European Journal of Sustainable Development (2024), **13**, 1, 278-290 ISSN: 2239-5938
Doi: 10.14207/ejsd.2024.v13n1p278

Interaction of Digital Trends and Sustainable Development: The role of Contemporary Art

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ABSTRACT:
The purpose of the work is to analyze the impact of digital technologies on the sustainable development of contemporary art - an overview of the main trends that have emerged as a result of the integration of new media into artistic practices. The article methodologically classifies various genres of digital art by means of a critical qualitative analysis of practices, artworks, installations, exhibitions, collectives and events at the forefront of artistic innovation with new technologies. The scientific novelty lies in a comprehensive analysis of digital art through the prism of the concept of sustainable development. The work considers digital art not just as another technological innovation, but as a full-fledged artistic phenomenon of our time. The systematization of artistic practices associated with the use of the latest technologies is carried out, their common conceptual foundations are revealed. In addition, the article deals with issues of environmental sustainability, social responsibility, inclusiveness of digital practices. The dilemmas around the balance of technological innovation and artistic freedom from the perspective of sustainability ethics are outlined. The conclusions provide a conceptual understanding of optimal pathways for developing digital art in relation to societal sustainability.

Keywords: digital art, sustainable development, new media art, network art, generative art, interactive art, AI, VR, AR, digital culture

1. Introduction

The idea of sustainable development runs like a red thread through the paradigm of existence of modern generations. Digital culture in all its manifestations has become

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the core, the heart, the innovative content of the very factual dimensions and meanings of representing the concept of sustainable development as such. Digital trends have affected, without exception, all spheres of human existence.

Art is eternal. Signs, symbols, images, works of art run through the mental memory of mankind. It is art that connects the past with the present and, addressing future generations in the language of semantics, emphasizes the priorities of the future. Art is a "symbolic text" through the content of which the present speaks to the future, it is the genetic memory of the past...

It was this that determined both the author's interest in the chosen topic and the elements of novelty in the process of philosophizing and representing the problem of the presence of digital innovations in the artistic dimension of human existence in order to effectively implement the sustainable development of human civilization a priori.

Summarizing all of the above, we can state the practical task of the research objectives:

- To analyze the attitude of student youth towards the phenomenon of digital art, to identify possible differences in perception depending on specialty.
- To establish the level of awareness of modern youth regarding the features and capabilities of digital art compared to traditional forms.
- To find out how informed Ukrainian students are about the concept of sustainable development and its connection with the latest technologies.
- Identify which environmental solutions for the field of digital art students consider the most promising.

2. Discussion in scientific literature

Art can bridge the gap between theory and practice of sustainable development. To bridge this gap, it is proposed to harness the potential of art, art-based methods, and aesthetics to develop passion and emotional connection for sustainable organization and living (Shrivastava, P., Ivanaj, V. & Ivanaj, S., 2012).

Analysis of the "green" practices of art organizations allows identifying key competencies for the successful implementation of sustainability principles (Pulido, C., Ravanas, P. & Courchesne, A., 2022).

Art programs provide meaningful and effective ways to awaken cultural values, enhance the sense of being and place, and provide social services that open doors for building resilient communities (Joubert, L., 2004).

Art contributes to the UN Agenda about the SustainabLe Development of the world. In particular, art promotes the strengthening of democracies and the resolution of a number of social problems (Utrera, 2021).

Art transforms education towards sustainable development. Thanks to the unique languages of art, children can better understand the issues of sustainable development, express their own experiences, and form an active civic stance on building a more just world (Chapman S. & O`Gorman L., 2022).

Analysis of works of art allows developing skills in systems thinking and critical reflection on the concept of sustainable development from different perspectives (Molderez I. & Ceulemans K., 2018).

Contemporary digital art, created using the latest technologies, can stimulate critical reflection. Analyzing works of art, viewers reflect on the desired future, the balance between scientific and technological innovations, the needs of society, and environmental conservation (Wang, 2018).

Digital art games can promote the popularization of contemporary art and introduce a wide audience to current trends in this area. The development of interactive games based on areas of digital art can attract new audiences and overcome established cultural barriers (Gintere, 2019).

Digital primitivism in art reflects nostalgia for past technological eras, as well as anxiety about artificial intelligence and digitalization. Analysis of artistic practices can contribute to a better understanding of the challenges of the digital age (Venkova, 2020).

Modern interactive art projects promote active communication between authors and viewers. This creates a new environment for artistic dialogue, and technology acts as a catalyst for the further development of art and the emergence of new directions (Kharchenko, 2023).

The growing interest in ethnographic approaches is a response to current trends in society. This indicates the desire of art to focus on real challenges of the time and contribute to harmonious interaction between the technosphere and sociocultural sphere (Hjorth, 2014).

Thus, despite some variability of approaches, scientists mostly positively assess the transformative role of contemporary art on the way to a sustainable future.

3. Methodology

An important aspect of the analysis of the interaction between digital trends and sustainable development was a survey among students of leading Kyiv universities aged 18-24 years. 62 philosophy students from KUBG and 48 psychology students from NAVS were interviewed. The analysis of the results made it possible to identify differences in the attitude of representatives of the humanities and exact sciences to digital art. Thus, the study will allow us to better understand the perception of modern student youth regarding current processes in the world of art under the influence of the latest technologies.

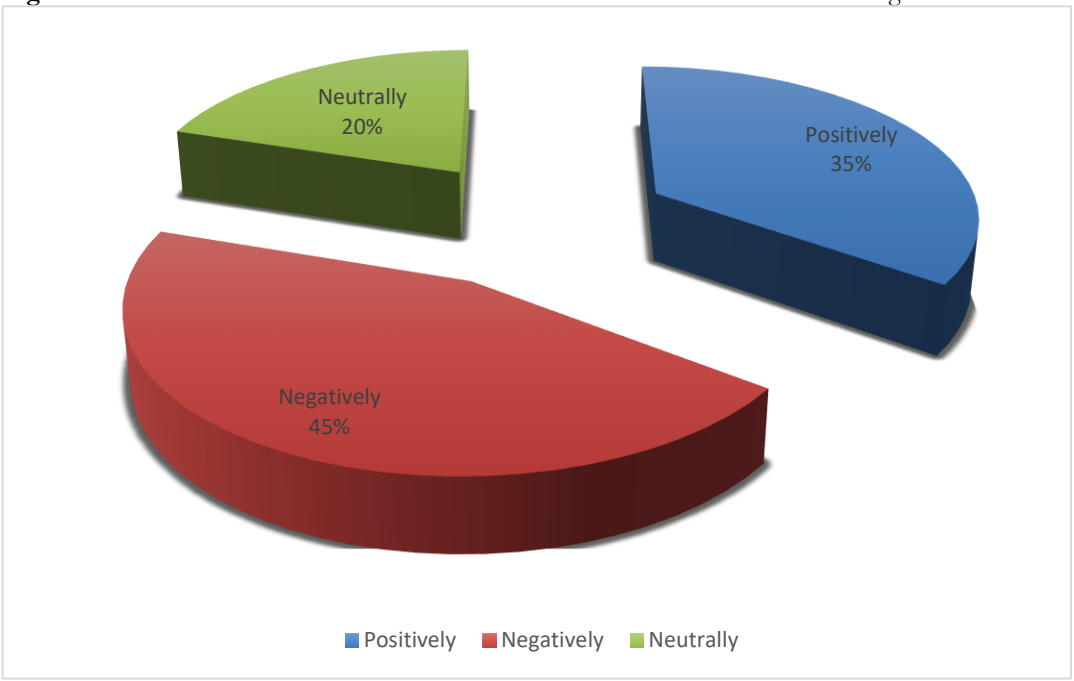
Within the framework of our research, we found out the attitude of students of various specialties regarding the phenomenon of "digital art". From this survey, it can be concluded that philosophy students generally demonstrate a more positive attitude towards digital art compared to psychology students. The vast majority of philosophers consider it to be real art, feel an emotional connection with digital art objects and are convinced that such art can affect the viewer no less strongly than traditional forms. Instead, among psychology students there are significantly more skeptics who do not recognize digital art as full-fledged art or do not have a clear position on this issue. Such differences in attitude can be explained by the greater flexibility of thinking of students of humanities compared to exact sciences.

Table 1. Attitudes of students of different specialties towards digital art.

Question	Responses	Students-philosophers of KUBG	Students-psychologists of NAVS
1. Do you consider digital art to be real art?	Yes	72%	27%
	No	18%	31%
	Difficult to say	10%	42%
2. Do you feel an emotional connection with digital art objects?	Yes	54%	19%
	No	31%	69%
	Occasionally	15%	12%
3. Do you think digital art can influence the viewer as much as traditional art forms?	Yes	81%	23%
	No	8%	56%
	Not sure	11%	21%

The commercialisation of contemporary art is a hot topic in today's society. To better understand the different views on this issue, we thought it would be useful to ask students' opinions. We asked respondents whether they view positively or negatively the fact that digital art objects are increasingly being sold at auctions, exhibited in commercial galleries, etc. Analysis of the answers showed students divided in their perspectives. A significant portion demonstrate negative attitudes towards the commercialization of digital art, believing it contradicts the spirit of art itself, turning creativity into an industry. Some, on the contrary, welcome the fact that digital artists are finally getting recognition and the ability to earn from their creativity. Still others remain relatively neutral on this topic. Such differences in attitudes likely reflect divergent views on the nature and social role of art. So this issue remains a subject of heated discussion within both professional artist circles and the general public.

Figure 1. Attitudes towards the commercialization of digital art.



Since the issue of emerging technologies' environmental impact is quite topical in the context of sustainable development, we also asked Ukrainian students which "green" solutions they consider most promising specifically for the digital art sphere. Analysis of the results showed the vast majority of respondents prefer renewable energy sources – solar panels, as digital content production requires considerable computing power and accordingly – electricity. Biodegradable materials and energy consumption optimization are also popular. Such findings indicate Ukrainian students are rather well informed and consciously concerned about environmental issues. They understand eco-friendly technologies are the key to sustainable development of digital art as an industry of the future. And this gives hope that the next generation of specialists will approach these challenges responsibly.

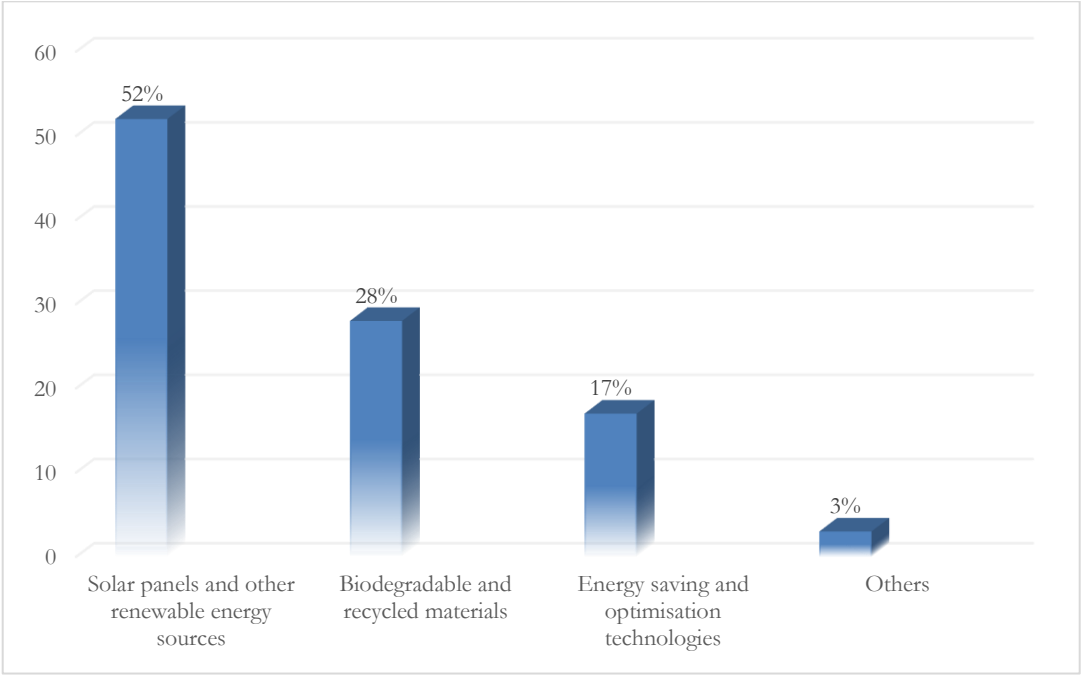


Figure 2. Which green technologies do you think are the most promising for digital art?

4. Results and Discussion

As a result of the technological revolution, cardinal changes took place in all spheres of human activity. The powerful leap in the development of computer technology and digital technologies had an unprecedented impact on artistic culture as a whole, on all types of classical, traditional art, and stimulated the emergence of the newest hybrid varieties of art (Aliyev E., 2021). The new exciting media radically expand artistic capabilities and transform the contemporary art scene. Thus, under the influence of new technologies, a phenomenon called "digital art" appeared in the artistic environment. As part of our research, we found out students' attitudes towards the phenomenon of "digital art" (Tab.1).

The genre of "computer art" began in the 1950s, when long exposure photography was used to capture images created by an oscilloscope manipulating electronic waves on a small fluorescent screen. Through the 1960s, most works of computer art were created using plotters and impact printers by the scientists and engineers who had access to emerging computing technology. By the 1970s, artists were learning to program, and some universities began to integrate computers into the fine arts curriculum (Avila L. & Bailey M., 2016).

The term "digital art" was first used in the 1980s when programmers began working in the AARON graphics editor developed by one of the founders of digital art, Harold Cohen. He laid a large canvas on the floor and with the help of a robot painted an image on it that can now be seen in the Tate *Modern* Gallery in London.

The internet became more widespread during the 1990's which made digital art become more accessible to artists and viewers. Artists began to explore how they could use the internet's interactive nature to create their works of art. Also the improvement of digital technology made it possible to download video onto computers, allowing artists to manipulate the images they had filmed with a video camera for the first time (Rosanio, 2020). The spread of affordable multimedia programs caused a real boom in digital creativity.

The pioneers of digital art integrated the latest technologies into their work in different ways. Some, like Richard Hamilton or Jeff Wall, used them to transform and collage traditional images. Others, like Mark Wilson, worked exclusively with digital tools.

With the advent of the Internet, pioneers of network art like Joan Heemskerk and Dirk Paesmans also appeared. Their experimental installation sites and hacker happenings brought digital creativity to a conceptually new level. These are witty links and funny pictures that are constantly changing and "criticizing" virtually everything - from software to capitalism.

So in a few decades, digital art has gone from primitive computer drawings to high-tech interactive works of the network era. This has radically expanded the notion of what is possible in contemporary visual art.

Today, digital art includes multimedia installations, processed digital videos and computer animations, but this term mostly denotes artworks created on a computer, digitally edited photographs, and artworks for online publication.

As our daily lives have become saturated with digital means through smart devices and online platforms, contemporary artists have insightfully directed this cultural shift into their practice, experimenting with new technologies. Today, artists use everything from data visualizations of big data collected through web scraping to sculptures created with bioengineering from modified living tissues.

Major art institutions have also begun showcasing innovative digital works through specialized departments for new media arts, acquiring net art into museum collections, and prestigious awards recognizing integrated technologies. So genres once considered marginal, such as code-based generative art, information visualization, and video distributed on the Internet, have entered the cultural mainstream in circles of contemporary art.

There are different views on digital trends in contemporary art. For example, American film critic Ed Halter looks at the digital revolution with trepidation. He believes that our time is a time of star authorities, video memories, individual technologies, electronic terrorism and an excess of information pouring from countless screens. In his opinion, for modern youth social assistance and military conflicts have become a game that can be downloaded. On the other hand, American writer George Fifield sees endless possibilities in digital art. He believes that in virtual space the artist can combine images and colors in a new way, opening up an unthinkable freedom of creativity before.

As new technologies have emerged over the past few decades, artists have applied them in innovative ways, using everything from multimedia software to artificial intelligence algorithms. Digital art encompasses a wide spectrum of genres and practices. Key types of digital art have been identified:

- Net Art. Early 90s internet artists like Vuk Cosic sought to reflect the pleasures, politics and anxieties of the new internet culture. Today net artists experiment with web platforms, data surveillance and interconnectivity.
- Glitch art. Manipulating digital errors and compression artifacts for aesthetic effect, exploring "glitches" as a medium. Pioneers included artists like Jamie Fenton and Rosa Menkman.
- Generative art. Algorithmically generated art created using systems of computer programs. Artists like Refik Anadol today use machine learning algorithms to create artworks with a certain autonomy.
- Bio Art. Artworks dealing with biotechnology and artificial life, such as experiments blending organic tissue with computer modeling to model complex systems. Orlan's performances of plastic surgery also engage with biological and technological shifts in identity.
- Computer animation. As opposed to CGI in film, artists have used computer software and 3D animation software specifically to create avant-garde films and video game art installations. Feng Mengbo created new visual languages.

Digital trends in contemporary art build on a history of experiments with technology in the art world. "All art is experimental, otherwise it's not art", - wrote American critic Gene Youngblood.

A true explosion occurred in the 21st century as artists hacked, glitched, hybridized and implemented exciting new forms of digital expression, commentary and cultural critique unique to our technology-saturated world today, using these innovative genres and platforms. Digital art transforms along with the development of new technologies. With each day contemporary artists have more and more tools to create works and platforms to post them. The Internet and social media give complete freedom to various artists – this is a real revolution in the art space. Back in 1926 the French philosopher Paul Valery wrote about how the development of technology, its universality and precision give confidence in profound changes in the "ancient craft of the Beautiful" (Benjamin. W., 1936). Today we see how prophetic these words turned out to be. Digitization, computer and multimedia technologies are radically transforming the nature of art.

In general, digital art tends to share some attributes that art critic Ed Halter described as "manic visual turbulence" and "aesthetics of Gb/sec," directing a tremendous flow of data online. Although diverse visually, conceptually digital art encompasses flux, nonlinearity, interconnectedness, immediacy and disembodied experience in a way uniquely suited to the electronic medium and digital technology era. Yet balancing this intensity is also a bias toward order, precision and calculated systems drawn from the computational sphere.

Digital interactivity transforms passive viewers into active participants immersed in artworks that uniquely respond to each audience member's behavior. Key forms include:

- Installations. Custom-built enclosed spaces staging interactive digital art encounters through sensors and responsive projection mapping that react in real-time to a viewer's body movements and gestures as inputs. Artists like Gabriel Dawe create beautiful reactive water-light installations.

- Augmented reality (AR). Overlaying virtual art elements tethered to mobile devices onto a real environment that users directly interact with, such as at the Riga Motor Museum. There AR was used to demonstrate the operating principles of vintage automobiles. Using smartphones or tablets, visitors were able to "look inside" the exhibited vehicles to see 3D animation of component movements and mechanics, engine operation, etc. Such projects showcase the fantastic potential of AR technologies in art.
- Virtual reality (VR). Fully artificial worlds created through virtual reality goggles that allow one to traverse and manipulate dreamlike imagined landscapes introduced by the computer art collective Marpi. VR provides radical freedom to construct unreal interactive situations.

The integration of VR and AR into the art world is changing not only the way art is experienced, but also the way it is created. Artists leverage these technologies to immerse viewers in their work, offering a multidimensional experience that goes beyond traditional mediums. Some art critics posit augmented reality and virtual reality as the next natural progression of creative expression, even an evolution of art itself.

Some exciting digital installations employ emerging technologies to shed light on issues of sustainable urban development and ecology. For example, George Legrady's "Making Visible the Invisible" project visualizes dynamics through data, provides a real-time living picture of what the community is thinking. Interactive works by Rafael Lozano-Hemmer allow people to control visual effects with their biometric data, underscoring the harmony of humankind and the environment.

Projection mapping enables creating large-scale eco-oriented artworks in public spaces. For instance, teamLab transforms buildings into fantastic landscapes, organizes art exhibitions, drawing the attention of viewers to the beauty of nature and the need to live in harmony with it. Other artist collectives like Moment Factory in Montreal stage impressive city-wide events combining light art, interactive triggers and augmented overlays that dissolve the external urban reality into transportive temporary digital spaces reimagining locales through technology.

Some artists like Ned Kahn create interactive sculptures and facades that respond to the environment – wind, rain, etc. And in Tatiana Bilbao's botanical pavilion robotic flowers bloom and close according to real-time local precipitation, reminding of the fragility of ecosystems.

Thus these innovators unite digital media tools with emerging biosciences through cutting-edge installations materializing tomorrow's technologies in today's cultural context. Functioning as laboratories demonstrating theoretical ideas around digital societies, this work collapses traditional institutional divides between art, science, and technology.

Although once considered peripheral to the contemporary art world, over the past decade digital art has gained increasing recognition and validation by prestigious institutions. Museums have become active in collecting seminal new media artworks, for instance New York's Museum of Modern Art acquired video games including Pac-Man and Tetris into its permanent collection in 2012. The Whitney Museum created its Artport online portal for internet art back in 2001. Museum curators stated that by collecting

artworks based on code for their collections, they acknowledge programming as an artistic practice defining our time.

An even bigger indicator of recognition is digital art's inclusion within traditional institutional spaces alongside more conventional works. Recently at the Uffizi Gallery in Florence situated a digital reproduction of Michelangelo's David next to actual ancient Greek and Roman sculptures, provocatively questioning notions of reproduction and authenticity with this juxtaposition of the physical and virtual.

Through collecting, patronage, and exhibitions, art institutions confer legitimacy onto digital art. In showcasing it, they dispel past perceptions of it being a novelty for tech geeks, cementing its cultural significance. However some contemporary thinkers, notably philosopher Boris Groys, believe certain strands of contemporary art do not require institutionalization. In his view, to "museumify" such art is to strip it of public impact and deliver it over to the art industry sphere, which can undermine its very essence. To explore the attitudes of Ukrainian students towards the commercialisation of digital art, we conducted a survey (Fig.1).

Another important role in digital art is played by artificial intelligence, offering artists radically new creative tools by automating the generation of ideas and imagery. Computer algorithms can analyze input samples like artworks, texts or datasets before leveraging identified patterns to output new unexpected results with a degree of autonomous creativity. For example, there are thousands of photos of the Statue of Liberty taken from various different angles, by AI these images become moving visuals and create a video cycle that produces images of melting, melting statues (Sungkar A., 2023).

Philosophical debate rages around AI art as to whether machines can be considered truly creative, or whether their output simply reflects the programmer's choices and data bias. Critics view the randomly generated images as a rather sterile gimmick devoid of intentionality behind their fabrication, with all decisions based on artist-selected data sources and algorithms. Yet advocates argue the code itself utilizes procedural systems comparable to artistic thinking. Programming the idea rather than technical mastery guides the generative process, requiring artists to conceptually creative-direct what they want the AI to produce. "My machine is way more talented at art than I am – not as creative but talented," stated Pindar Van Arman. "The question is whether it will become more creative".

Recently the art market for AI-created works has thrived, with major auction houses initiating specialized sales of digital art. In 2018 a portrait created by the AI Obvious sold at Christie's for over $400,000. Since 2020 prices at AI art auctions have skyrocketed into the millions, outpacing real artworks. Time will tell whether artificial intelligence sees a bubble similar to NFTs or truly has staying power as machine creativity systems continue advancing.

As digital art utilizing emerging technologies becomes more widespread, debates sharpen around the ethical ramifications of these new mediums, particularly regarding sustainable societal development. Some key issues include

- Environmental friendliness. What is the impact of manufacturing technologies for digital art on the environment? How to make it more sustainable?
- Accessibility. How to provide access to digital art and educational resources for artists around the globe? How to overcome the digital divide?

- Diversity. How can digital technologies facilitate preserving and popularizing art from diverse cultures and countries?
- Accountability. How to develop digital art responsibly and ethically towards society and humans? How to ascertain true provenance and ownership of digital art easily copyable and modifiable online?

These are but some of the questions raised by digital art, prompting profound ethical discussions. It's not just about appearances but values. It's not only about creativity but critical thinking. It's not simply fun but thought-provoking.

Digital art undoubtedly opens fantastic opportunities for artists to create vivid, dynamic artworks with the help of computers and other digital devices. However, alongside advantages, digital technologies also pose some threats to the sustainable development of society.

Firstly, the very process of creating digital art demands considerable expenditures of resources and energy. After all, the operation of computers, software, servers requires electrical power. Large data centers storing information for digital platforms are veritable "energy vampires". By some estimates, the entire IT industry consumes about 7% of global electricity and this share is rapidly rising, leading to immense carbon emissions. Thus the issue of energy efficiency becomes paramount.

Secondly, manufacturing digital equipment (computers, gadgets, sensors, etc) necessitates mining significant amounts of various metals and minerals. Their extraction often harms the environment, while waste recycling or disposal is a complex process also demanding resources.

Therefore, the exponential growth of digital art can have inadvertent ecological side effects. Hence artists and IT companies must take responsibility for sustainable development of this sphere – from utilizing "green" energy to e-waste recycling. Only then will the positive potential of new technologies be fully realized. Given sustainable development concerns, we asked students which environmental solutions they view as most promising for mitigating the ecological impact of digital art (Fig.2).

On the other hand, it is digital technologies that provide artists with unique opportunities to draw attention to environmental issues and spread ideas of sustainable development. Interactive installations, 3D mapping, augmented and virtual reality - all these are new art forms that can be used as a tool to promote "green" thinking and lifestyle. For example, with the help of projection mapping on buildings, various eco-statistics can be visualized - CO2 emissions, air pollution levels, melting glaciers, etc. AR helps "animate" images of environmental threats, making them more visual and convincing. VR creates an effect of complete immersion in alternative worlds where environmental disasters can be shown. So the potential of digital media for eco-education is significant.

However, artists must approach the use of advanced technologies thoughtfully and responsibly. It is necessary to choose more environmentally friendly solutions when creating digital installations and media shows - from low-voltage power sources to recycled equipment. It is important to optimize electricity consumption, minimize waste. It is also worthwhile to more actively engage the audience, encourage people themselves to get involved in solving environmental problems.

5. Conclusions

To sum up, the growth of digital art represents a seismic shift transforming cultural landscapes. Rapid technological advances open up ever new horizons for artistic exploration, radically expanding aesthetics, concepts, materials and methods of creation. Along with this comes the question: how appropriate is it to integrate new technologies into artistic practices?

Optimists welcome digitization as emancipation while pessimists warn against dehumanizing art due to excessive technical simplification of complex creative processes. However most maintain a balanced position, perceiving both risks and opportunities of digital art for sustainable development.

On the one hand, integrating technologies and art can help popularize ideas of environmental sustainability. On the other - uncontrolled growth in demands for energy, electronics and other resources will have a detrimental eco-impact.

A balanced approach involves the conscious use of digital technologies in art – to amplify its positive social influence rather than purely commercial ends. Digital art should promote the development of empathy, sustainability and social awareness. Under these conditions digitization has a chance of passing the test of time and becoming human progress balancing between technological leaps and the ethical responsibility of artists.

In studying the problematic discourse regarding the interconnection of digitalization, contemporary art and the concept of sustainable development, attention is paid to both theoretical aspects and practical application.

From a theoretical point of view, a multidimensional conceptual understanding of digitalization processes and their impact on art and society is necessary. This requires regional, institutional and interdisciplinary studies.

In this article, we have attempted to summarize the available theoretical and journalistic materials on the research issues. We also present the results of our own micro-research within a certain time frame, certain universities, certain specialties and a certain generation.

One of the key practical areas is the digital archiving and preservation of artistic heritage. Augmented and virtual reality technologies will create immersive interactive museums and galleries. The use of blockchain will facilitate the authentication and protection of property rights to art objects. The Internet and social networks provide unique opportunities for disseminating the ideology of sustainable development through digital art and activism. Artificial intelligence technologies open up opportunities for generative art inspired by natural forms. And the development of environmentally friendly materials will allow the creation of physical art objects with a minimal carbon footprint.

In the futuristic dimension, further syntheses of artistic creativity, technology and eco-awareness will have an even more powerful impact on society.

It is the digitalization of the art space that provides the potential, motivation and tools to preserve and transmit the cultural and semantic heritage to future generations for their sustainable development.

Thus the digital era brings with it both hope for a technological leap forward in the evolution of art as well as the threat of losing its humanistic essence. Will it become an era of flourishing or decline of artistic creativity depends on whether a balance between innovation and ethical principles can be struck. The synthesis of contemporary art, latest

technologies and the concept of sustainability opens up broad horizons for both theoretical understanding and practical application in order to achieve the Sustainable Development Goals. Further interdisciplinary research in this field is extremely relevant and promising. Only a harmonious combination of technological progress with preserving moral values will bring art onto the path of sustainable development and evolution of public.

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