COGNITIVE DISCOURSES

INTERNATIONAL MULTIDISCIPLINARY JOURNAL

ISSN 2321-1075 ISSN 2347-5692

VOLUME 13 ISSUE 1 JULY 2025

cdimj.naspublishers.com

Published Since 2013

COGNITIVE DISCOURSES
International Multidisciplinary Journal
pISSN 2321-1075 eISSN 2347-5692

Volume 13, Issue 1, July 2025

Students' Perceptions towards the Use Of AR/QQ Technology in Enhancing Visual Sense, Spatial Visualization, and Engagement in Learning Spatial Literacy: A Quantitative Survey Study

P.Karkuzhali
Research scholar, Department of Education,
Bharathiar University,Coimbatore-641046

Dr.K.Vijayarani
PhD, Controller Of the Examination
Bharathiar University, Coimbatore – 641046

Abstract

The human senses are vital in shaping how we perceive and interact with our environment, with vision being the most dominant sense. In educational contexts, visual perception significantly influences students' performance by providing clarity, enhancing comprehension, and supporting informed decisions. Recent technological developments, such as Augmented Reality (AR) QR Codes, have further underscored the value of vision in creating engaging learning experiences. This paper examines the effectiveness of AR in educational settings with the aim of identifying specific research questions related to its impact. To achieve this, the study applied a quantitative survey method involving 50 male and 50 female eighth-grade students from a self-finance school. A validated questionnaire was used to collect data. The findings indicate that visualization and real-life applications in AR are both effective and meaningful. The mean visualization score was 4.63, which is significantly higher than neutral ($p < .001$), highlighting the importance of visual perception in education.

Keywords: Visual Sense, visualization, engagement, learning, AR-QR code, spatial literacy

Abbreviations

AR: Augmented Reality QR: Quick Response

Introduction

Research indicates that about 75% of the information the brain processes comes from visual input, highlighting the essential role of sight in making decisions and navigating daily life. AR QR Codes merge traditional QR code capabilities with interactive 3D visualizations, allowing users to access augmented reality experiences by simply scanning them with a smartphone camera, eliminating the need for extra applications. This innovation has been transformative across various sectors, including marketing, retail, and education. Within education, AR QR Codes provide students with a distinctive chance to shift from static printed materials to active, interactive 3D content.

Humans rely on five senses: sight, taste, hearing, smell, and touch. Each sense has unique characteristics. According to scientific research, 77% of people consider sight their most important sense. Visual input provides critical information to the brain, guiding actions and decisions. This means our actions often reflect what we see. Accurate visual information enhances understanding and helps us avoid harm in daily tasks. In education, the sense of sight plays a crucial role in students' success.

Literature Review

In this study, we adopted the screen-based augmented reality display method, utilizing mobile device screens to display augmentation images that appear larger in size. Sight and visual play crucial but distinct roles. While sight pertains to the physical act of seeing, visual is understood as a metaphysical idea. Both elements are essential for grasping our everyday experiences. Particularly, Learning experience is crucial in education, which requires mental visualization of concepts for a better understanding of analogies with less mental effort (T. Thornton, 2012). According to the dictionary, visual sense provides guidance and a clear perspective on our goals and ambitions, enabling them to materialize. Moreover, visual is

considered more significant than our other senses, as it occupies a significant portion of our brain's resources.

Importance of Visual Sense

Visual is a unique capability and the most dominant of all senses. Various studies indicate that 75% of the information processed by the brain originates from visual stimuli. Visual supplies information to the brain, which in turn influences our decision-making. Sound decisions stem from clear visual. When decisions are well-informed, individuals can act appropriately, leading to effective outcomes. Additionally, making sound decisions and taking appropriate actions helps conserve time when navigating toward our goals. Ultimately, having a clear visual direction allows for a smoother existence.

It ignites student interest and encourages engagement in learning with clarity. This ability allows students to make their own choices and support experiential learning. Students can focus better on their studies.

It offers hope to students who may feel confused about their studies, strengthening their ability to tackle critical academic challenges. A strong visual sense simplifies complex information.

It aids in comprehending the connections between images and information, helping students generate ideas. Through visual input, students develop spatial knowledge for better organization.

It enhances memory retention among students, creating a powerful learning approach via visual means. Visual learning encourages active engagement and strengthens memory recall. Additionally, it establishes a solid foundation for academic pursuits as the brain processes visual data 60,000 times faster than text, which can boost learning effectiveness by as much as 400%.

It promotes critical thinking through visuals and improves visual literacy skills. This sensory capability empowers students to think independently and approach tasks with confidence, while also helping maintain emotional equilibrium in challenging situations.

Innovation in Education

Modern educational methods must evolve through innovation, particularly in the digital age. Innovation represents the future of education, equipping students with tools for success in advanced learning environments. While innovating in education can be challenging, it requires a thoughtful approach to address the needs of students. All the studies in the review specify that AR applications when used in education are capable of increasing students‟ academic achievement as compared to traditional learning methods for all grade [K. R. Bujak,2013., Tsinakos and A. Tesolin, 2018., W.-K. Liou, 2016., M.T. Y. a. W.C. Liao,2014., J. Zhang,2014., M. P. and S. O,2014.,]. Once new learning methods are adopted, they also refine students' soft skills and prepare them for future careers. Innovation brings transformative change to education, aiding in the more effective organization of information.

Examples of innovative teaching and learning approaches include project-based learning (PBL), blended learning, and educational technology. In the realm of educational technology, recent techniques such as augmented reality (AR), virtual reality (VR), and mixed realities are being utilized within education. However, innovation extends beyond simply incorporating technology in classrooms; it includes methods that enhance knowledge and educational experiences.

AR tools

There are various studies discussing the use of AR applications in learning environments [K. R. Bujak,2013., Tsinakos and A. Tesolin, 2018., W.-K. Liou, 2016., M.T. Y. a. W.C. Liao,2014., J. Zhang,2014., M. P. and S. O,2014.,]. The AR tool is best for the high school students, distance

students, individual students and for the STEM education students. It is the most innovative and useful tool to the teachers and the students needs, also respecting the individual learning pace of each students. Augmented Reality tool is an advanced experience for the students. The tools bring them new idea and good experience for the students in education along with Virtual classroom is an example to the innovation. Additionally, AR development technology offers a variety of ready-made tools to the learner's need for their need and very useful for the future digital era. Furthermore the AR tools are quite easy for the non-specialist to handle the latest technology via smartphone without extra effort. In USA 77% of people accessed the technology through their smartphones. Next there is customized AR apps for the users convenient and need. Depending on the age of the students the apps can customized. Further, the customized apps are available for low-cost budget users. According to the users need, the tools are in five types. They are, Marker-based AR, Marker less AR, Projection-based AR, Superimposition-based AR, and Location based AR. The present study utilized marker-based (image recognition) augmented reality (AR) through the DEVAR application integrated within AR-enabled textbooks. This type of reality is also known as Image Recognition (T. Thornton, J. Ernst and C. Clark,2012). A camera and a visual marker such as a QR code or a 2D code is used. First the marker is sensed by the reader and then the output is given. Apps based on this type uses a camera to differentiate a marker from any other real world object. Markers can be anything which are unique yet simple (e.g. QR Code) and should be detectable by the camera. Calculations of position and orientation is done. Marker Detection Algorithm (K. J. and R. H.,2007)includes (1) Dividing images in regions, (2) Detecting images in the region, (3) Finding segments in the region, (4) Merging segments into lines, (5) Extending lines along the edges, (6) Keeping lines with corners and finally, (7) Finding the markers In this system, specific printed images and QR codes within the book served as visual markers. When students scanned these pages using the DEVAR app on a mobile device, the software recognized

the image marker and superimposed three-dimensional (3D) augmented objects and animations directly over the physical textbook image. This interactive visualization allowed learners to observe virtual 3D content in real time while still viewing the real-world book context. Such a superimposition-based AR environment facilitated students' engagement and enhanced their spatial visualization, understanding of shape structure transformation, and real-life application of lesson content. In the same way, by using AR, the user doesn‟t get completely disconnected from real environment, but the user can remove or add any object from the real-world (N. González,2012).

Advantages of AR QR Codes

The fusion of traditional QR codes and AR QR Codes with interactive augmented reality experiences offers an enhanced level of engagement and innovative experiences. These codes serve as marker-based links that activate 3D presentations for visualization. The activation process is simple; users just need to scan it using their smart phone camera. There's no requirement to invest in additional applications. By visualizing the content, users can grasp the information clearly. Typically, AR QR Codes appeal to tech-savvy shoppers. This emerging trend in marketing tools represents a notable innovation in our digital age. Users benefit from the features of this marker, which comes to life when they utilize their mobile cameras for a live experience. Numerous beneficiaries, such as shoe manufacturers, furniture retailers, face filter developers, gaming enthusiasts, and real estate agents, cater to visitors; the code can include detailed city information that animates and reveals routes.

AR QR Codes can significantly influence education. They are essential and beneficial for students, as activating the code offers a remarkable opportunity. The information provides an immersive experience that captivates interest in education. Users can seamlessly transition from a printed message to a 3D interactive link to the real world. The creativity of the students' content comes to life through the AR QR Code, enabling them to clear their doubts during live

experiences. For example, if science students wish to understand heart function, the Augmented Reality QR Code can facilitate this learning. Similarly, students can explore any content they are interested in detail via the link. Teachers can leverage this tool to bring students' imaginations into reality. From various locations, users can gain video information about different sites, such as museums, zoos, and other geographic locations. In this light, the following research question was asked:

In this study, the research questions addressed in this study are:

- How does the use of AR/QR technology affect students spatial visualization and 3D thinking abilities?
- How do the students perceive the effectiveness and engagement of AR/QR for learning shapes and 3D images?

And some hypotheses framed are:

- H1: AR/QR significantly improves students spatial visualization and 3D thinking abilities.
- H2: Students perceive AR/QR as effective for learning spatial literacy.
- H3: using AR/QR significantly improves students ability to apply spatial literacy skills in real-life situations.

Research Methodology

Participants

The participants for this study were 50 male and 50 female students totally 100 samples of 8th grade in a self-finance school located in urban area. It was ensured the participants are familiar to the concept of QR.

Procedure

The study was conducted with N=100 participants in 5 rooms simultaneously, wherein each room had one participant accompanied by 5 researchers. With the school administration permission

100 android phones given to assess the AR technology for this study. Book materials with AR QR code has given to them to each, to visualize the AR experience. And AR QR code given to understand the spatial thinking through the concept of congruent shapes and similar shapes. In between researcher asked question to the participants about the difference of 2D and 3D images. Two tasks were given to them to apply the spatial thinking knowledge in the real-life situation.

Instruments

A questionnaire five -point Likert scale used and It consist 21 tool items constructed into three namely: Engagement with AR, Visualization, and Applied In Real Life Situation. Based on the questionnaire the research question and the hypothesis were concluded.

Table 1

No of Questions in Each Construct and Purpose of the Constructs

Construct	Number of Item	Purpose
Engagement with AR QR	7	To measure effectiveness
Visualization	4	To measure improvement visual sense
Real-Life Application	6	To assess transfer to real life

I measured the reliability for 21 tool items and I removed to get improved my reliability. Therefore 17 are in the questionnaire.

Construct	Cronbach's α
Engagement	0.427
Visualization	0.532
Real-life application	0.369

Data Analysis

In this study, one-sample t-test were taken to compare the composite mean value to neutral value 3 (neither agree nor disagree).

A one-sample t-test was conducted to determine whether the overall perception of AR-based learning differed from the neutral value of 3 on a five-point scale. In the following table 2, construct visualization The Sig.(2-Tailed) = .000 – this means p <0.001, which is highly significant. The Confidence Interval is 95% (1.57, 1.69).

Table 2

One-Sample Test(Engagement)

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
overallmeans_eng	71.600	99	.000	1.67571	1.6293	1.7222

Table 3

One-Sample Test(Visualization)

	Test Value = 3					
					95% Confidence Interval of the Difference	
	T	df	Sig. (2-tailed)	Mean Difference	Lower	Upper

overallmean	50.510	99	.000	1.630	1.57	1.69

Table 4

One-Sample Test(Transfer to Real-Life)

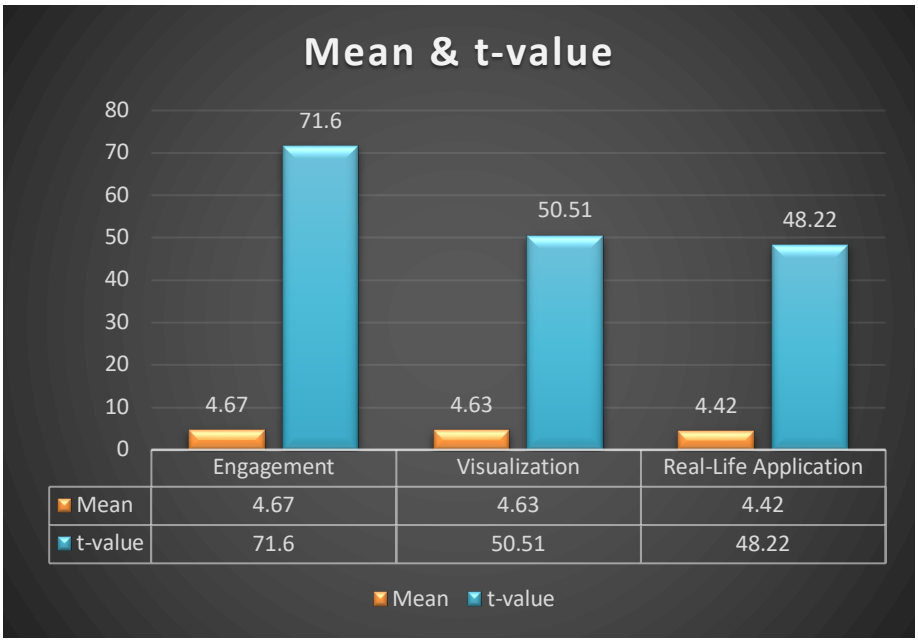
	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
overallmeans_realife	48.229	99	.000	1.42000	1.3616	1.4784

Results

The below fig 1. Shows the mean and t-value for each construct to understand in visual.

Figure 1

Mean Value and t-value

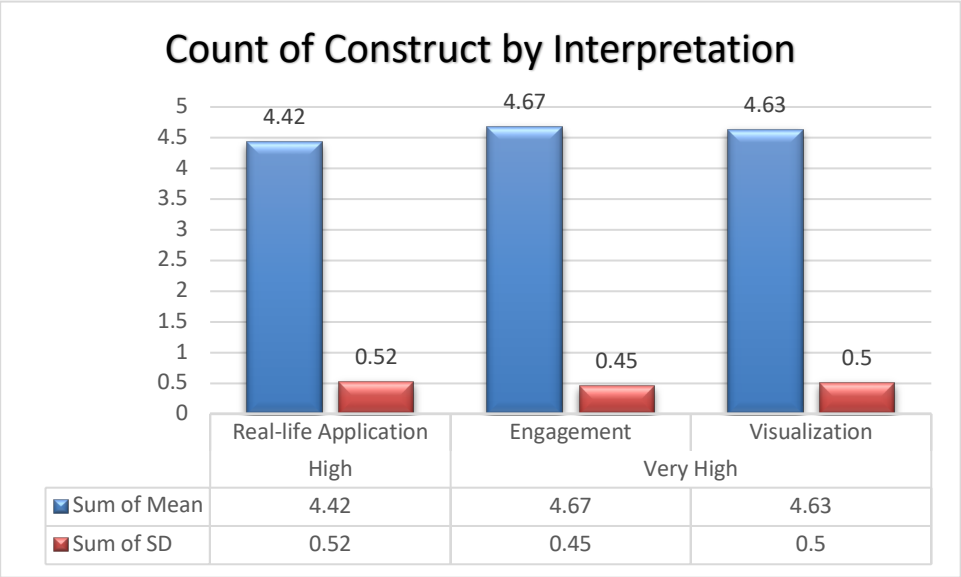


In this study, one-sample t-tests were used to compare the composite mean value to the neutral value of 3 (neither agree nor disagree).

- According to Table 3, the results for Research Question 1 show that the p-value for each construct is significant (0.000 < 0.05). Students are highly effective and engaging, significantly enhanced students' spatial visualization and 3D thinking, and significantly improved in real-life application. Furthermore, it supports my **H1**.
- The engagement Mean = 4.67, p <.001 it means students are highly engaged and enjoyable with meaningful. It supports the H2 and the Research Question 2.
- Real-life Mean = 4.42,p<.001 it means AR/QR significantly improved the application of spatial skills to real contexts, which supports H3: AR/QR significantly improves students' ability to apply spatial literacy in real-life situations.

Figure 2

Construct By Interpretation



The above fig.2 shows the interpretation of data in each construct. Engagement and visualization significant are very high.

Conclusion

In the survey design, the analyzing results show clear that the students' overall perception is significantly positive towards learning through the AR QR-based concept. In this study, all three hypotheses are supported. Teachers can also use the AR QR based learning to enhance the teaching style in a modern way to step on the digital era. While the applications may differ, the concept represents a sophisticated advancement for the forthcoming digital age. Users can gain 360-degree perspectives with a single device without interruption. Consequently, the Augmented Reality Quick Response Code is crucial for students to satisfy their educational needs. Additionally, it is designed to be user-friendly throughout the learning journey. A single tool can inspire students to explore a variety of ideas, fulfilling their educational objectives.

References

AR codes: how they work & applications in education. (n.d.). https://ar-code.com/blog/augmented-reality-codes-in-education#:~:text=What%20is%20an%20AR%20QR,%2C%20packaging%2C%20and%20educational%20books.

AR QR code for shapes - Google Search. (n.d.). https://www.google.com/search?sca_esv=767cd598432ecedb&rlz=1C1JJTC_enIN996IN996&q=AR+QR+code+for+shapes&sa=X&ved=2ahUKEwi59-e1j-2JAxWpR2wGHRqKEE8Q8ccDegQIERAF&biw=1366&bih=568&dpr=1&udm=7#fpstate=ive&vld=cid:08521207,vid:O_Q7IZXEtSU,st:0

AR code, Augmented Reality QR codes. (n.d.). https://ar-code.com/

Augmented Reality QR codes - benefits and use cases. (n.d.). KOMPANIONS. https://www.kompanions.com/blog/augmented-reality-qr-codes

Elsayed, S. A., & Al-Najrani, H. I. (2021). Effectiveness of the augmented reality on improving

the visual thinking in mathematics and academic motivation for middle school students. *Eurasia Journal of Mathematics Science and Technology Education*, *17*(8), em1991. https://doi.org/10.29333/ejmste/11069

Gönen, S. İ. K., & Zeybek, G. (2021). Using QR code enhanced authentic texts in EFL extensive reading: a qualitative study on student perceptions. *Education and Information Technologies*, *27*(2), 2039–2057. https://doi.org/10.1007/s10639-021-10695-w

Omar, M., Ali, D. F., Surif, J., Mokhtar, M., Jumaat, N. F., Samah, N. A., & Ashari, Z. M. (2019). Improving spatial visualization skills in educational settings. *Indian Journal of Public Health Research & Development*, *10*(9), 1808. https://doi.org/10.5958/0976-5506.2019.02716.5

Milgram, P., Kishino, F.: A taxonomy of mixed reality visual displays. IEICE Trans. Inf. Syst. 77(12), 1321–1329 (1994)

he Ultimate Guide to Augmented Reality (AR) Technology, http://www.realitytechnologies.com/augmented-reality

Marker Based Augmented Reality, https://www.slideshare.net/arshiyasayd/marker-based-augmented-reality

T. Thornton, J. Ernst and C. Clark, "“Augmented reality as a visual and spatial learning tool in technology education," Technology Engineering Teachnology, pp. Vol. 71, no. 8, pp. 18–21, 2012.

Hsu, T. C. (2019). Effects of gender and different augmented reality learning systems on English vocabulary learning of elementary school students. *Universal Access in the Information Society*, *18*(2), 315-325.

Gargrish, S., Mantri, A., & Kaur, D. P. (2020). Augmented reality-based learning environment to enhance teaching-learning experience in geometry education. *Procedia Computer Science*, *172*, 1039-1046.

K. R. Bujak, I. Radu, R. Catrambone, B. MacIntyre, R. Zheng and G. Golubski, "A psychological perspective on augmented reality in the mathematics classroom," Computers & Education, pp. vol. 68, no. 2013, pp. 536- 544, 2013.

Tsinakos and A. Tesolin, "Opening real doors: Strategies for using mobile augmented reality to create inclusive distance education for learners with different-abilities," Mobile and Ubiquitous Learning: A International Handbook, Singapore, Springer., pp. pp. 59-80, 2018.

W.-K. Liou, K. K. Bhagat and C.-Y. Chang, ""Beyond the flipped classroom: A highly interactive cloud- classroom (HIC) embedded into basic materials science courses," Journal of Science Education and Technology, pp. vol. 25, no. 3, pp. 460-473, 2016.

M.T. Y. a. W.C. Liao, "Computer-assisted culture learning in an online augmented reality environment based on free-hand gesture interaction," IEEE Transactions on Learning Technologies, pp. vol. 7, no. 2, pp. 107-117, 2014.

J. Zhang, Y. T. Sung, H. T. Hou and K. E. Chang, "The development and evaluation of an augmented reality- based armillary sphere for astronomical observation instruction," Computers & Education, pp. vol. 73, pp. 178- 188, 2014.

M. P. and S. O., "Augmented reality in informal learning environments: A field experiment in a mathematics exhibition," Computers & Education, pp. vol. 79, pp. 59-68, 2014.

N. González, "How to include augmented reality in descriptive geometry teaching.," Procedia Computer Science, pp. 75, 250–256., 2015.

Aggarwal, R., & Singhal, A. (2019, January). Augmented Reality and its effect on our life. In *2019 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence)* (pp. 510-515). IEEE.

Team. (2020, December 12). *The edtech that India needs*. The Hard Copy. https://thehardcopy.co/the-edtech-that-india-needs/

GeeksforGeeks. (2024, September 18). Top 10 AR developer tools Every developer should know. GeeksforGeeks. https://www.geeksforgeeks.org/top-ar-developer-tools-every-developer-should-know/

Shalimov, A. (2024, October 30). Augmented Reality in Education: How to Apply it to your EdTech Business. Eastern Peak - Technology Consulting & Development Company. https://easternpeak.com/blog/augmented-reality-in-education/#:~:text=What%20is%20augmented%20reality%20in,creating%20an%20immersive%20learning%20space.

Staff, C. (2024, November 25). 9 augmented reality examples. Coursera. https://www.coursera.org/articles/augmented-reality-examples