Development of Holo-Du Through Edupreneurship - A Glocalised Instructional Resource for Teaching in Computer Science Education, University of Ilorin

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Abstract

The use of 3D holographic technology in the classroom has a potential to make learning more engaging and memorable for students. However, in order for this technology to be effectively utilised in Nigerian schools, it is important to incorporate local context and traditional teaching methods in instruction. This approach, known as "glocalisation", can help to increase students interest in science subjects by making the material more relevant to their experiences. Additionally, addressing the lack of infrastructure, materials and skilled educators, as well as support from stakeholders, is essential in order for the Nigerian education system to meet the demands of instruction around the world. Edupreneureship also fostering innovative mindset in education. This study develops Holo-Du for teaching in computer science education in University of Ilorin. The objectives of this study is to: develops Holo-Du for teaching selected computer science concept; find the cost of developing Holo-Du in teaching selected computer science concept. This study employ research and development of model type. The development of a localized holographic tool (Holo-Du). However, Holo-Du do not produce a true volumetric image, and the 3D appearance is merely an illusion. They do, however, produce a convincing illusion of a holographic 3D object. Despite the Holo-Du successful creation and projection, there are still numerous work to be done. A device that not only displays 3D visuals but also allows people to interact with them could be created with more study.

Keyword: Beam, Glocalised Instructional Resource, Holo-Du, Hologram, Laser, Technology, Virtual reality, Artificial intelligence (AI)

Introduction

Technology integration, means the effective implementation of educational technology to infuse positive changes in the methods of teaching to ease students' learning and boost their capability, productivity and competence in their learning process. The edict to integrate technology into teaching and learning has led to a significant transformation in the way teachers instruct students. Technology can play a vital role, positively changing student's ways of learning, but it cannot be a total replacement for teachers. They will be the one to integrates the technology into instruction to the students by encouraging and motivating them to grasp new knowledge and ideas in their studies. Teachers uses technology as a tool to make teaching easier and foster more interest in learning in the students (Jhurree, 2005; Kabariah, & Adiyono, 2023). In education, technology have been implemented in numerous ways to enhance how people learn and address some demanding situations confronted by individuals in the process of teaching and learning.

Virtual reality which is a form of advancement in technology is being implemented in education. With virtual reality, students can attend lectures in digital surroundings. Virtual reality also allows for mobility, due to the fact that students can get access the virtual campus from different geographical areas. To implement the use of virtual reality in education, holographic devices need to be used. There are numerous benefits to this technology. Virtual reality compared to other methods, it offers much greater storage capacity and better object capability, including depth. It can generate multiple images at the same time, and does not require a projection screen and can operate from any angle (Muhammed, 2022).

Bringing this technology into education presents numerous challenges. The cost of production is higher than that of 2D projection and using holographic projection in product design is both more expensive and takes more time. It is also crucial to have the necessary equipment in the classrooms. While developed countries have already started using this technology in their classrooms, it will likely take longer for it to be implemented in developing countries (Oladapo, 2010). There is also the need to educate teachers and students on how to use it effectively. Further research is necessary to embed the right materials inside the devices (RF Wireless World Magazine, 2012).

In an effort to address the problem of high production costs for holograms, a local solution has emerged in the form of a device called Holo-Du. This device is made from carton and a pyramid structure, which allows learners to view the projected learning content from all angles, offering a 360-degree view to create a 3D illusion of a real hologram. The term "Holo-Du" is derived from the words "Hologram" and "Education" and refers to the integration of holograms in education. Holo-Du is a tool that presents educational content in 3D to learners, enabling them to better understand the concepts being taught and improving the way they learn. The concept of holography involves creating three-dimensional (3D) photographic images that appear to have depth (Barbara, 2010). It was first introduced by scientist Dennis Gabor in 1947 and has evolved over time, particularly with the discovery of lasers in 1960. Currently, holographic technology is used for a variety of purposes such as security measures for currency and advertising displays (Bellis, 2010).

The use of holography in the education sector has the potential to change the way students learn in the future. For instance, using hologram technology to project a teacher in multiple locations can improve learning and address some of the challenges faced in the education sector, such as a shortage of teachers in educational institutions (Smith, 2006). With holography, educational institutions can also have the opportunity of assisting each other overcome lack of teachers. For instance, if a college of applied sciences in United States has a trainer who teaches Strategic Management however a University of Applied Sciences in Nigeria is short of teacher who can teach this subject. An agreement can be made among these institutions and the teacher from United States can be projected to teach in Nigeria.

The integration of technology into the education sector has numerous benefits, particularly through the use of 3D in teaching. This approach makes learning more engaging and memorable for both students and teachers (Salih, et a.l, 2017). With advancements in technology, there has been an increased use of 3D hologram technology in education. Scientists have even managed to use this technology to "beam" individuals from one location to another without physically traveling. This was demonstrated in 2008 during a U.S election when Jessica Yellin was projected into Wolf Blitzer's studio in New York. The event attracted millions of viewers through a YouTube video, showcasing the impressive holographic effect (Welch, 2008).

Glocalised Instructional Resources for Teaching

The term ‘Glocalise’ was coined from the word ‘global and local’ to describe a product or service developed globally but fashioned to accommodate local users. It is a blend of global and local resources to generate a desired and mutual outcome without prejudice to either party. The well-known phrase “think globally and act locally” is often used to described the concept of glocalisation. In education and technology, open educational resources serve as an instance of promoting glocalisation, as they offer a diverse range of people access to both local and global educational content online (Adedokun-Shittu, 2019).

Recently, in the 21st-century, entrepreneurship is becoming more relevant in education. It is necessary that schools change and develop innovative mindset to bridge the gap between education and employment (Lăcătuş & Stăiculescu, 2016). Edupreneurship is an innovative approach which combines elements of entrepreneurship and education, which aims at transforming and improving the learning process, Edupreneurship, fosters essential 21st-century skills like critical thinking, problem-solving, and collaboration among learners and educators (Maruntelu, 2023; Muthmainnah, 2022). Glocalised instructional resources are instrumental in transforming education systems. These resources empower students to tackle real-world challenges through innovative approaches, thereby enhancing their ability to think critically, solve complex problems, and work effectively in teams. By integrating such tools into the curriculum, educational institutions can significantly contribute to the evolution and modernization of teaching and learning processes.

To achieve glocalisation in education, both teachers and students must participate in inquiry-based and problem-solving activities, that connect global concepts to local contexts. This involves finding local games, proverbs and cultural activities that align with the subjects they are studying, which can help students understand abstract ideas in a familiar and relatable way. To incorporate technology and reach a wider audience, a web repository that presents global content in a local context could be created as an open resource. However, this would require input and approval from local, global and subject matter experts to ensure that pedagogical, assessment and curriculum considerations are taken into account (Adedokun-Shittu, 2019).

The focus of this study is on a locally produced educational tool known as Holo-Du. This tool is designed to make holographic education more accessible and affordable for students who may not have access to expensive technology. By reducing educational disparities, all students can be given equal learning opportunities. Furthermore, the development of low-cost instructional tools can stimulate innovation and creative thinking in education, encouraging educators to find new and engaging ways to teach.

Research Questions

The following research questions were answered in this study:

1. What are the processes involved in the development of Holo-Du for teaching selected computer science concept?
2. What is the cost of the developed Holo-Du in teaching selected computer science concept?

Application of Holographic Technology in Education

Changes are occurring in practically every industry as a result of technological advancements in the twenty-first century, and these changes are mirrored in fields such as health, tourism, art, and education. Learning and teaching environments are rearranged as a result of technological improvements, particularly in the field of education, and technology is defined as a tool that aids education. In this view, it is regarded as an essential component of education, with emphasis placed on education-technology integration, particularly in science education. From the past to the present, many different technology tools have been utilized in education, and they continue to be used depending on current development. Digital holograms, which have previously been employed in areas such as health, art, tourism, manufacturing, and entertainment, have lately entered the educational agenda, and they are expected to be integrated in education due to their benefits (Harper, 2010). In this regard, the benefits of using digital holograms in education include providing users with realistic visuals, allowing individuals in various regions to communicate through virtual images, and allowing non-alive characters to be included in the real world using holograms (Kalansooriya, Marasinghe, & Bandara, 2015).

Furthermore, it is well known that using digital holograms in education has other benefits, such as contributing to the education industry on a wide scale, organizing future knowledge, and supporting educational industrial development with innovative technologies (Mavrikios, et al., 2019). When all of these benefits are considered, the use of holograms in education is called into question, particularly in science education, where technology integration is assumed to be easier. In science, it is expected that the use of holograms, which enable us to obtain 3D images, will be appropriate in the explanation of abstract topics such as microscopic creatures, extinct creatures, systems in our bodies, the nature and particulate structure of matter, biodiversity, cells and divisions, reproduction, growth, and development of living creatures (Seckin, 2020). This was done in the hopes that students would be able to visualize the abstract notions they heard in class better. In this way, it is expected that integrating holographic technology in the classroom can help pupils remember concepts and offer them with quick learning chances (Aslan & Erdogan, 2017).

Also, STEAM subjects (i.e. Sciences, Technology, Engineering, Art and Mathematics) requires inquiry, creativity and collaboration hence, teaching requires methodologies and styles that focus on students' retention, gradual assimilation and knowledge application. A teaching approach that minimizes the role of students as active participants in their learning may not meet any of these goals. It is intended that by placing learning in the context of the learners, abstract notions will be transformed into real and identifiable concepts. As a result, it should be noted that this strategy necessitates extending engagement by establishing a network of instructors, subject matter experts, local/cultural experts, and other stakeholders to discuss on way to improve chances for students' learning (Adedokun-Shittu, Abdulkadir & Nuhu, 2018).

Figure 2: Holographic image of the human body system

Furthermore, the usage of digital holograms in the delivery of science curriculum themes may provide students with relevant learning opportunities and holograms may boost student motivation. Orcos and Magrenan (2018) evaluated the impact of using digital holograms to teach the topic of cell division on meaningful learning. The pupils' satisfaction levels with holograms were determined to be high as an outcome of the research. At the conclusion of the study, it was also determined that digital holograms can be used as a motivating teaching aid. Teachers in the field of aeronautical engineering can utilize holograms to demonstrate and explain enormous engines that would otherwise be impossible to put into a classroom or, in certain situations, unaffordable for the school. In 2006, the GEnx Theatre at the Farnboroogh Airshow demonstrated the use of holography to portray enormous engines, as shown in the image below (Oladapo, 2010).

Figure 3: Holographic image of aeronautic engine

Theoretical Framework

The learning model which serves as the theoretical framework for this study is the visual, auditory and kinesthetic (VAK) learning style. VAK learning styles form a model of learning designed by Walter Burke Barbe and later developed by Neil Fleming. These learning model divides people into three categories of learners which are Visual learners (absorb information by sight), Auditory learners (absorb information by sound) and Kinesthetic learners (absorb information by moving) (Fiona, 2018). Loh and Shaharuddin (2019) also identified three key learning styles: visual, auditory and kinesthetic (VAK), as centered learning models that have shown effective in assisting students in learning in the method that is best for them, resulting in increased focus. As a result, the use of technology-based learning is that it may blend all three learning styles of visual, auditory and kinesthetic (VAK) techniques into a class to engage students in learning.

This is also confirmed by VAK theorists, who believe that presenting knowledge in all three types allows all learners to participate, regardless of their favorite style. Holography is a technology that generates auditory, visual, and haptic content in three-dimensional space using an effective visualization tool. This technology enables students to obtain more on-the-spot experience and integrate with the real world, thereby capturing the attention of learners (Barkhaya & Halim, 2016). A meta-analysis is carried out in this study to determine the learning style features in digital learning, to capture students' attention and boost their understanding in their studies, in order to build hologram with effective learning content.

Students learn better in the classroom when they can perceive the value and importance of the knowledge offered in the learning environment. According to Lamba, et al., (2014) study, a variety of factors can influence students' attention and concentration in the classroom, including duration and technique of instruction, novelty and recurrence of topics, surrounding environment, interest, health, and emotional condition. Furthermore, Gilakjani, (2012) stated that visual learners benefit from visual information, auditory learners benefit from oral or auditory modes, and kinesthetic learners benefit from moving, doing, and touching. As a result, combining auditory, visual, and kinesthetic teaching methods allows all students to participate, regardless of their preferred learning style. In addition, curiosity is the most basic form of interest. When a student is involved in the learning process, it is critical to get his or her attention (Naimie, Siraj, Ahmed Abuzaid, & Shagholi, 2010). Several components, such as colorful graphics, animation, and music, must be included in the learning content to stimulate students' interest. It must also include objects that introduce the students to the topic.

When students find a lesson difficult to understand, it could be that they have not been paying attention. Other teaching methods could be employed, such as visual learning aid, which can be well adapted to converting complex information into a simpler visual form, such as challenging concepts, text, charts, and diagrams. Visualization of information is critical for learners' development of attention skills and comprehension of the topic. Visuals have also been shown to be a learning enhancer when they are linked to learning styles. As Habib and Solomon (2015) pointed out, a well-written scenario, appropriate music, visual effects, and a decent-looking character in learning tools are all important components that draw students' attention to their studies. These are also the key characteristics that traditional schools lack in terms of providing academic knowledge; in some cases, the teacher may still need to employ facial expression, acting, and vocal effects to help the pupils understand the scenario. In a nutshell, a student's learning abilities are linked to their ability to pay attention during the learning process.

History and Generation of Computer Science and Concept taught using Holo-Du

In the 1950s and early 1960s, computer science emerged as a distinct academic discipline. The Cambridge Diploma in Computer Science, the world's first computer science degree program, began in 1953 at the University of Cambridge Computer Laboratory. Purdue University established the first computer science department in the United States in 1962. Since the advent of practical computers, several computing applications have grown into distinct fields of study in their own right (EDSAC, 2011).

The first generation of computer (1940-1956) used vacuum tube, these computer systems were huge, took up entire rooms, and utilized vacuum tubes for circuitry and magnetic drums for memory. These computers were extremely expensive to run, and in addition to consuming a lot of electricity, they also produced a lot of heat, which was frequently the source of failures. To accomplish operations, first-generation computers used machine language, which is the lowest-level programming language that computers understand, and they could only solve one problem at a time. A new problem would take operators days, if not weeks, to set up. Printouts were used to show output, which was based on punched cards and paper tape. First-generation computing devices include the UNIVAC and ENIAC computers. In 1951, the United States Census Bureau received the UNIVAC, which was the first commercial computer supplied to a business client (Vangie, 2021).

In the second generation of computers (between 1956-1963), transistors take the place of vacuum tubes. Although the transistor was conceived in 1947 at Bell Labs, it was not widely used in computers until the late 1950s. The transistor outperformed the vacuum tube, allowing computers to grow smaller, quicker, cheaper, more energy-efficient, and more dependable than their predecessors in the first generation. Despite the fact that the transistor still generated a lot of heat, which caused the computer to malfunction, it was a huge advance over the vacuum tube. Punch cards were still used for input and printout for output in second-generation computers (Vangie, 2021).

The third generation of computers (between 1964-1971) was defined by the advancement of the integrated circuit. Transistors were downsized and placed on silicon chips, known as semiconductors, allowing computers to run faster and more efficiently. Instead of punch cards and printouts, users interacted with third-generation computers via keyboards and monitors, which were connected to an operating system that allowed the device to execute multiple programs at once while being controlled by a central program. Computers became accessible to a wider audience for the first time since they were smaller and less expensive than their predecessors (Vangie, 2021).

In the fourth generation (between 1971-Present) thousands of integrated circuits were packed onto a single silicon chip. What once took up an entire room might now be contained in the palm of one's hand. The Intel 4004 microprocessor, introduced in 1971, combined all of the computer's components, including the central processing unit, memory, and input/output controllers, on a single chip. In 1981, IBM released its first personal computer, and in 1984, Apple released the Macintosh. As more and more daily devices began to employ microprocessors, they migrated out of the sphere of desktop computers and into many other aspects of life. As the power of these little computers grew, they could be joined together to build networks, leading to the creation of the Internet. The fourth generation of computers witnessed the introduction of graphical user interfaces (GUIs), the mouse, and handheld devices (Vangie, 2021).

The fifth generation (i.e. present and beyond) computer is based on Artificial intelligence, are still in development, however some applications, such as voice recognition, are now in use. Artificial intelligence is becoming a reality because to the usage of parallel processing and superconductors. In the coming years, quantum computation, molecular and nanotechnology will fundamentally alter the face of computers. The goal of fifth-generation computing is to create machines that can learn and self-organize and respond to natural language input (Vangie, 2021).
Other technology advancement such as virtual reality is also emerging, virtual reality and holography are related in that they both deal with creating 3D visual experiences, Holography technology is an innovative tool that significantly enhances teaching and learning by offering dynamic 3D representations of complex concepts. Whether in science, art, or engineering, holograms provide a more interactive, immersive, and engaging way to understand difficult concepts, bridging the gap between theory and practice. As the technology continues to advance, its applications in education are likely to expand, offering even more opportunities to enrich the learning experience.

Methodology

This study employed research and development of the model type which dealt with design, development and cost of the development of Holo-Du. Research and development of a model type refers to the systematic process of creating, or refining a conceptual or physical model in order to solve a specific problem or improve a particular product or service. This process typically involves several stages, as discussed in the development of Holo-Du below, each of the stages aimed at ensuring that the final model is effective, efficient, and practical.

Results

The result of this study are presented below.

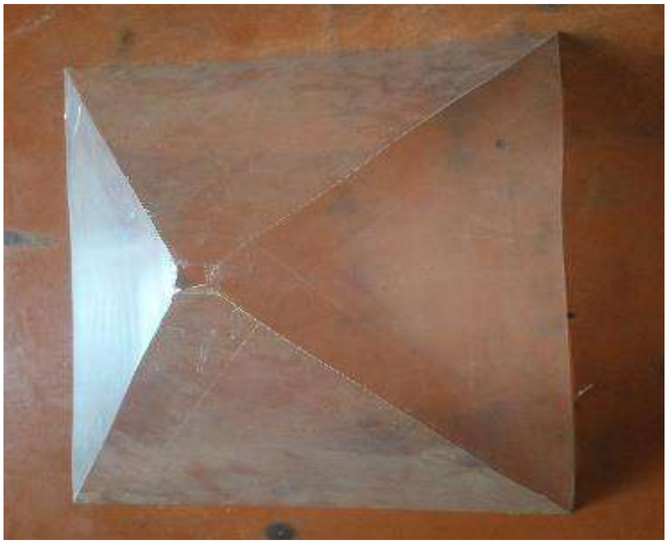
Research Question 1: What is the process involved in the development of Holo-Du?

The processes involved in the development of Holo-Du were broken down into:

Step 1: Get a carton and cut it into desired pieces (in the sense that when you combine the piece together it will form a cuboid shape).

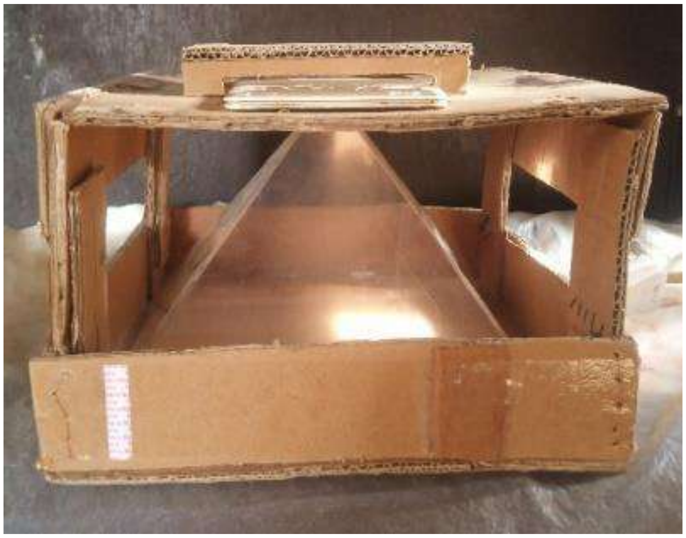
Step 2*:* Arrange the pieces and hold them together to form a cuboic shape, leaving the top of the cuboid open. The cuboid will have a rectangular opening where learners can see the holographic projection by the four sides. Check the image below.

Step 3: Get four transparent films (laminated films), cut out each into four equal triangles, and join them together using transparent sellotape to form a pyramid shape. Check the image below.



Step 4: Place the pyramid inside the cuboid already created through the top opening you made in step 2.

Step 5: Get a cover to close the top opening and be sure you create another opening on the cover where a mobile device can fit in; preferably a tablet. Check the image below.



Step 6: Use mp3 recorder on phone to record the audio learning content.

Step 7: Using CorelDraw version X7 or any graphic design app, the lesson content that are to be projected should be captured as an image and replicated on four sides. Repeat this process for every lesson content that will be projected using Holu-Du. The images should be inverted and placed on a black background to get upright and clear projection, bright color e.g. green should be used for text for audience to see clearly. See the image below.

Step 8: Using Movavi video suite version 15 or any video editing tool of your choice, combine the audio and images created in step 6 appropriately to form audiovisual output.

Step 9: Play the video on a tablet. The tablet should be placed on the opening created for projection on top of the Holu-Du. The video on the tablet screen will reflect the pyramid's four sides forming a holographic projection. See the image below:

Research Question Two: What is the cost of developing Holo-Du?

List of materials and items used for developing Holo-Du

S/N	Materials/Items	Cost (₦)
1	Carton	1,000
2	Set of squares	1,300
3	Four laminated films	400
4	Steel rule	1,500
5	Sellotape	300
6	Pencil	200
7	Gum	500
8	Knife cutter	2,300
	Miscellaneous	1,000
	TOTAL	**8,500**

A total of eight thousand, five hundred naira was spent in developing the instructional package.

Discussion of findings

This study developed and evaluated Holo-Du for teaching in Computer Science Education in University of Ilorin. Result of the findings from this study is based on the processes involved in the development of Holo-Du for teaching in Computer Science Education. This involves the use of carton to create a localised holographic tool (Holo-Du) to teach in order for learners to understand abstract concept as (Adedokun-Shittu 2019) posited the need for glocalisation which involves the use of local games, proverbs and cultural activities that align with the subjects' students are studying, which can help them understand abstract ideas in a familiar and relatable way. CorelDRAW and Movavi Video Suite was used to create pictures and edit video for audio-visual projection using Holo-Du instructional package and a tablet, this helps to blend the three learning style (Visual, Auditory and Kinesthetic). This is in line with the study carried out by (Barkhaya & Halim, 2016) whereby they stated that presenting knowledge in all three styles allows all learners to participate, regardless of their favorite style. Holography is a technology that generates auditory, visual, and haptic content in three-dimensional space using an effective visualization tool. Holo-Do was developed in a step-by-step manner in order to make it an effective instructional delivery tool. The total cost of producing the locally-made Holo-Du was eight thousand, five hundred Naira.

Limitation

The availability of high-quality raw materials is a constraint, as glocalisation focuses on using locally sourced resources. Holo-Du produced a convincing illusion of a holographic 3D object, however, it does not produce a true volumetric image, and the 3D appearance is merely an illusion. Despite the Holo-Du's successful creation and projection, there are still numerous works to be done to produce a device that not only displays 3D visuals but also allows people to interact.

Conclusion

This article discusses the use of glocalisation in Nigerian education system, where global contents are adapted to the local context for better engagement and understanding by students. The article fucuses on the use of a locally made instructional tool, Holo-Du, as a low-cost solution for making holography education accessible and reducing educational disparities. Holo-Du can help to present knowledge in all the three styles, in this case majority of students will not be left out in learning. To capture student attention, learning content should include components such as graphics, animation, music and objects that introduce the topic. Complex information should be presented in a simple visual form. In traditional schools, the teacher may need to use facial expression, acting and vocal effects to help students understand the topic. A student's ability to pay attention during the learning process is crucial for their learning success.

Recommendations

This study recommends that government should organize enlightenment programs to educate the teachers and students on the advantage of using Holo-Du and other similar technologies in education. Provision of necessary technological facilities should be made by the Government and private stakeholders to schools in order to be able to implement and promote further use of technology in education. Students should help themselves by making use of information on the internet for learning and shifting their focus from using it for fun and entertainments only.

References

Adedokun-Shittu, N. & Obielodan, O. (2016). Innovation in the Teaching of Computer Science. In Methods of Teaching Science, Basic Technology and Computer Science. Edited by Abimbola, I.O., Olorundare, A. S., Fajemidagba, M.O., Omosewo, E.O., Onasanya, S.A., Fakomogbon, M.A. and Adedokun-Shittu N.A.

Adedokun-Shittu, N.A., Abduljaleel, K.S., Ahmed, A.M., Oyekunle, A.R., & Asmau, I.A. (2018). Computer Studies' Curriculum Review: A Proposal for an Innovative Curriculum. Journal of Curriculum and Instruction. Published by Department of Science Education University of Ilorin, Ilorin, Nigeria.

Adedokun-Shittu, N.A. (2019). Ideas with no History of Application in Education and Technology. Glocalisation. A Crowd-Authored Book. 2nd Edition Pg. 265

Aimiuwi, Ehimwenma (1996). The Moon was Full Again.http://www.edofolks.com/html/folk1.htm

Aslan, R., & Erdogan, S. (2017). Hologram [Medical education in the 21st century: Virtual reality, augmented reality and hologram. *Kocatepe Veterinary Journal*, *10*(3), 204-212.

Barbara, C. (2010). *Hologram Types*. Retrieved from eHow Inc.: Downloaded from https://www.ehow.com/list_6062700_hologram-types.html

Barkhaya, N., & Halim, N. (2016). A Review of Application of 3d Hologram in Education. *A Meta-Analysis, IEEE 8th International Conference on Engineering Education: Enhancing Engineering Education through Academia-Industry Collaboration, ICEED, Institute of Electrical and Electronics Engineers Inc.,, 4*, 257-260. doi:DOI: 10.1109/ICEED.2016.7856083

Bellis, M. (2010). *History of Holography*. Retrieved from About.com: https://inventors.com/od/hstartinventions/a/Holography.htm

Bellis, M. (2010). *History of Holography*. Retrieved from About.com: https://inventors.com/od/hstartinventions/a/Holography.htm

EDSAC. (2011). Electronic Delay Storage Automatic Calculator Statisitcs . University of Cambridge.

Fiona, M. (2018). *VAK learning styles: what are they and what do they mean?* Retrieved from Engage-Education: https://www.engage-education.com

Gilakjani, A. (2012). A Study on the Impact of Using Multimedia to Improve the Quality of English Language Teaching. *Journal of Language Teaching and Research, 3*(6), 1208–1215. doi:doi.org/10.4304/jltr.3.6.1208-1215

Habib, K., & Solomon, T. (2015). Cartoons' Effect in Changing Children Mental Response and Behavior. *Open Journal of Social Sciences, 3*(9), 248-64.

Harper, G. (2010). Holography projects for the evilgenius. The McGraw-Hill Companies.

Jhurree, V. (2005). Technology Integration in Education in Developing Countries: Guidelines to Policy Makers. *International Education Journal*, 467-483.

Kabariah, S., & Adiyono, A. (2023). Efforts to Use Technology Effectively in Supporting the Implementation of Educational Supervision. *Indonesian Journal of Education (INJOE),* 3(1), 63-78.

Kalansooriya, P., Marasinghe, A., & Bandara, K. (2015). Assessing the applicability of 3D holographic technology as an enhanced technology for distance learning. *Journal of Education*, *1*(16), 43-57.

Lăcătuş, M. L., & Stăiculescu, C. (2016). Entrepreneurship in Education. *International Conference Knowledge-Based Organization,* 22(2), 438–443. https://doi.org/10.1515/kbo-2016-0075

Lamba, S., Rawat, A., Jacob, J., Arya, M., Rawat, J. C., & Panchal, S. (2014). Impact of Teaching Time on Attention and Concentration. *IOSR Journal of Nursing and Health Science, 3*, 1-4.

Loh, N., & Shaharuddin, S. (2019). A Proposed Concept of Learning Based 3D Hologram to Enhance Attention Among Primary School Learner. *International Journal of Innovative Technology and Exploring Engineering (IJITEE),* 1131.

Maruntelu, C. L. (2023). The Edupreneur: Empowering Education through Entrepreneurial Innovation. SCIENTIFIC BOARD, 88.

Mavrikios, D., Alexopoulos, K., Georgoulias, K., Makris, S., Michalos, G., & Chryssolouris, G. (2019). Using holograms for visualizing and interacting with educational content in a teaching factory. *Procedia Manufacturing, 31*, 404-410.

Muhammed, H. (2022). Education System in the Future: The Use of Hologram Technology. Retrieved from http://skylineuniversity.ac.ae/knowledge-update/information-systems/education-system-in-the-future-the-use-of-hologram-technology

Muthmainnah, M., Al Yakin, A., Massyat, M., Lulaj, E., & Bayram, G. E. (2022). Developing Students' Life Skills through Edupreneurship in the Digital Era. In The New Digital Era: Digitalisation, Emerging Risks and Opportunities (pp. 169-190). Emerald Publishing Limited.

Naimie, Z., Siraj, S., Ahmed Abuzaid, R., & Shagholi, R. (2010). Hypothesized learners' technology preferences based on learning style dimensions. *Turkish Online Journal Educational Technology* - *TOJET,* 9(4), 83-93.

Oladapo, A. (2010). *Application of Holographic Technology in Education.* Kemi-Tornio University of Applied Sciences .

Orcos, L., & Magrenan, A. (2018). The hologram as a teaching medium for the acquisition of STEM contents. *International Journal of Learning Technology*, *13*(2), 163-177.

RF Wireless World Magazine (2012). Advantages of 3D Hologram | disadvantages of 3D Hologram. RF Wireless World, RF & Wireless Vendors and Resources. Retrieved from https://www.rfwireless-world.com/Terminology/Advantages-and-Disadvantages-of-3D-Hologram.html.

Salih, S., Sulaiman, P., Ramlan, M., & Rahmat, R. (2017). *3D Holographic Rendering For Medical Images Using Manipulates Lighting in a 3D Pyramid Display* (Vol. 7).

Seckin, K. (2020). Examination of science curriculum in terms of innovative technologies. *Innovative approaches in enriched material production in science education*, 31-35.

Smith, P. (2006, April 25). *Global teacher shortages threaten goal of quality education for all*. Retrieved from www.un.org/apps/news/story.asp?

Vangie, B. (2021). *Five Generations of Computers Checklist*. Retrieved from Webopedia: www.webopedia.com/DidYouKnow/Hardware_Software/FiveGenerations.asp

Welch, C. (2008). Beam me up, wolf CNN debuts election-night “hologram”. CNN News.

Welch, C. (2008, Retrieved October 19 2009). Beam me up, wolf CNN debuts election-night “hologram”. CNN News.