, koji nazivamo referentnom zrakom, usmjeravaju ogledala i leće kako bi se osvijetlio film. Kada se hologram razvije, prvo izgleda kao nasumični vrtlog svijetlih i tamnih linija. Međutim, čim druga laserska zraka osvijetli razvijeni film, pojavljuje se 3D slika izvornoga predmeta. Nakon toga se izrađuje holografski film kao crno-bijela fotografija. Kada je proces završen, može se vidjeti hologram. Rezultat ovoga niza postupaka je glavni hologram izrađen pomoću lasera.

Hologramska tehnologija svakodnevno se koristi u raznim područjima, počevši od bankovnih kartica, sigurnosnih rješenja, putovnica, tekstilnih proizvoda, karata za koncerte i za predstave, osobnih iskaznica, slika, dokumenata o proizvodima i brandovima, CD-ova, kaseta pa sve do vizualnih prikaza (Hwang i sur., 2014). Preciznije rečeno, hologram je danas vrlo napredna tehnologija koja se koristi na upravljačkim pločama zrakoplova za holografsku pohranu podataka, prepoznavanje optičkih uzoraka te sustav fokusiranja digitalnih kamera (Donnelly, 2007). Hologram, koji je zbog suvremene napredne tehnologije teško kopirati, postao je najomiljenijom tehnikom upravo zbog sigurnosti.

Takva se tehnologija koristi i u obrazovnom procesu, koji se razlikuje od ostalih ranije spomenutih područja. Omogućava brz prijenos podataka, pomaže nam da učinkovito koristimo znanje i vještine te tako pozitivno utječe na proces učenja. Njezina je važnost neupitna, posebno u području obrazovanja za vizualnu komunikaciju, pri čemu je vizualna komponenta u prvom planu.

Hologrami kao obrazovna tehnologija

Çilenti (1994) u svojoj knjizi „Obrazovna tehnologija i nastavni proces" tvrdi da što je više osjetnih organa uključeno u proces učenja, to ćemo bolje učiti i duže zadržati naučeno znanje. Njegova se tvrdnja temelji na „stošcu iskustva" Edgara Dalea. S obzirom da 83 % onoga što naučimo primamo vidom, 10 % sluhom, 4 % mirisom, 2 % dodirom te 1 % okusom, važnost osjetila u obrazovanju od velike je važnosti i za nastavnike i za učenike (Birkeland Wilhelmsen i Felder, 2021; Shabiralyani i sur., 2015; Strazdina, 2021). U tom kontekstu, korištenje računalno izrađenih medija kao obrazovne tehnologije jača njegovu važnost.

Time se još jednom ističe važnost obrazovne tehnologije. Tas (2011) na sljedeći način objašnjava obrazovnu tehnologiju:

„Obrazovna tehnologija je dinamičan proces fokusiran na sustavni dizajn, provedbu, evaluaciju i razvoj procesa učenja i poučavanja, kako bi se obogatila svaka faza obrazovanja, potaknuli pojedinci na učenje i poučavanje, olakšalo učenje te motiviralo učenike na temelju rezultata obrazovne teorije i istraživanja, s ciljem osiguranja učinkovitijega okružja za poučavanje i učenje" (str. 10).

U današnje je vrijeme hologramska tehnologija uključena u obrazovnu tehnologiju. Smatra se da se 3D tehnike, koje vizualno osnažuju proces učenja, osim u nastavnom procesu također koriste u raznim predmetima i tečajevima u obrazovnom okružju.

Godine 2000. slika Catharine Darnton, nastavnice matematike, teleportirana je na manjoj udaljenosti. Teleportaciju je provela najveća internetska kompanija u Velikoj Britaniji, Edex, u dvorani jedne škole u južnome dijelu Londonu (BBC, 2000).

Sudeep Upadhye, s Instituta za tehnologiju Vidya Vikas u Indiji, u istraživanju provedenome s 200 sudionika 2012. godine naglašava važnost korištenja 3D hologramske tehnologije u obrazovnom okružju (Upadhye, 2018). U tom je istraživanju ispitao je li hologramska tehnologija učinkovit alat za nastavnike. Njegov je cilj bio utvrditi izazove koji otežavaju primjenu holograma u 3D okružju za učenje. U istraživanju je 68 % nastavnika izrazilo mišljenje da je 3D hologram učinkovit alat, dok ih je 32 % mišljenja da hologram neće promijeniti obrazovanje, ali može biti koristan u nastavnom procesu (Upadhye, 2018). S druge pak strane, Aslan i Erdoğan (2017) došli su do saznanja da hologramska tehnologija doprinosi bržem procesu učenja kod učenika, što pomaže trajnom učenju. U drugoj se studiji navodi da hologram omogućava idealno okružje za učenje u obrazovnom procesu koje se odvija uživo, licem u lice, te učinkovito ispravlja različite konceptualne pogreške (Chen i Wang, 2015).

Osim toga, hologram ima i nedostataka. Dok je Upadhye (2018) u svojem istraživanju spomenuo visoke troškove holograma i potrebu za brzim internetom, Lee (2013) je u svojem istraživanju utvrdio da hologram, iako ima odličan vizualni učinak, ima i nedostatke. Na primjer, teško je izraditi visokokvalitetne 3D slike, javlja se vizualni umor i teško je osmisliti aplikacije za njihovu uporabu.

Uz to što se može koristiti u raznim obrazovnim i edukativnim okružejima, hologramska tehnologija može se koristiti i kao nastavni materijal u umjetničkim obrazovnim institucijama. Za razliku od standardnih obrazovnih materijala, smatra se da hologramska tehnologija poboljšava spremnost učenika i njihovu motivaciju te im pomaže bolje razumjeti predavanje jer ima vizualni sadržaj (Shabiralyani i sur., 2015; Strazdina, 2021). Hologram, koji se može smatrati oblikom 3D tehnologije, omogućava detaljan pregled i analizu predmeta ili umjetničkoga djela. U tom smislu hologram je puno učinkovitija tehnika nego fotografija. Kod fotografije slika se dobiva u 2D obliku pomoću svjetla, dok se u hologramu dobiva u 3D obliku pomoću lasera.

Štoviše, hologram je tehnika koja je izuzetno pogodna za analizu umjetničkih djela, a osim toga, čini ih i lako dostupnima. Osoba koja želi vidjeti i analizirati kip Afrodite u Louvreu mora onamo i otići, što može biti problem zbog vremenskih i financijskih ograničenja. No, ako se kip Afrodite izradi pomoću hologramske tehnike, to može biti pogodno za različite svrhe. Na primjer, hologramska tehnologija može otkloniti sva ograničenja u smislu vremena i financija potrebnih za putovanje na lokaciju na kojoj se kip nalazi. Osim toga, kip izrađen pomoću hologramske tehnologije također može biti sačuvan za daljnju upotrebu u budućnosti.

Hologramska tehnologija, koja povećava dostupnost takvih umjetničkih djela, trebala bi se smatrati novom i pogodnom tehnikom koja će se koristiti u obrazovnom okružju jer pruža mnoge mogućnosti poput neograničene analize, promatranja i reprodukcije.

Metodologija

Rezultat je jedan od ključnih elemenata obrazovnoga sustava. Iako se očekuje da je rezultat u skladu s ciljevima obrazovnoga sustava, oni se povremeno mogu razlikovati. Stoga je potrebno odrediti je li rezultat u skladu s ciljevima, što se može učiniti pomoću mjerenja koja se primjenjuju u obrazovanju (Gelbal, 2013).

U ovome dijelu rada prikazat će se model istraživanja i postupci određivanja skupina koje će sudjelovati u istraživanju, priprema mjernih instrumenata te prikupljanje i obrada podataka. U ovome se istraživanju koristila kvantitativna metoda, u skladu s njegovim ciljevima. Kvantitativna metoda istraživanja korištena je kako bi se odredio utjecaj vizualnih materijala, izrađenih pomoću holografske tehnologije, na proces učenja kod učenika koji u sklopu grafičkoga obrazovanja proučavaju modul Perspektiva. Holografska vizualna pomagala korištena kao nastavni materijal sastojala su se od uzoraka fotografiranih pomoću lasera te su obuhvatila dubinu prostora i točku nedogleda, koje su ključne za objašnjavanje pojma perspektiva. Hipoteza ovoga istraživanja jest da bi učenici koji uče nastavne sadržaje pomoću hologramske tehnike trebali detaljnije razumjeti temu nego učenici koje se poučava primjenom tradicionalnih nastavnih metoda.

Postupak

U ovome se istraživanju koristio kvazieksperimentalni dizajn s predtestom i posttestom u kontrolnoj skupini, s ciljem prikupljanja podataka (Karasar, 1984). Cilj je bio odrediti utjecaj holografskih vizualnih materijala na proces učenja i zadržavanje znanja kod učenika koji uče o grafici. Prije eksperimenta, učenici u eksperimentalnoj i u kontrolnoj skupini tijekom prvoga tjedna nastave modula Perspektiva u sklopu predmeta Osnove umjetnosti riješili su predtest. Uzimajući u obzir mišljenja predmetnoga nastavnika, modul Perspektiva pripremljen je i izveden primjenom tradicionalnih nastavnih metoda u kontrolnoj skupini. Međutim, holografski vizualni materijali korišteni su kao nastavni materijali u predavanjima u modulu Perspektiva u eksperimentalnoj skupini. Obje skupine poučavao je isti nastavnik, upoznat s holografskim vizualnim materijalima, kako bi se svele na najmanju moguću mjeru razlike nastale zbog uključenosti više nastavnika. S učenicima je nakon eksperimenta proveden posttest.

Autor je svoju odluku o odabiru modula Perspektiva u sklopu nastavnoga predmeta Osnove umjetnosti donio na temelju činjenice da taj nastavni predmet ima za cilj učenike upoznati sa zajedničkim jezikom umjetnosti/dizajna, metodama/tehnikama, dati im znanje o materijalima te, što je najvažnije, razviti kod njih vještine „gledanja", „percepcije" i „rješavanja problema". S time se slaže i Yakar (2008). Osim toga, upravo taj predmet ima najveći fond nastavnih sati i donosi najviše bodova u obrazovnom programu za dizajn. Nadalje, autor je pregledao sve module i nastavni sadržaj Osnova umjetnosti u kurikulu te je našao modul u kojemu se holografski vizualni materijali mogu koristiti kao nastavni materijali. Nakon toga je ispitao mišljenja nastavnika koji poučavaju predmet Osnove umjetnosti u srednjim školama i profesora s Fakulteta za strukovno obrazovanje na Sveučilištu Gazi te je donesena odluka da se hologram može koristiti kao nastavni materijal u modulu Perspektiva. Tijekom nastave u tome modulu, učenicima u eksperimentalnoj skupini pomoću tiskanih holograma (Slika 1) pojašnjeni su tehnički koncepti povezani s temom. Tijekom nastavnoga procesa korišteno je ukupno 12 hologramskih vizualnih materijala u tiskanom obliku. Nakon toga je autor pripremio preliminarni test koji se sastojao od 52 pitanja, kako bi odredio pouzdanost pitanja iz predtesta u eksperimentu. Ovaj je preliminarni test pripremljen s ciljem utvrđivanja razine znanja učenika koji nisu prethodno učili o pojmu perspektiva. Preliminarni je test prije provedbe eksperimenta podijeljen učenicima (104 učenika) desetoga razreda Zübeyde Hanım djevojačke tehničke i strukovne srednje škole u Anatoliji i Etimesgut djevojačke tehničke i strukovne srednje škole u Anatoliji.

Bitno je napomenuti da iako ime ovih škola upućuje na to da škole pohađaju samo djevojke, takve škole u Turskoj pružaju obrazovanje i mladićima i djevojkama. Nakon provedbe testa uslijedila je analiza rezultata te je eliminirano 28 pitanja sa srednjom vrijednošću ispod 0,5. Izrađena je konačna verzija predtesta s 24 pitanja (primjeri pitanja prikazani su u Prilogu 1). Učenici su bili ocijenjeni s brojem bodova između 0 i 100.

Slika 1

Kako su ove slike prikazane pomoću lasera, ne mogu se jasno vidjeti kada su fotografirane. Međutim, kada se u tiskanom obliku gledaju golim okom, mogu se jasno vidjeti dubina prostora i predmeti.

Kontrolnu i eksperimentalnu skupinu sačinjavali su učenici desetoga razreda iz Odjela za grafiku i fotografiju u Gaziosmanpaşa anatolskoj djevojačkoj tehničkoj i strukovnoj srednjoj školi u Ankari, u Turskoj. Kako je već ranije napomenuto, skupina koja je sudjelovala u istraživanju sastojala se i od mladića i od djevojaka, unatoč imenu škole, a prosječna dob učenika kretala se između 15 i 16 godina. Odabrani su učenici iz ovoga odjela upravo zato što su po prvi put slušali modul Perspektiva u sklopu nastavnoga predmeta Osnove umjetnosti. S obzirom na veličinu skupine, 20 učenika iz 10-AG razreda svrstano je u eksperimentalnu skupinu, dok ih je 19 iz 10-MG razreda svrstano u kontrolnu skupinu.

Instrumenti

Nakon podjele učenika u skupine, predtest je podijeljen učenicima iz 10-AG i 10-MG razreda iz Gaziosmanpaşa anatolske djevojačke tehničke i strukovne srednje škole. Pri analizi rezultata korišten je t-test, statistički test kojim se uspoređuju srednje vrijednosti dviju skupina u istraživanju (Kim, 2015). Nakon predtesta proveden je t-test za nezavisnu skupinu kako bi se utvrdilo postoji li razlika u rezultatima predtesta između dviju skupina. Nakon završetka modula, obje su skupine riješile posttest kako bi se izmjerili rezultati. Proveden je t-test za utvrđivanje razlike između srednjih vrijednosti zavisnih skupina, kako bi se ispitalo postoje li razlike u postignućima na predtestu i posttestu između eksperimentalne i kontrolne skupine. Također je proveden i t-test uzorka kako bi se ispitalo postoji li značajna razlika između rezultata obiju skupina na predtestu i posttestu.

Rezultati i rasprava

U ovome dijelu prezentirat će se rezultati dobiveni analizom podataka. Podatci su prikazani u tablicama i popraćeni interpretacijom. Međutim, potrebno je napomenuti da zbog toga što su eksperimentalna i kontrolna skupina, koje su po prvi put slušale modul Perspektiva, nasumično odabrane za sudjelovanje u istraživanju, postoji razlika u broju učenika u skupinama, što bi moglo predstavljati ograničenje ovoga istraživanja. Nadalje, trebala bi se razmotriti i činjenica da je višestruki t-test imao marginu pogreške Tipa I od 5b %.

U Tablici 1 prikazan je rezultat usporedbe t-testa za analizu rezultata predtesta kod nezavisne skupine. Na predtestu su i kontrolna i eksperimentalna skupina odgovorile na 24 pitanja sa srednjom vrijednostima od 14,18 i 18,09, za svaku skupinu pojedinačno.

Tablica 1

Iz Tablice 1 može se zaključiti da postoji značajna razlika u rezultatima predtesta u objema skupinama, i to na razini od 0,05. Činjenica da je ta razlika značajna upućuje na to da su eksperimentalna i kontrolna skupina različite u smislu izmjerenih svojstava. Osim toga, proveden je i Cohenov D test na rezultatima predtesta obiju skupina te je dobivena vrijednost od 1,54.

Rezultati t-testa za zavisne uzorke pokazuju razliku između rezultata na predtestu i posttestu u eksperimentalnoj skupini, što je prikazano u Tablici 2.

Tablica 2

Može se vidjeti da su rezultati postignuća na posttestu kod učenika u eksperimentalnoj skupini (M = 20,68) bolji od njihovih postignuća na predtestu (M = 18,79). Također, statistički značajna razlika uočena je između rezultata na njihovom predtestu i posttestu ($p < 0,05$). Ova razlika ide u prilog rezultatima posttesta kod učenika u eksperimentalnoj skupini. Drugim riječima, može se zaključiti da se uspjeh učenika poboljšao nakon predavanja u kojima su se koristili vizualni holografski materijali.

U Tablici 3 prikazani su rezultati t-testa za zavisne uzorke koji su se koristili kako bi se ispitalo postoji li značajna razlika između rezultata na predtestu i posttestu kod učenika u kontrolnoj skupini.

Tablica 3

Može se vidjeti da su rezultati postignuća na posttestu kod učenika u kontrolnoj skupini (M = 19,53) bili bolji od njihovih rezultata na predtestu (M = 14,18). K tomu, utvrđena je statistički značajna razlika između njihovih rezultata na predtestu i posttestu ($p < 0,05$). Ta razlika ide u prilog rezultatima postignuća na posttestu kod učenika u kontrolnoj skupini. Drugim riječima, može se zaključiti da je primjena tradicionalnih nastavnih metoda u predavanjima kod učenika u ovoj skupini također imala pozitivan utjecaj na njihov uspjeh.

Kako se može vidjeti u Tablici 1, postoji značajna razlika u korist kontrolne skupine između rezultata postignuća na predtestu kod učenika iz eksperimentalne skupine, u kojoj su se predavanja održavala uz primjenu 3D i hologramske tehnologije i učenika iz kontrolne skupine, u kojoj su se predavanja održavala uz primjenu tradicionalnih nastavnih metoda.

Uočeno je i da su rezultati predtesta kod učenika iz eksperimentalne skupine ($M = 18,79$), u kojoj su se predavanja odvijala primjenom 3D i hologramske tehnologije, bili bolji od rezultata učenika iz kontrolne skupine ($M = 14,18$), u kojoj su se predavanja odvijala primjenom tradicionalnih metoda. Utvrđena je statistički značajna razlika između srednjih vrijednosti rezultata predtesta kod učenika iz eksperimentalne i kontrolne skupine ($p < 0,05$).

Je li eksperiment koji je kasnije primijenjen u eksperimentalnoj skupini eliminirao ovu razliku utvrđeno je usporedbom rezultata posttesta. Rezultati posttesta i testa zadržanoga znanja u obje skupine također su analizirani t-testom za nezavisne uzorke. Nakon što je test proveden s učenicima iz eksperimentalne skupine, modul Perspektiva po prvi put je poučavan pomoću nastavnih materijala, uključujući hologram i hologramsku tehnologiju, a posttest je proveden nakon što su predavanja završila.

T-testom za nezavisne uzorke ispitano je postoji li značajna razlika između rezultata na posttestu kod učenika iz eksperimentalne i kontrolne skupine, a rezultati su prikazani u Tablici 4.

Tablica 4

Uočeno je da su rezultati posttesta kod učenika u kontrolnoj skupini ($M = 19,53$) slabiji od rezultata učenika u eksperimentalnoj skupini ($M = 20,68$). Međutim, nije uočena statistički značajna razlika između srednjih vrijednost rezultata postignuća na posttestu u eksperimentalnoj i u kontrolnoj skupini ($p > 0,05$). K tomu, proveden je Cohenov D test na rezultatima posttesta obiju skupina te je dobivena vrijednost od 0,56. Iako su učenici u eksperimentalnoj skupini imali bolje rezultate na predtestu nego učenici iz kontrolne skupine, činjenica je da ne postoji statistički značajna razlika između rezultata na posttestu obiju skupina nakon provedbe obrazovnoga programa, što upućuje na to da je on unaprijedio znanje učenika. Stoga se može reći da je korištenje 3D i hologramske tehnike u predavanjima važan faktor za postizanje boljega uspjeha učenika.

Nadalje, učenici i nastavnici koji su sudjelovali u istraživanju izrazili su pozitivna mišljenja o upotrebi hologramske tehnologije kao nastavnoga materijala. Uočeno je da upotreba tehnologije kao nastavnoga materijala, uz tradicionalne nastavne materijale, doprinosi dodatnoj motivaciji učenika.

Zaključak

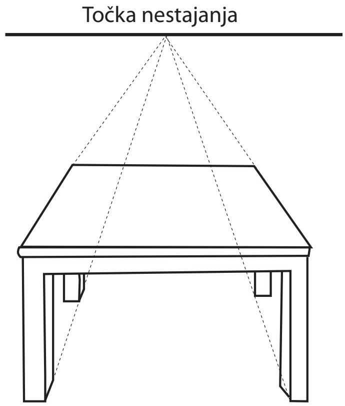
U ovome su istraživanju obje skupine učenika pratile modul Perspektiva u sklopu nastavnoga predmeta Osnove umjetnosti. Dok su se u eksperimentalnoj skupini koristili hologrami i hologramska tehnologija, u kontrolnoj su se skupini koristile tradicionalne nastavne metode (npr. grafoskop, ravnalo, kaliper i kutnik).

Prije provedbe samoga eksperimenta u obje je skupine proveden predtest. Nakon provedbe modula, u objema je skupinama proveden posttest kako bi se procijenilo njihovo znanje o modulu. Rezultati posttesta nisu pokazali statistički značajnu razliku između skupina. Kontrolna je skupina odgovorila na pitanja i ostvarila srednji rezultat od 19,53, dok je srednji rezultat eksperimentalne skupine bio 20,68. Rezultati postignuća na predtestu i posttestu u eksperimentalnoj skupini iznosili su 18,79 i 20,68, za svaki test pojedinačno, što upućuje na blagi porast. S druge strane, rezultati kontrolne skupine bili su 14,18 i 19,53, za svaki test posebno, što pokazuje veći porast.

Prosječni uspjeh na posttestu u objema skupinama bio je izvanredan. Takva situacija pokazuje da su učenici u objema skupinama ovladali temom na visokoj razini te se može uočiti da je hologramska tehnologija korištena kao nastavni materijal povećala stopu uspješnosti.

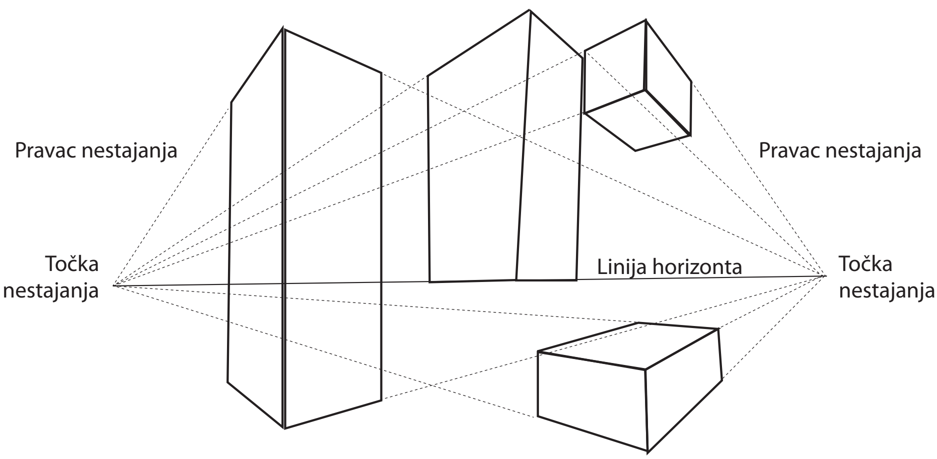
Na temelju rezultata ovoga istraživanja može se zaključiti da se 3D i hologramska tehnologija mogu koristiti kao dodatne nastavne metode koje pomažu učenicima bolje razumjeti teoriju i praksu u nastavi umjetnosti. 3D i hologramska tehnologija mogu se koristiti kao nastavni materijali i mogu se uvrstiti u udžbenike i kurikule jer je uočeno da ona pomaže učenicima bolje razumjeti temu na vizualni način. Osim toga, u module i nastavne predmete moglo bi se uključiti više vizualnih materijala popraćenih 3D vizualnim elementima i hologramima kako bi se obogatili teorijski sadržaji. Međutim, hologram je tehnološka aplikacija koja se izrađuje pomoću različitih znanstvenih metoda pa je stoga neophodno u predavanja uključiti i tehničke informacije o toj tehnologiji. 3D i hologramske tehnologije mogu se koristiti i u drugim granama u nastavi umjetnosti kao nastavni materijal i kao potpora vizualnim elementima. No, potrebno je uzeti u obzir da izrada i upotreba holografskoga materijala zahtijeva tehničku podršku, što može biti skupo. Uz to, holografski materijal ne može proizvesti bilo tko, bilo gdje. Taj proces zahtijeva angažman kvalificiranih osoba s odgovarajućim sredstvima kako bi se izradio i prezentirao holografski materijal.

Prilog



1. Pitanje: Slika stola prikazana iznad je primjer koje vrste perspektive?

a) perspektive s jednim nedogledom
b) perspektive s četiri nedogleda
c) kružne perspektive
d) zračne perspektive
e) perspektive s dva nedogleda



2. Pitanje: Slika iznad je primjer koje vrste perspektive?

a) zračne perspektive
b) perspektive s jednim nedogledom
c) kružne perspektive
d) perspektive bez točke nedogleda
e) perspektive s dva nedogleda