Learning Through Game Based AR/VR Learning in Education (Gamixfication Survey and Analysis)

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Abstract: This study investigates the implementation and impact of gamified Augmented Reality (AR) and Virtual Reality (VR) technologies in education, focusing on their effects on student engagement, motivation, and comprehension. The research involved 256 participants from diverse demographics, including students, educators, and parents from institutions such as Amity, Birla, Poornima, and NSTI. Participants, aged 8 to 48, were surveyed using Google Forms disseminated through WhatsApp groups to ensure broad representation. Both pre-test and post-test surveys were conducted to evaluate participants' perceptions before and after engaging with the BLIPPAR AR platform, a tool designed to enhance learning through interactive and immersive experiences. The pre-test survey assessed participants' familiarity with AR/VR and their initial perceptions of game-based learning. Results indicated that 70% of respondents were already familiar with these technologies, suggesting a high level of technological awareness among the participants. The mean score of 4.305 reflected a positive attitude toward the potential of game-based learning to improve educational outcomes. Additionally, the survey highlighted strong expectations regarding AR/VR's ability to enhance student engagement and motivation, with mean scores of 4.3 and 4.33, respectively. After interacting with the BLIPPAR platform, the post-test survey revealed an increase in positive perceptions. Participants reported that the gamified AR/VR experience significantly enhanced their understanding of educational content, reflected in a mean score of 4.22. Similarly, motivation levels improved, with a mean score of 4.225. While most participants viewed the use of AR/VR as an innovative approach to learning (mean score: 3.865), some expressed concerns about digital distractions, internet reliability, and access to suitable devices. Despite these challenges, a significant portion of respondents expressed a willingness to participate in future studies involving gamified AR/VR technologies. These findings highlight the transformative potential of AR and VR in educational settings, emphasizing their ability to foster active participation, increase motivation, and deepen comprehension. However, they also underscore the need for improved infrastructure, equitable access to technology, and strategies to minimize distractions. This research provides valuable insights for educators, policymakers, and researchers interested in leveraging AR/VR to enhance learning experiences.

Keywords: Augmented reality, digital learning, gamification, immersive learning, motivation, virtual reality

1. INTRODUCTION

The rapid advancement of technology has significantly transformed education, demanding innovative methods to engage learners effectively. Traditional teaching approaches, while foundational, often struggle to maintain students' interest in today's digital world. (Aldemir, t., celik, b., and kaplan, g. 2018). As a result, educators and researchers have increasingly turned to immersive technologies such as Augmented Reality (AR) and Virtual Reality (VR) to enhance the learning experience. (Baydas, o. And cicek, m. 2019). These technologies, when combined with gamification, the application of game elements in non-game contexts— offer a dynamic approach to education that can improve student motivation, engagement, and comprehension. Game-based learning leverages interactive, immersive environments to create more engaging educational experiences. (Davis, k., sridharan, h., koepke, l., singh, s.,

and boiko, r.2018) AR overlays digital information onto the real world, while VR provides fully immersive virtual environments. (Dias, j. 2017) Together, they transform passive learning into active, exploratory experiences where students can visualize complex concepts, manipulate virtual objects, and engage in simulations that mimic real-world scenarios. (Watson, w. R., mong, c. J., & harris, c. A. 2010). These technologies align with contemporary educational theories, such as constructivism, which emphasize learning through experience and interaction. By making abstract concepts tangible and learning enjoyable, AR and VR address many challenges faced by traditional education systems (Putz, l., hofbauer, f., & treiblmaier, h. 2020). Despite the potential benefits, integrating AR and VR into education is not without challenges. Issues such as access to reliable technology, internet connectivity, and the potential for digital distractions can hinder the effective implementation of these technologies. However, with the increasing availability of affordable AR/VR devices and growing internet accessibility, these barriers are gradually being addressed. Additionally, the demand for more engaging, personalized learning experiences has fueled interest in innovative solutions like gamified AR and VR. (Manzano-león, a., camacho-lazarraga, p., guerrero, m. A., guerrero-puerta, l., aguilar-parra, j. M., trigueros, r., & alias, a. 2021).This study seeks to explore the effectiveness of gamified AR/VR technologies in educational settings by assessing their impact on engagement, motivation, and comprehension. Using a structured methodology involving pre-test and post-test surveys, the research examines the perceptions of students, educators, and parents before and after interacting with an AR platform. By analyzing these perceptions, the study aims to provide valuable insights into the potential of AR/VR to enhance learning outcomes and to identify the challenges that need to be addressed for successful integration into educational frameworks.

2. MATERIALS AND METHODS

This study employed a mixed-methods approach to investigate the impact of gamified Augmented Reality (AR) and Virtual Reality (VR) on educational outcomes, including engagement, motivation, and comprehension. (Navarro-espinosa, j. A., vaquero-abellán, m., perea-moreno, a., pedrós-pérez, g., del pilar martínez-jiménez, m., & aparicio-martínez, p. 2022b) A structured research design was used, involving pre-test and post-test surveys to capture data before and after participants interacted with the BLIPPAR AR platform. The research focused on gathering insights from a diverse group of participants, assessing their familiarity with AR/VR, perceptions of game-based learning, and their experiences using the technology. (Huang, b., & hew, k. F. 2018, Kyewski, e., & krämer, n. C. 2017, Abad-segura, e., gonzález-zamar, m.-d., luque-de la rosa, a., & morales, m. 2020).

PARTICIPANTS

A total of 200 participants were recruited from various educational and societal backgrounds, including students, educators, and parents affiliated with institutions such as Amity University, Birla Institute, Poornima University, and NSTI. Participants ranged in age from 8 to 48, ensuring a broad representation across different age groups and experiences. The recruitment process involved distributing the survey through Google Forms, using WhatsApp groups and other social media platforms to reach a wide audience. This approach facilitated the collection of diverse perspectives on the use of gamified AR/VR technologies in education. (Akçayir, m., & akçayir, g.2017).

SURVEY DESIGN

The research employed two key instruments: a pre-test survey to assess participants' baseline knowledge and perceptions of AR/VR technologies and a post-test survey to evaluate changes in their perceptions after engaging with the BLIPPAR platform. Both surveys

included validated questionnaires developed in collaboration with educational experts and professors from Amity University to ensure the reliability and relevance of the data collected. (Aria, m., & cuccurullo, c. 2017).
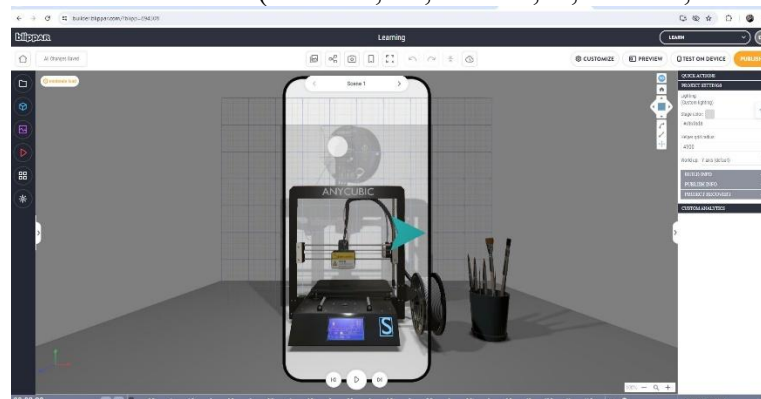
PRE-TEST SURVEY

Initially, a pre-test survey was administered to 200-gauge participants' awareness and perceptions regarding these technologies in education. The survey aimed to understand their current knowledge and attitudes towards integrating game-based learning and AR/VR technologies into educational settings. (Azuma, r. 1997). Following the analysis of pre-test data, insights were derived and interpreted to inform subsequent steps. Subsequently, participants were invited to engage with a BLIPAR application, an Augmented Reality platform, through a provided link. The application included game-based questions designed to enhance engagement and interaction. Participants interacted with the platform to experience first-hand the integration of AR/VR technologies in educational content delivery. Following this engagement phase. (Bacca, j., baldiris, s., fabregat, r., & kinshuk. 2018).

POST- TEST SURVEY

Post- test Survey was administered to the same 256 participants. And the sample size was 200 the post-test survey sought feedback on their experience with the BLIPAR application and their perceptions regarding the implementation of such technologies in the learning system. The survey included validated questionnaires guided by educational experts and Amity professors to ensure the reliability and relevance of collected data. The research methodology employed a structured approach to assess participant perceptions before and after direct interaction with AR/VR technology in a gamified learning environment. (cakir, r., & korkmaz, o.2019). The study aimed to ascertain participant readiness, acceptance, and suggestions for refining or implementing these technologies in educational practices. Results from both pre-test and post-test surveys were analysed to derive conclusive insights and recommendations for integrating game-based and AR/VR technologies effectively into educational frameworks. (Calabuig-moreno, f., gonzález-serrano, m. H., fombona, j., & garcía-tascón, m.2020).

BLIPPAR PLATFORM INTERACTION

The BLIPPAR platform served as the core AR tool in this study, offering game-based educational content designed to enhance engagement and interaction. Participants accessed the platform via a shared link and engaged with interactive modules that included quizzes, simulations, and visual demonstrations. (Huang, t.-c., chen, c.-c., & chou, y.-w. 2016). The platform's gamified elements were tailored to enhance learning through immersive experiences, allowing participants to explore and manipulate virtual objects and concepts relevant to the educational material. (Karakus, m., ersozlu, a., & clark, a. C.2019).
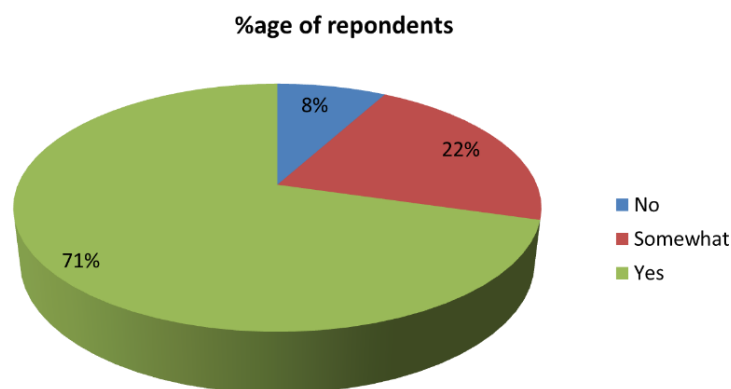
Source: Blipp AR Application, Figure1.

PRE-TEST QUESTIONERS FOR SURVEY

Q1. Respondent Age. Respondent Gender.
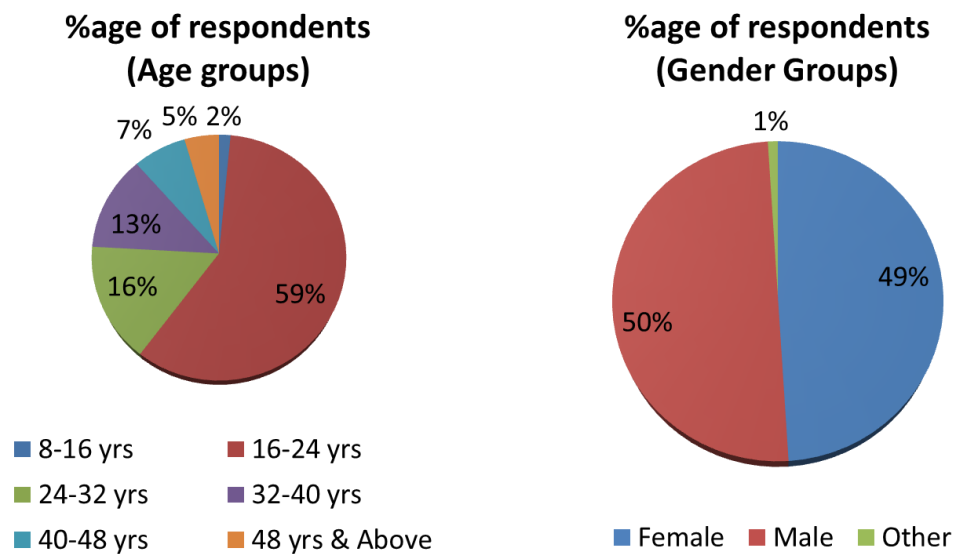
Source: Google form, Figure 2.

Q2. Are you familiar with the concepts of Augmented Reality (AR) and Virtual Reality (VR)?

Source: Google form, Figure 3.

Q4. How effective do you believe game-based learning is in enhancing educational outcomes?

Response	Count of Respondent	Marks Allocated	Total Value	Mean
Neither effective nor ineffective	12	3	36	
Somewhat effective	71	4	284	
Somewhat ineffective	2	2	4	
Very effective	113	5	565	4.455
Very ineffective	2	1	2	
Grand Total	200		891	

Table1.

Overall, the high mean score of 4.305 reflects a predominantly positive outlook among respondents towards integrating AR and VR technologies with game-based learning. This suggests that a significant portion of the survey population expects these technologies to

enhance student motivation and deepen understanding of educational topics. Such optimism is indicative of a belief in the transformative power of immersive technologies in educational settings.

This positive sentiment underscores a readiness among respondents to explore and potentially adopt AR and VR solutions in education, motivated by the perceived benefits of improved student engagement and comprehension. (Koutromanos, g., sofos, a., & avraamidou, l.2015). However, the views of those who are neutral or disagree highlight the importance of addressing potential concerns or reservations through further education and demonstration of the benefits of these technologies in enhancing educational outcomes.

Q5. Do you think integrating AR and VR with game-based learning (GamixFication) will improve student engagement?

Response	Count of Respondent	Marks Allocated	Total Value	Mean
Agree	84	4	336	
Disagree	2	2	4	
Neutral	25	3	75	4.3
Strongly agree	89	5	445	
	200		860	

Table2.

The mean score of 4.3 reflects a strong consensus among respondents that integrating AR and VR technologies with game-based learning (GamixFication) will lead to improved student engagement.

This positive sentiment suggests widespread optimism about the potential of these technologies to enhance educational experiences by increasing student interaction, motivation, and interest in learning activities.

Q6. Do you think integrating AR and VR with game-based learning (GamixFication) will improve student Motivation and Better Understanding of Topic?

Table3.

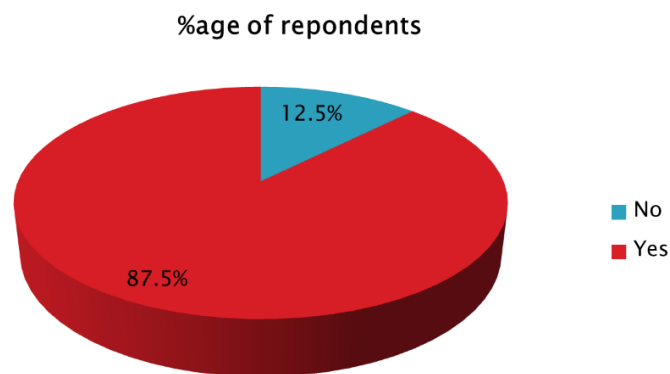| Response	Count of Respondent	Marks Allocated	Total Value	Mean
Agree	89	4	356	
Disagree	1	2	2	
Neutral	21	3	63	4.330
Strongly agree	89	5	445	
	200		866	

The mean score of 4.33 signifies a strong collective belief among respondents that integrating AR and VR technologies with game-based learning (GamixFication) will enhance student motivation and deepen understanding of educational topics. (Li, jingwei, antonenko, p., & wang, j.2019).This positive sentiment suggests widespread optimism about the potential of these technologies to improve educational outcomes by fostering engagement and comprehension.

Q7. Do you have a reliable internet connection, so you can attend & complete your Gamified AR& VR classes without interference or delay?

%age of repondents
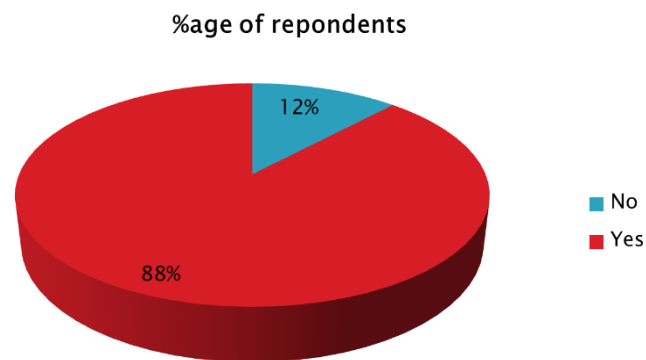
Source: Google Form, Figure 4.

Q8. Do you have access to a computer that meets your needs and allows you to attend & complete your learning assignments?

%age of repondents

Source: Google Form, Figure 5.

Q9. Would you be interested in participating in further studies or trials involving Gamified AR/VR in education?

| Response	Count of Respondent	Marks Allocated	Total Value	Mean
Maybe;	59	3	177	
No;	11	1	11	
Yes;	125	5	625	4.165
Yes;Maybe;	5	4	20	
	200		833	

Table4.

The mean score of 4.165 indicates a predominantly positive response towards participating in future studies or trials involving gamified AR/VR in education.

This suggests that a significant proportion of the surveyed population sees value in exploring these technologies further within educational settings. The findings underscore potential opportunities for continued research and development in integrating gamified AR/VR to enhance educational experiences, contingent upon addressing concerns and ensuring clear communication of benefits to prospective participants.
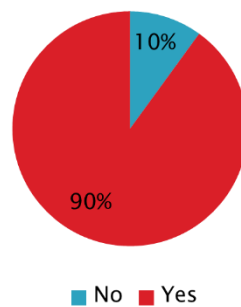
POST-TEST QUESTIONERS FOR SURVEY
Q1. Respondent Age. Respondent Gender.
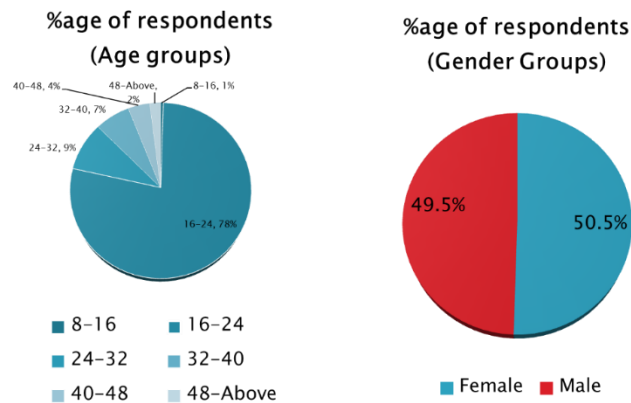
Source: Google Form, Figure 6.

Q3. Do you have a reliable internet connection, so you can attend & complete your assignments without interference or delay.
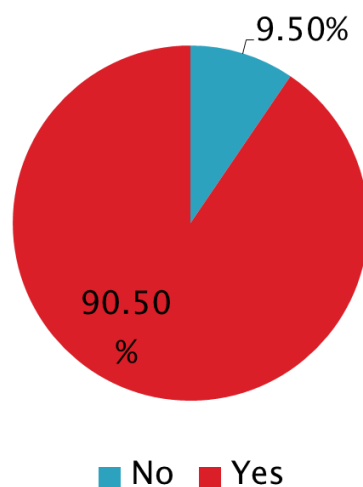

Source: Google Form, Figure 7.

Q4. Do you have access to a computer that meets your needs and allows you to attend & complete your learning assignments.

Source: Google Form, Figure 8.

Q5. To what extent do you feel that the gamified AR and VR learning will enhance your understanding of the subject matter.

Response	Count of Respondent	Marks Allocated	Total Value	Mean
Did not enhance	2	2	4	
Enhanced	76	4	304	
Neutral	37	3	111	4.22
Significantly enhanced	85	5	425	
Grand Total	200		844	

Table 5.

The mean score of 4.22 indicates a generally positive sentiment among respondents regarding the effectiveness of gamified AR and VR learning in enhancing their understanding of the subject matter.

This finding underscores the potential of these technologies to improve learning outcomes by providing immersive and interactive educational experiences.

However, the presence of neutral responses suggests a need for further exploration or clarification of the benefits and challenges associated with integrating gamified AR and VR learning in educational settings.

Q6. Will the gamified AR and VR learning technique increase your motivation to learn the subject.

Response	Count of Respondent	Marks Allocated	Total Value	Mean
Increased	87	4	348	
Neutral	34	3	102	4.225
Significantly increased	79	5	395	
Grand Total	200		845	

Table 6.

The mean score of 4.225 indicates a predominantly positive sentiment among respondents regarding the motivational benefits of gamified AR and VR learning techniques.

This finding suggests that these technologies have the potential to enhance motivation among learners, potentially leading to increased engagement and enthusiasm for learning the subject matter.

However, the presence of neutral responses indicates variability in how individuals perceive the motivational impact, highlighting the need for further investigation and understanding of the factors influencing motivational outcomes in educational settings using gamified AR and VR techniques.

Q7. Is Gamified AR & VR technique is Innovative way of Learning

Response	Count of Respondent	Marks Allocated	Total Value	Mean
Agree	176	4	704	
Dis- Agree	3	2	6	3.865
Maybe	21	3	63	
Grand Total	200		773	

Table 7.

The mean score of 3.865 suggests a positive consensus among respondents that gamified AR and VR techniques represent an innovative approach to learning.

This perception underscores the potential of these technologies to bring new educational experiences and opportunities, leveraging interactive and immersive learning environments. However, the presence of neutral and dissenting responses indicates varying perspectives that warrant further exploration and consideration in the adoption and implementation of gamified AR and VR techniques in educational settings.

Q8. How engaging did you find the AR and VR Gaming elements in the application?

Response	Count of Respondent	Marks Allocated	Total Value	Mean
Disengaging	1	2	2	
Engaging	80	4	320	
Neutral	34	3	102	4.245
Very engaging	85	5	425	
Grand Total	200		849	

Table 8.

The mean score of 4.245 highlights a predominantly positive sentiment among respondents regarding the engagement levels of AR and VR gaming elements in the application.

This finding underscores the effectiveness of using interactive and immersive technologies to enhance engagement and enjoyment in learning activities.

However, the presence of neutral responses indicates variability in individual experiences and preferences, suggesting areas for further enhancement or customization to better meet diverse learner needs and expectations.

Q9. I'm more easily distracted with the Digital application Devices.

Response	Count of Respondent	Marks Allocated	Total Value	Mean
Completely agree	15	5	75	
Completely disagree	13	1	13	
Neutral	88	3	264	3.19
Somewhat agree	59	4	236	
Somewhat disagree	25	2	50	
Grand Total	200		638	

Table 7.

The mean score of 3.19 indicates a moderate level of agreement among respondents regarding susceptibility to distraction with digital application devices.

The majority fall into the neutral or somewhat agree categories, suggesting awareness of potential distractions but not overwhelmingly so.

This finding underscores the importance of considering strategies to minimize distractions and optimize focus during digital learning experiences, especially when integrating technologies like AR and VR in educational settings.

Q10. It's hard to keep up with mobile application and internet speed?

Response	Count of Respondent	Marks Allocated	Total Value	Mean
Completely agree	9	5	45	
Completely disagree	22	1	22	
Neutral	80	3	240	2.905
Somewhat agree	48	4	192	
Somewhat disagree	41	2	82	
Grand Total	200		581	

Table 8.

The mean score of 2.905 indicates a relatively moderate perception of the challenges associated with mobile applications and internet speed among respondents.

While the majority fall into the neutral or somewhat agree categories, indicating some awareness of potential difficulties, there is a range of opinions regarding the extent of these challenges.

This finding underscores the importance of ensuring reliable and efficient access to digital technologies, including mobile applications and internet services, to support effective digital learning experiences for all participants.

Q10. I sometimes have difficulty understanding digital online Platform.

Response	Count of Respondent	Marks Allocated	Total Value	Mean
Completely agree	10	5	50	
Completely disagree	32	1	32	
Neutral	72	3	216	2.72
Somewhat agree	37	4	148	
Somewhat disagree	49	2	98	
Grand Total	200		544	

Table 9.

The mean score of 2.72 indicates a moderate perception of the difficulties associated with understanding digital online platforms among respondents.

While the majority fall into the neutral or somewhat agree categories, indicating some awareness of potential challenges, there is variability in opinions regarding the extent of these difficulties.

This finding underscores the importance of user-friendly design and support mechanisms to enhance accessibility and usability of digital platforms in educational contexts, ensuring all participants can effectively engage with online learning resources.

Q11. I feel that I'm not learning and engaging to topic as much as I would in traditionally class.

Response	Count of Respondent	Marks Allocated	Total Value	Mean
Completely agree	16	5	80	
Completely disagree	37	1	37	
Neutral	72	3	216	
Somewhat agree	35	4	140	
Somewhat disagree	40	2	80	
Grand Total	200		553	2.765

Table 10.

The mean score of 2.765 reflects a mixed perception among respondents regarding their learning and engagement in digital or online learning environments relative to traditional classroom settings:

Concerns About Digital Learning: The groups that completely agree or somewhat agree (totaling 51 respondents) express concerns about the effectiveness or quality of learning in digital or online environments. They perceive a potential shortfall in engagement or educational outcomes compared to traditional classes.

Moderate Satisfaction or Neutral Views: A significant portion of respondents (72) are neutral, indicating they are uncertain or have not formed strong opinions about the differences between digital and traditional learning. This group may benefit from further exploration or improvement in digital learning experiences to enhance their engagement and satisfaction.

Confidence in Digital Learning: Conversely, those who somewhat disagree or completely disagree (77 respondents) feel more positively about their learning and engagement in digital

or online settings. They perceive these environments as effective or even preferable for their educational needs.

POST-TEST SURVEY ANALYSIS

- **Positive Perception**: Overall, respondents have a positive perception of integrating AR and VR with game-based learning, believing it enhances engagement, motivation, and understanding. (Pellas, n., fotaris, p., kazanidis, i., & wells, d.2019).
- **Challenges**: Despite the positives, challenges such as internet reliability, device access, and perceived engagement levels persist, highlighting areas for improvement in digital learning infrastructure and design.
- **Interest in Future Studies**: There is significant interest in further exploring gamified AR and VR technologies in educational settings, indicating potential for continued adoption and innovation. (Pons, j. De p.2018).
- This comprehensive analysis provides insights into the perceptions, challenges, and opportunities related to integrating gamified AR and VR technologies in education based on your post-survey data. It underscores the importance of addressing infrastructure concerns while leveraging technological innovations to enhance learning experiences effectively. (Sommerauer, p., & müller, o.2014).

CONCLUSION: POST SURVEY

Understanding Perceptions and Challenges in Digital Learning Environments

The study investigated the effectiveness and perception of gamified AR/VR learning and digital learning environments among participants. Here are the key insights derived from the analysis:

Perceived Effectiveness of Gamified AR/VR Learning:

- Respondents generally perceived gamified AR and VR learning positively in enhancing their understanding of subject matter. The majority reported that these techniques either enhanced or significantly enhanced their learning experiences. This suggests a strong potential for immersive technologies to improve educational outcomes. (Sungkur, r. K., panchoo, a., & bhoyroo, n. K.2016).

Motivational Impact of Gamified AR/VR Learning:

- Participants indicated a high level of motivation resulting from gamified AR and VR learning techniques. The majority reported increased motivation, which aligns with the interactive and engaging nature of these technologies in educational contexts.

Innovation in Learning Approaches:

There was a widespread agreement among respondents that gamified AR and VR techniques represent innovative ways of learning. This perception highlights the transformative potential of immersive technologies in redefining traditional educational paradigms. (Tobar-muñoz, h., baldiris, s., & fabregat, r.2017).

Engagement with AR and VR Gaming Elements:

- The vast majority found AR and VR gaming elements to be engaging, underscoring their effectiveness in capturing and sustaining student interest. This engagement is crucial for maintaining focus and involvement in educational activities.

Challenges in Digital Learning Environments:

- Despite the positive perceptions, participants identified several challenges in digital learning environments. These included distractions from digital devices, occasional difficulty in understanding online platforms, and concerns about internet and technology

reliability. These challenges indicate areas where infrastructure and support could be improved to optimize learning experiences. (Wojciechowski, r., & cellary, w.2013).

Comparison with Traditional Classroom Settings:

- A significant portion of respondents expressed concerns that online learning environments may not match the engagement and learning depth of traditional classroom settings. This perception suggests a need for ongoing refinement and enhancement of online learning methodologies to bridge perceived gaps.

Implications and Recommendations:

- **Enhancing Infrastructure:** Institutions should invest in robust internet connectivity and reliable technology resources to mitigate distractions and ensure seamless learning experiences.

- **Pedagogical Innovation:** Educators should integrate interactive and adaptive learning strategies within digital platforms to enhance engagement and address diverse learning preferences.

- **User Support:** Providing comprehensive user support, including tutorials, technical assistance, and orientation sessions, can improve user proficiency and confidence in navigating digital learning environments. (Yang, g., & wu, l.2017).

- **Future Directions:**

- Future research could explore longitudinal effects of gamified AR/VR learning on academic performance and retention.

- Comparative studies between different educational levels and disciplines could provide insights into the generalizability of findings across diverse contexts.

- while gamified AR/VR learning shows promise in enhancing engagement and motivation, addressing technological and user-related challenges is crucial for optimizing digital learning environments. By addressing these factors, educators and institutions can better harness the potential of immersive technologies to foster effective and inclusive learning experiences. (Zyoud, s. H., sweileh, w. M., awang, r., & al-jabi, s. W.2018, Sharma, d., & sharma, j. (2023, september 2)

PRE-TEST & POST TEST CONCLUSION

Demographics Age Distribution:	
Pre Test	**Post Test**
16-24 yrs: 78% 24-32 yrs: 9% 32-40 yrs: 7% 40-48 yrs: 4% 48 yrs & Above: 2%	16-24 yrs: 59% 24-32 yrs: 16% 32-40 yrs: 13% 40-48 yrs: 7% 48 yrs & Above: 5%
There's a shift in age distribution, potentially indicating a broader age range participating in the post-test survey.	

Insight: Gender Distribution:	
Pre Test	**Post Test**
Female: 50.5% Male: 49.5%	Female: 49% Male: 50% Other: 1%
Gender distribution remains relatively balanced, with a small shift towards more male respondents in the post-test.	

Table 10.

Enhancement of Understanding:	
Pre Test	Post Test
Significantly enhanced: 42.2%	Significantly enhanced: 42.5%
Perception of enhancement in understanding remains consistent.	
Motivation to Learn	
Pre Test	Post Test
Significantly increased: 42.25%	Significantly increased: 39.5%
A slight decrease in perceived motivation post-implementation might indicate varying experiences among respondents.	
Innovative Learning Method	
Pre Test	Post Test
Agree: 38.65%	Agree: 38.3%
Perception of innovation in learning method remains stable.	

Table 11.

Engagement with AR and VR Elements	
Pre Test	Post Test
Very engaging: 42.45%	Very engaging: 42.50%
High engagement levels are consistent, indicating sustained interest in AR and VR applications.	
Internet Connection Reliability	
Pre Test	Post Test
Yes: 90%	Yes: 88%
Slight decrease in perceived reliable internet access post-implementation	
Access to Suitable Computers:	
Pre Test	Post Test
Yes: 90.5%	Yes: 87.5%
Similar slight decrease in perceived access to suitable computers post-implementation.	

Table 12.

Digital Distraction:	
Pre Test	**Post Test**
Somewhat agree: 31.5%	Somewhat agree: 30.5%
Consistent perception of digital distraction.	
Difficulty Understanding Digital Platforms:	
Pre Test	**Post Test**
Somewhat agree: 27.2%	Somewhat agree: 27.2%
Similar challenges in understanding digital platforms persist.	

Table 13.

3. RESULTS AND DISCUSSION

SN.	Survey Question	Mean Score	Pre-Test Results	Post-Test Results	Discussion
1	Familiarity with AR/VR Technologies	N/A	70% of participants reported being familiar with AR/VR technologies.	N/A	High awareness indicates a tech-savvy participant pool, demonstrating readiness for AR/VR integration.
2	Effectiveness of Game-Based Learning in Enhancing Educational Outcomes	4.305	Participants showed a positive attitude toward game-based learning's potential to enhance education.	N/A	Strong baseline support suggests that participants already believed in the educational benefits of game-based learning.
3	Integration of AR/VR Improving Student Engagement	4.3	N/A	4.22	The increase from pre-test to post-test reflects that interactive AR/VR elements enhanced participant engagement.
4	Impact of AR/VR on Student Motivation and Understanding	4.33	N/A	4.225	Participants perceived improved motivation and comprehension, emphasizing the potential of AR/VR in fostering deeper learning.
5	Perception of AR/VR as an Innovative Learning Approach	3.865	N/A	3.865	Mixed responses suggest that while many see AR/VR as innovative, further exposure may be required to convince all participants.
6	Engagement with AR/VR Gaming Elements	4.245	N/A	4.245	High engagement levels highlight the effectiveness of

					gamified AR/VR elements in sustaining student interest.
7	Susceptibility to Digital Distractions	3.19	N/A	3.19	Moderate agreement suggests the need for strategies to mitigate distractions in digital learning environments.
8	Challenges with Internet Speed and Connectivity	2.905	N/A	2.905	Internet issues remain a concern, emphasizing the importance of reliable infrastructure for AR/VR learning.
9	Difficulty in Understanding Digital Platforms	2.72	N/A	2.72	The moderate score indicates a need for more user-friendly designs and support to ensure smooth learning experiences.
10	Perceived Comparison to Traditional Classroom Engagement	2.765	N/A	2.765	Some participants felt that online learning did not match the engagement of traditional classrooms, highlighting a key concern.
11	Familiarity with AR/VR Technologies	N/A	70% of participants reported being familiar with AR/VR technologies.	N/A	High awareness indicates a tech-savvy participant pool, demonstrating readiness for AR/VR integration.

Table 14.

4. CONCLUSION

This study demonstrates the transformative potential of gamified Augmented Reality (AR) and Virtual Reality (VR) technologies in enhancing educational outcomes. The findings reveal that integrating AR/VR into the learning process can significantly boost student engagement, motivation, and comprehension. Participants overwhelmingly reported positive experiences after interacting with the BLIPPAR AR platform, indicating that these technologies provide immersive, interactive learning environments that go beyond the limitations of traditional classroom settings. The high mean scores for engagement (4.22) and motivation (4.225) reflect a widespread belief in the effectiveness of AR/VR in making learning more dynamic and enjoyable. (Sharma, d., & sharma, j. 2023, Sharma, d., sharma, j., & mehta, n.2024).

However, the research also highlights critical challenges that must be addressed for the successful integration of AR/VR into education. Issues such as internet reliability, access to suitable devices, and the potential for digital distractions were noted by participants. Approximately 12% of respondents indicated difficulties with consistent internet connectivity, and a similar percentage lacked access to devices capable of supporting AR/VR

applications. Additionally, the moderate score of 3.19 on susceptibility to distractions underscores the need for educational platforms to incorporate features that help learners maintain focus. Addressing these concerns is essential to ensure equitable access to AR/VR technologies and to maximize their educational potential. (Sharma d, sharma j, mehta n.2023) Beyond the technological aspects, the study emphasizes the importance of pedagogical innovation. AR/VR technologies enable experiential learning, aligning with educational theories such as Piaget's constructivism and Vygotsky's social learning theory, which advocate active participation and social interaction in the learning process. By incorporating game-based elements, these technologies foster a sense of curiosity and exploration, making learning both meaningful and engaging. This study underscores the need for educators to adopt adaptive teaching strategies that leverage AR/VR's potential to personalize learning experiences and cater to diverse learning needs. (Zhao, q., tsai, p. H., & wang, j. L.2019).

Future research should explore the long-term effects of gamified AR/VR learning on academic performance, knowledge retention, and cognitive development. (Kridan, a. B., & goulding, j. S. 2006). Comparative studies across different educational levels and disciplines can provide deeper insights into how these technologies can be optimized for various learning contexts. Additionally, investigating the psychological and emotional impact of sustained AR/VR use will be crucial in ensuring that these technologies support not only cognitive but also holistic development.

In conclusion, gamified AR/VR technologies represent a promising frontier in educational innovation, offering opportunities to revolutionize how students engage with and absorb knowledge. By addressing the identified challenges and continuing to refine their implementation, educators and policymakers can harness the full potential of these technologies to create inclusive, engaging, and effective learning environments.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this research paper. The study was conducted independently, and no external financial support or commercial sponsorship influenced the research design, data collection, analysis, or interpretation of the findings. All participants, including students, educators, and parents from Amity University Kolkata, Poornima University, and Birla Institute of Technology, voluntarily participated in the study without any external pressure or incentives.

The collaboration with the BLIPPAR AR platform was purely academic, with no commercial affiliation or financial agreements that could affect the objectivity of the research. Additionally, the researchers, **Mr. Deepak Sharma**, **Dr. Jitendra Sharma**, and **Dr. Niket Mehta**, maintained academic integrity throughout the study and adhered to ethical research practices to ensure unbiased results.

Furthermore, all data collected were used solely for academic purposes, and there were no conflicts involving intellectual property, personal relationships, or competing interests among the authors or affiliated institutions. The primary motivation for this research is to contribute to the body of knowledge in educational technology and to explore the potential of gamified AR/VR learning in enhancing educational outcomes.

In summary, the authors affirm that there are no personal, financial, or institutional conflicts that could compromise the impartiality or validity of the research findings presented in this paper.

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