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Perceived Effects of Mobile Games and Augmented Reality on Secondary School Students' Learning Outcomes in Basic Science and Technology in Oyo State, Nigeria

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ABSTRACT

It is a well established fact that mobile games and augmented reality positively impact students' learning outcomes. However, there is dearth of literature on the perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in Basic Science and Technology in Oyo State, Nigeria. Therefore, this study investigated teachers' perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in Basic Science and Technology in Oyo State, Nigeria. Three research questions and six hypotheses guided the study, adopted a mixed methods quantitative and qualitative approaches in a concurrent triangulation design, Sampled by cluster random sampling technique 300 secondary school teachers. Data was collected using Perceived Effects of Mobile Game and Augmented Reality on Secondary school Students Learning Outcomes Questionnaire (PEMgArSLQ, R=0.81) and Interview (PEMgArSLI, IRR=0.74). Data was analyzed using frequency counts, percentages, mean, standard deviation, thematic analysis t-test and ANOVA. The teachers have high perception of mobile games and augmented reality on secondary school students' learning outcomes in Basic Science and Technology in Oyo state, Nigeria which contradicted the thematic analysis results that majority of the teachers' perception was very low. The perception was significant (Mean=103.81, SD=7.11, df=273, t=102.05, p<.05). There is a significant difference in perceived perception based on gender (t=-9.830, df=271, p<.05), age (F(3,270)=19.91, p<.05), school types (t=-3.016, p<.05), qualifications (F(3,270)=3.96, p<.05) and experience (F(2,271)=13.87, p<.05). Government should refurbish the secondary schools with ICT infrastructural facilities and arrange more Teachers Professional Development Programmes (TPDP) on ICT utilization in science educati

1. Introduction

Teaching basic science and technology in secondary schools is crucial for developing students' intellectual and practical skills. It enhances students' understanding of fundamental scientific concepts, facts, hypotheses, theories, scientific laws and principles that fosters critical thinking, problem-solving, and decision-making skills, and prepares them for the job market. Basic science and technology equally lay solid foundation upon which advanced sciences and technology can be effectively laid. It espouses the students to basic Chemistry, Biology, Physics, Technology which serves as precursor knowledge, scientific skills and attitudes for specialties in sciences, technology and engineering. The relevance of the curriculum, the quality of teaching, access to resources, infrastructure, socio-economic factors, gender disparities, assessment practices, and teacher motivation are all crucial factors in enhancing students' learning outcomes in Basic science and technology. Disconnecting the curriculum from real-world applications can hinder students' engagement, while

inadequate teacher training, large class sizes, and limited resources can hinder quality education. Insufficient access to resources, particularly in rural or economically disadvantaged areas, can also hinder students' ability to grasp basic scientific concepts. Poor infrastructure, socio-economic disparities, gender biases, and assessment practices can equally mar students' understanding and engagement (Akram et al., 2022). Addressing these issues requires a comprehensive approach involving curriculum reform, teacher training initiatives, investment in resources, community engagement, and policies aimed at reducing socio-economic inequalities. However, interventions in curriculum methodologies using games and

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augmented realities have proven effective in enhancing students' knowledge, attitude and skills in the subject.

Studies have shown that using mobile games and augmented reality in teaching science and technology improves students' conceptual understanding, problem-solving skills, and motivation, leading to better learning outcomes (Liu & Horton, 2019; Martín-Gutiérrez et al., 2017; Sari &Kocakoyun, 2018; Wang et al., 2021; Xu et al., 2019). A meta-analysis of 33 studies on the use of mobile games in science education found that it had a positive effect on students' learning outcomes, including knowledge acquisition, conceptual understanding, and critical thinking skills. Additionally, the use of augmented reality in teaching biology and physics has increased students' interest and motivation in the subject. Therefore, educators and policymakers should consider incorporating these technologies into their teaching methods to enhance students' engagement and learning outcomes in science and technology education.Educational games are a fun and effective way to learn, creating challenges and providing feedback for improvement. Mobile games, played on small handheld devices like smartphones and tablets, offer a tailored learning environment that includes different levels of education. Research shows that educational games and mobile learning can improve students' learning achievements and motivation in various learning contexts, including science, mathematics, and language learning.

Digital games have become popular due to their ability to meet children's needs and interests, create an attractive atmosphere, and keep learners focused on tasks. Mobile learning is an important component of education, allowing students to learn, collaborate, and share ideas using the internet and technology. However, it is essential for developers to consider how learners and educators will accept mobile learning. Augmented reality is another effective way to enhance learning experiences by providing visualized learning content that makes students focus and interesting during the learning process. Augmented reality involves combining real-world and computer-generated data such as audio, video, graphic, GPS, and location information. It allows users to view the real world as enhanced, enriched, or augmented, and is a virtual reality application where users interact with the real world. Augmented reality, a concept similar to virtual reality, is being used in educational settings to promote authentic, local, and contextualized learning. Mobile-based learning strategies with augmented reality make teaching and learning more interesting, interactive, and flexible. Mobile devices are becoming a part of every class activity, promoting active learning, classroom accountability, and student interaction. The integration of mobile game-based learning with augmented reality offers a promising solution to address challenges in conventional pedagogical methods. Benefits of augmented reality include enhanced interactive learning, increased student engagement, improved knowledge retention, personalized learning, real-world application, and accessibility and inclusivity. In reality, educational games and mobile learning provide a fun and effective way to learn, making the process easier, more interesting, and more effective. However, developers must consider how learners and educators will accept mobile learning and ensure that mobile devices are accessible and supported for effective educational platforms.However, challenges include information overload, confusion, lack of necessary skills, resistance from teachers, expensive training, health and discomfort concerns, and technical problems like poor connections and Global Positioning System (GPS) errors.

The use of mobile games and augmented reality in teaching basic science and technology has been supported by various theoretical frameworks. These include the Cognitive Load Theory (Sweller, 2019), which suggests efficient management of cognitive load, the Technology Acceptance Model (Sari &Kocakoyun, 2018), which explains how teachers' attitudes towards technology affect their acceptance and use, the Constructivist Learning Theory (Jonassen& Land, 2012), which suggests active and meaningful experiences, and the Social Cognitive Theory (Bandura, 2016), which suggests learning occurs through observation, imitation, and modeling. These frameworks provide a comprehensive understanding of the relationship between technology-enhanced learning and students' learning outcomes. The real way that technology is incorporated into the teaching and learning process is greatly influenced by teachers' perspectives on this matter. Research indicates that the way teachers perceive technology in the classroom can have a positive or negative impact on its effective implementation. For instance, it was discovered that a significant portion of instructors in Ghanaian Senior High Schools did not use computers in the classroom even though they had access to them (Owusu-Darko, 2023). Similarly, pre-service teachers in an Indonesian study reported running into issues when using technology into their English instruction, including a lack of facilities and time restraints. However, research has also indicated that educators are more willing to incorporate technology into their lessons when they have a positive attitude toward it (Resendez, 2019; Veridiano&Brondo, 2023). As a result, it's critical to change instructors' perspectives and give them the tools and resources they need to successfully incorporate technology into their lesson plans. Lacko (2019) in cultural heritage objects in education by virtual and augmented reality reported of students increase in education attainment in vr/ar supported learning than those without vr/ar supported learning. Mundy et al. (2022) suggests a competitive gaming method for AR-based learning in real-world contexts, demonstrating improved learning attitudes and performance on field trips compared to conventional mobile learning in an elementary school ecology course. Koumpouros (2024) proposes an integrated adoption model for mobile AR in primary science teaching, involving 89 undergraduate pre-service teachers. It predicts 72% variance in teachers' intention to use AR, highlighting growing interest in AR in education. Cao and Yu (2023) posited that the COVID-19 pandemic has prompted students to use augmented reality for education, despite positive attitudes and higher learning achievements, but no significant difference in motivation levels. Pombo and Marques (2019) study reviewed 73 articles on AR applications in education, primarily targeting university students and physics classes. Most used marker detection technology. However, evaluations were subjective due to technical issues and equipment limitations that calls for further research in augmented reality. Mundy et al. (2022) explored the perspectives of innovative and first-adopter educators on augmented reality (AR) in education. Results show that downloadable AR apps are highly engaging, and some teachers create AR using various platforms.

Recent research has explored the impact of gender, age, type of schools, qualifications, and years of teaching experience on the use of mobile games and augmented reality in secondary schools. Results show mixed results, with some studies finding significant relationships and others finding no significant impact. Teachers with higher qualifications were found to be more likely to use educational games, while those with more years of experience showed higher levels of technology integration. Therefore, it is crucial for educators and policymakers to consider individual factors and provide appropriate support and training to all teachers, regardless of

their gender, age, school types, qualifications, or years of teaching experience. According to Özdemir's (2020) study, female teachers were shown to be more likely than male teachers to incorporate educational games into their lessons. According to a different Malaysian study, female teachers integrated technology into their lessons more frequently than their male counterparts (Azman, 2019). According to a Chinese study, younger teachers were shown to be more inclined than older teachers to include augmented reality into their lessons (Zhang, Li, & Wang, 2020). Özdemir (2020) conducted a study in Turkey that did not find any significant correlation between the age of teachers and their use of educational games in the classroom. Whereas Armingeon et al. (2019) found in selected interviews that digital immigrants (older ones) have better engagement with the augmented reality application of Augusta Raurica than digital natives (the younger ones) do. According to a Greek study (Gouli, Gogoulou, &Grigoriadou, 2020), instructors with higher qualifications were more likely than those with lower qualifications to incorporate educational games into their lessons. A different Turkish study discovered that the use of educational games in the classroom was not significantly impacted by the qualifications of the teachers (Özdemir, 2020). According to a Malaysian study, teachers with more years of experience integrated technology into their lessons to a greater extent than those with less experience (Azman, 2019). Özdemir (2020) did a study in Turkey which revealed no noteworthy correlation between the number of years of teaching experience and the utilization of educational games by teachers.

Studies indicate that the kind of school—public, private, or charter—can have an impact on how technology is adopted and incorporated into the classroom (Mustapha et al., 2020). Due to their higher financial means, private schools can have easier access to technology and be more willing to try out cutting-edge teaching strategies like augmented reality (AR) and mobile apps. However, public schools—especially those in underprivileged areas—may be unable to integrate these technologies into the curriculum due to infrastructure and financial limitations. Private school teachers equally have more access to professional development and support, technological gadgets which prone them to positive attitudes, less fearful, uncertain and doubtful about technology integration than the public teachers.

1.1 Statement of problem

Despite the increasing popularity of mobile games and augmented reality, little is known about their effects on secondary school students' learning outcomes in Oyo State. It is not clear whether these technologies are effective in improving students' knowledge and understanding, or whether they have any negative effects on students' learning. In addition, it is unclear whether these technologies are appropriate for use in Oyo State schools, given the differences in resources and infrastructure between urban and rural areas. This study aims to explore these issues and provide recommendations for the effective perceptions of mobile games and augmented reality in secondary schools in Oyo state, Nigeria.

1.2 Objectives of the study

The following are the objectives of the study, to:

1. investigate the perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology in Oyo state, Nigeria;
2. evaluate the awareness of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology in Oyo state, Nigeria;
3. assess the acceptance of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology in Oyo state, Nigeria;
4. identify the challenges and benefits associated with the implementation of this innovative approaches in a classroom setting.
5. provide recommendations for the integration of mobile game-based learning with augmented reality into mainstream educational practices.

2. Research Questions

The following questions were answered in the study:

1. What is the level of teachers' perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in Basic Science and Technology in Oyo state, Nigeria?
2. Are the secondary school teachers aware and accept the novel mobile games and augmented realities in Basic Science and Technology in Oyo state, Nigeria?
3. What are the perceived challenges in the acceptance and use of novel mobile games and augmented realities in Basic Science and Technology in Oyo state, Nigeria?

3. Hypotheses

Ho 1: There is no significant perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology in Oyo state, Nigeria;

Ho2: There is no significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on gender

Ho3: There is no significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on age;

Ho4: There is no significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on types of school;

Ho5: There is no significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on qualifications

Ho6: There is no significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on experience;

4. Methodology

The study adopted a mixed methods quantitative and qualitative approaches in a concurrent triangulation adopting a descriptive survey research design. This method is more suitable as both the qualitative and the quantitative data give complementary and more robust data for results discussion in the study. All the secondary school Basic Science and Technology teachers in Oyo state constitute the population for the study. The study adopted a cluster random sampling technique to select 300 secondary school teachers from the clusters of senatorial districts (Oyo central, Oyo south and Oyo North) and school types (public and private schools) in Oyo State, Nigeria. Two Basic Science and Technology teachers were randomly selected from twenty-five public and twenty-five

private secondary schools from each of the senatorial districts in the state to give a sample size of three hundred.

Two researchers' constructed instruments were used for data collection, a four Likert scale questionnaire titled: Perceived Effects of Mobile Game and Augmented Reality on Secondary school Students Learning Outcomes Questionnaire (PEMgArSLQ) and Perceived Effects of Mobile Game and Augmented Reality on Secondary school Students Learning Outcomes Interview (PEMgArSLI). PEMgArSLQ consist of Sections A and B, Section A has the socio-demographgic variables of the respondents like the gender, school types, years of teaching experience, academic qualification, Section Bhas30 items used to collect data from the teachers. PEMgArSLI has five interview questions. Both PEMgArSLQ and PEMgArSLI were given to experts in Test and Measurement for critique to enhance the face and construct validity of the tools. PEMgArSLQ was subjected to Cronbach's Alpha reliability having being trial-tested on 20 Basic Science Teachers in Osun state and yielded 0.81. PEMgArSLI was trial-tested on five of the respondents outside the population of the study, the coded data subjected to Fliess Kappa analysis yielded a value of 0.74.

The researchers sought the ethical approval of the research from the state Ministry of Education and the ethical consent of the participants. The questionnaire forms were administered to the teachers in person. The researchers explained the purpose of the study and obtained the consent of the participants before distributing the questionnaires. The participants were given ample time to complete the questionnaires and return them to the researchers. Fifteen of the respondents were randomly subjected to in-depth interview to collect the qualitative data. The data collected was analyzed using descriptive statistics of frequency counts, percentages, mean, and standard deviation. Thematic analysis was used to analyse the qualitative data to answer the research questions while the parametric, inferential statistics t-test and ANOVA were used to test the set hypotheses at 0.05 level of significance.

5. Results

Table 1: Socio-demographic distribution of the respondents

Variables	Frequency	Percentage (%)
Gender		
Male	38	13.9
Female	236	86.1
Total	274	100.0
Age		
20-29 Years	19	6.9
30-39 Years	43	15.7
40-49 Years	182	66.4
50 Years & Above	30	10.9
Total	274	100.0
School Type		
Public	182	66.4
Private	92	33.6
Total	274	100.0
Years of Teaching Experience		
1-9 Years	104	38.0
10-19 Years	111	40.5
20-29 Years	50	18.2
30yrs & above	9	3.3
Total	274	100.0
Academic Qualification		
First Degree	176	64.2
Second Degree	90	32.8
Ph.D	8	2.9
Total	274	100.0

Table 1 indicates that there are 104 (38.1%) male, 169 (61.9%) female, 3 (1.1%) 10-12 years, 164 (60.1%) 13-15 years, 106 (38.8%) 16 years and above respondents in the distribution. Also, there are 251 (91.9%) from intact homes, 22 (8.1%) from non-intact homes, 134 (49.1%) Christians, 138 (50.5%) Muslims and 1 (0.4%) other religion in the distribution. There are more female, 13-15 years, intact homes and Muslims in the respondents' distribution for the study.

6.Answer to Research Questions

Research Question One: What is the level of teachers' perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in Basic Science and Technology in Oyo state, Nigeria?

Table 2: level of teachers' perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in Basic Science and Technology

Items	Mean	Std. D
Mobile games and augmented really have a positive impact on students' engagement in Basic Science and Technology	3.8248	.38082
Mobile games and augmented reality are very effective in enhancing students' understanding of Basic Science and Technology concepts	3.6679	.47183
Mobile games and augmented reality help students to retain and recall Basic Science and Technology knowledge	3.7774	.41677
Incorporating mobile games and augumented reality into teaching Basic Science and Technology improve students' overall academic performance	3.6788	.49071
Mobile games and augmented reality help to make learning Basic Science and Technology more fun	3.8358	.37117

Mobile games and augmented reality help to increase students' motivation to learn Basic Science and Technology	3.9270	.29982
Mobile games and augmented reality help students to develop problem-solving skills in Basic Science and Technology	3.8905	.42243
Mobile games and augumented reality help students to develop critical thinking skills in Baisc Science and Technology	3.8832	.35427
Mobile games and augmented reality help students to develop collaboration and teamwork skills in Basic Science and Technology	3.8066	.40486
Mobile games and augmented reality provide opportunities for differentiated instruction in Basic Science and Technology	3.5547	.59201
Mobile games and augmented reality can be used to assess students' understanding of Basic Science and Technology	3.7883	.40925
Mobile games and augmented reality can be used to provide instant feedback to students in Basic and Technology	3.7701	.44686
Mobile games and augmented reality can be used to personalize learning in Basic Science and Technology	3.3212	.48319
Mobile games and augmented reality can be used to teach real-world applications of Basic Science and Technology	3.7737	.48407
Mobile games and augmented reality can be used to crate immersive learning experiences in Basic Science and Technology	3.4161	.53647
Mobile games and augmented reality can be used to teach complex concepts in Basic Science and Technology	3.7445	.43693
Mobile games and augmented reality can be used to teach Basic Science and Technology in a way that is accessible to all students	3.5328	.49983
Mobile games and augmented reality canbe used to teach Basic Science and Technology in a way that is culturally relevant to students	3.3832	.49452
Mobile games and augmented reality can be used to teach Basic Science and Technology in a way that is inclusive of student with diverse learning styles	3.4891	.51522
Mobile games and augmented reality can be used to teach Basic Science and Technology in a way that is inclusive of students with disabilities	3.5073	.54297
Mobile games and augmented reality can be used to teach Basic Science and Technology in a way that is engaging for all students	3.6642	.47312
Mobile games and augmented reality help students to develop the science method skills in Basic Science and technology	3.6204	.51542
Mobile games and augmented reality enhance students further studies in science and technology	3.5182	.64736
Teachers do not like the use of Mobile games and augmented reality in Basic Science and Technology	3.2226	.88830
Government do not provide resources for Mobile games and augmented reality in Basic Science and Technology	3.5511	.70004
Educational policy do not encourage the use of Mobile games and augmented reality in Basic Science and Technology	2.8759	1.00872
Students do not like the use of Mobile games and augmented reality in Basic Science and Technology	1.8978	.90408
Basic Science and Technology contents cannot support the use of Mobile games and augmentd reality	1.9781	.92951
The time allocation for Basic Science and Technology contents cannot support the use of Mobile games and augmented reality	3.1533	.91300
I do not have the skills and knowledge of using Mobile games and augmented reality in Basic Science and Technology	2.7591	1.14210
Valid N (listwise) Grand Mean= 3.46		

From Table 2, the level of teachers' perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in Basic Science and Technology in Oyo state, Nigeria was very high with a grand mean of 3.46. However, a converse result was obtained from the thematic analysis of the qualitative dats as presented in Table 3.

Table 3: Thematic Analysis of level of teachers' perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in Basic Science and Technology

Items/ Interviewees	perception of mobile games and augmented reality	mobile games and augmented reality impact	changes in the behavior and attitudes by mobile games and augmented reality	Challenges of using mobile games and augmented reality	Optimisingmobile games and augmented reality use
A	I don't use it	I don't know	I cannot say	I don't know	They should teach us.
B	It has no effects	Little or no impact	Little or no changes	Low awareness	More awareness
C	I don't know about it	Probably some impacts	I can't really say	No equipments	Government to provide the equipments
D	Very effective	I have used mobile game before	Mobile games helps students learning	Low availability of instructional mobile games	More instructional mobile games production
E	No effect	No impact	No changes	Poor technical knowledge and skills	It is not needed
F	I think it is useful	Many impacts	Many changes in knowledge and skills	Poor materials and games	Training and professional development
G	I don't see the usefulness	No impacts	It can't effect change in students behavior	No need of games and augmented realities	I don't know
H	We have not been using it	I cant say	I cant say	They should bring the materials	Government should provide the training
I	No need for games or augmented realities	No impact	It cant bring any changes	No need	No need
J	I think Basic science is ok without Games and augmented realities	No impact	No changes	No need	No need
K	Games and augmented reality can aid Basic Science	Has real, meaningful impacts	Yes, can change positively students learning	Low technological knowledge and skills	Teachers' professional development
L	I can't use it.	It may impact it	It may change students behavior	Low idea and skills of using it	Need for training and re-training

M	Students will love playing mobile games	It can help students learn better	Students are stuck with playing games	Many teachers do not understand how to use games.	Teachers traing on games and augmented reality
N	I don't think games can be used for Basic science	Little or no impact	Little or no effects on students behavior	No educational mobile games	Government to provide the mobile games
O	Mobile games and augmented reality cannot be used for basic science	No impact	No change in students' behaviour	Really, I don't know about mobile game and augmented reality in Basic science	Teach awareness of mobile games and augmented reality in Basic science

Table 3 reveals that majority of the secondary school teachers have a negative perception of mobile games and augmented reality as educational tools for Basic science in secondary school students. Majority of the respondents equally have negative thoughts of mobile games and augmented reality impact on the learning outcomes of Basic science and technology in secondary school. Majority of the respondents did not notice any significant changes in the behavior and attitudes of secondary school students towards Basic science and technology learning since the introduction of mobile games and augmented reality.

Research Question Two: Are the secondary school teachers aware and accept the novel mobile games and augmented realities in Basic Science and Technology in Oyo state, Nigeria?

From the thematic results in Table 3, Majority of the respondents have never accepted the novel mobile games and augmented realities in Basic Science and Technology in Oyo state, Nigeria, only a very few of the respondents had adequate perception of the novel mobile games and augmented realities in Basic Science and Technology in Oyo state, Nigeria.

Research Question Three: What are the perceived challenges in the acceptance and use of novel mobile games and augmented realities in Basic Science and Technology in Oyo state, Nigeria?

From Table 2, the respondents agreed those teachers' factors, governmental factors, educational policy, the time allocation for Basic science and technology can hamper the use of novel mobile games and augmented realities in Basic Science and Technology in Oyo state, Nigeria. The thematic results in Table 3 equally buttressed the fact that teachers" factors, inadequate infrastructure, technical know how, low awareness of the novel mobile games and augmented realities in Basic Science and Technology can mar its utilization in Oyo state, Nigeria.

7.Hypotheses Testing

Ho 1: "There is no significant perceived effect of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology in Oyo state, Nigeria"

Table 4: T-test Analysis ofperceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology

	N	Mean	Std. D	df	t	Sig.	Remark
Teachers_perception	274	103.8139	7.10659	273	102.05	.000	*S

From Table 4, there is a significant perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology in Oyo state, Nigeria (Mean=103.81, SD=7.11, df=273, t=102.05, p<.05). Therefore, Ho1 was not accepted

Ho2: "There is no significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on gender"

	Student Gender	N	Mean	Std. D	Df	t	Sig.	Remark
wealth_issue	Male	38	94.7632	6.73207	271	-9.830	.000	*S
	Female	236	105.2712	6.01298				

Table 5 indicates that there is a significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on gender (t=-9.830, df=271, p<.05). Therefore, Ho2 was not accepted.

Ho3:" There is no significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on age"

Table 6.0: Analysis of Variance ofdifference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on age.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2497.691	3	832.564	19.911	.000
Within Groups	11289.817	270	41.814		
Total	13787.507	273			

Table 6.0 Analysis of Variance shows that there is a significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on age (F(3,270)=19.91, p<.05). Therefore Ho3 was not accepted. To determine the direction of difference, a Bonferroniposthoc analysis was conducted and presented in Table 6.1

Table 6.1: BonferroniPosthoc Analysis ofdifference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on age.

(I) Teachers' Age	(J) Teachers'Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound

40-49years	29-29years	3.60526	1.55900	.129	-.5383	7.7488
	30-39years	8.33721*	1.09644	.000	5.4231	11.2514
	50 years & above	1.16667	1.27419	1.000	-2.2199	4.5532
*. The mean difference is significant at the 0.05 level.						

Table 6.1 reveals that the respondents with 40-49years had the highest perception score followed by the 50 years and above, followed by 29-29years while the teachers with 30-39years had the least perception mean score.

Ho4: "There is no significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on types of school"

Table 7: T-test Analysis of difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on types of school

	Types of School	N	Mean	Std. D	df	t	Sig.	Remark
wealth_issue	Public	182	102.9066	7.38799	272	-3.016	.003	*S
	Private	92	105.6087	6.16790				

From Table 7, the t-test analysis reveals that there is a significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on types of school (t=-3.016, p<.05) in favour of the private schools. Therefore Ho4 was not accepted.

Ho5: "There is no significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on qualifications"

Table 8.0: Analysis of Variance ofdifference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on qualifications

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	581.182	3	193.727	3.961	.009
Within Groups	13206.325	270	48.912		
Total	13787.507	273			

Table 8.0 Analysis of Variance indicates that there is a significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on qualifications. (F(3,270)=3.96, p<.05). Therefore Ho5 was not accepted. To determine the direction of difference, a Bonferroniposthoc analysis was conducted and presented in Table 8.1

Table 8.1: BonferroniPosthoc Analysisof difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on qualifications

(I) Academic Qualification	(J) Academic Qualification	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
First Degree	Second Degree	.30088	.88035	1.000	-1.8198	2.4216
	Ph.D	12.91477*	2.45585	.000	6.9988	18.8307
*. The mean difference is significant at the 0.05 level.						

Table 8.1 BonferroniPosthoc analysis reveals that the respondents with first degree had the highest perception score followed by the second degree while the teachers with PhD had the least perception mean score.

Ho6: "There is no significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on experience"

Table 9.0: Analysis of Variance ofdifference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on experience

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1280.422	2	640.211	13.872	.000
Within Groups	12507.085	271	46.152		
Total	13787.507	273			

From Table 9.0, Analysis of Variance indicates that there is a significant difference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on experience (F(2,271)=13.87, p<.05). Therefore Ho6 was not accepted. To determine the direction of difference, a Bonferroniposthoc analysis was conducted and presented in Table 9.1

Table 9.1: BonferroniPosthoc Analysis ofdifference in perceived effects of mobile games and augmented reality on secondary school students' learning outcomes in basic science and technology based on experience

(I) Years of Teaching Experience	**(J) Years of Teaching Experience**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
1-9yrs	10-19yrs	1.38496	.95444	.888	-1.1518	3.9217
	20-29yrs	1.78154	1.20356	.840	-1.4173	4.9804
	30yrs & above	7.96154*	2.43002	.007	1.5029	14.4201
*. The mean difference is significant at the 0.05 level.						

Table 9.1 BonferroniPosthoc analysis reveals that the respondents with 1-9 years had the highest perception score followed by those with 10-19 years followed by those with 20-29 years while the teachers with 30 years and above had the least perception mean score.

7.Discussion

From he answered research questions, it was identified that many of the respondents have high perception of effects of mobile games and augmented reality on secondary school students' learning outcomes in Basic Science in Oyo state, Nigeria. This quantitative result contrasted the qualitative thematic analysis result that very many of the respondents were not familiar with the novel instructional pedagogy (mobile games and augmented reality). The reason for these thematic results might be the overzealousness on the parts of the teacher to have the perfect mastery of the regular didactic, conventional instructional pattern. This result find supports in Pombo and Marques (2019) study evaluations on mobile games and augmented realitywere subjective due to technical issues and equipment limitations that calls for further research in augmented reality. Also, from the answered research questions, it was identified that the Governmental policies, school infrastructures availability, technical skills low awareness and most especially the teachers' perceptions can make or mar the effects of mobile games and augmented reality on students' learning outcomes in secondary schools in Oyo state, Nigeria. These findings supported by Nikou (2023) that teachers' perception is a strong factor of mobile games and augmented reality effects on students' learning outcomes.

From the tested hypotheses, it was revealed that the respondents have a significant perceived effect of mobile games and augmented reality in Basic Science in Oyo state, Nigeria. Invariably, with high perception mobile games and augmented reality in the subject, the use of the technological pedagogy ought to have been an ubiquitous in the state. However, the qualitative thematic analysis revealed otherwise. This finding is supported by Nikou (2024), Hwang et al. (2015), Cao and Yu (2023) that teachers have significant perception of mobile games and augmented reality in teaching and learning. The significant perceived effects of mobile games and augmented reality on Basic Science was significantly influenced by the teachers' gender, age, years of teaching experience and academic qualification. These findings were in tandem with the results of Özdemir (2020), Azman (2019), Zhang, Li, and Wang (2020), Gouli, Gogoulou, and Grigoriadou (2020) that teachers" socio-demographic variables can make or mar their perceptions of mobile games and augmented reality in teaching and learning. Furthermore, the teachers' significant perceived effect of mobile games and augmented reality in Basic Science in Oyo state, Nigeria was influenced by the types of school. Whether the teachers are the private or public schools types have significant effects on their perceptions of impacts of mobile games and augmented reality in Basic Science. Their perception of effects of mobile games and augmented reality on secondary school students' learning outcomes in Basic Science was beclouded by the school types. This result find support in Mustapha et al. (2020) that public, private, or charter—can have an impact on how technology is adopted and incorporated into the classroom.

8.Conclusion

From the findings of the study, the following are concluded:

1. Many Basic Science teachers are not fully aware and have not accepted the use of mobile games and augmented reality in the subject;
2. The teachers have a significant perception of mobile games and augmented reality in Basic Science teaching and learning.
3. The teachers' significant perceived impacts of mobile games and augmented reality in Basic Science was not beclouded by school types;
4. The teachers' significant perceived impacts of mobile games and augmented reality in Basic Science was significantly influenced by the teachers' gender, age, yearsof teaching experience and academic qualifications.

9. Recommendations

From the findings of the study and the conclusion reached in the research, the following are recommended:

i. Government should empower and enforce the Information and Communication Technology (ICT) policies and programmes in secondary schools, this will engender adequate awareness and acceptance of ICTs including mobile games and augmented reality in Basic Science education.,

ii. Government should refurbish the secondary schools with ICT infrastructural facilities that will engender the use of mobile games and augmented reality in teaching and learning.,

iii. Government and Ministry of Education should arrange more Teachers Professional Development Programmes (TPDP) on ICT utilization in science education which will prioritise the use of mobile games and augmented reality in schools.

iv. Special training should be organized for the older and more academically qualified teachers that are not of the Netizen generation inorder to have better perception of mobile games and augmented reality in Basic Science.

References

Akram, H., Abdelrady, A. H., Al-Adwan A. S. &Ramzan, M. (2022) Teachers' Perceptions of Technology Integration in Teaching-Learning Practices: A Systematic Review. *Front. Psychol.* 13:920317. doi: 10.3389/fpsyg.2022.920317

Armingeon, M., Komani, P., Zanwar, T., Korkut, S. &Dornberger, R. (2019). A case study: assessing effectiveness of the augmented reality application in Augusta Raurica. In M. C. tomDieck and T. Jung (Eds) Augmented reality and virtual reality the power of ar and vr for business, (pp. 99-110).Switzerland: Springer. https://doi.org/10.1007/978-3-030- 06246-0_13

Azman, H. (2019). Teachers' level of technology integration in secondary schools in Malaysia. *Malaysian Journal of Learning and Instruction*, 16(2), 99-125.

Bandura, A. (2016). *Social cognitive theory of mass communication.* In J. Bryant & M. B. Oliver (Eds.), Media effects: Advances in theory and research (3rd ed., pp. 94-124). New York: Routledge.

Cao, W. & Yu, Z. (2023).The impact of augmented reality on student attitudes, motivation, and learning achievements—a meta-analysis (2016–2023).*Humanity aand Social Science Communications*,2534https://doi.org/10.1057/s41599023018522https://doi.org/10.1057/s 41599-023-01852-2https://doi.org/10.1057/s41599-023-01852-2

Gouli, E., Gogoulou, A., &Grigoriadou, M. (2020). The use of digital games in primary education: Teachers' attitudes and practices. *International Journal of Educational Research*, 99, 101501.

Hwang, G., Wu, P., Chen, C. &Tu, N. (2015): Effects of an augmented reality-based educational game on students' learning achievements and attitudes in real-world observations, *Interactive Learning Environments*, DOI: 10.1080/10494820.2015.1057747

Jonassen, D. H., & Land, S. M. (2012). Theoretical foundations of learning environments (2nd ed.). New York: Routledge.

Koumpouros, Y. (2024). Revealing the true potential and prospects of augmented reality in education.Koumpouros *Smart Learning Environments11:2*https://doi.org/10.1186/s40561- 023-00288-0

Lacko, J. (2019). Cultural heritage objects in education by virtual and augmented reality. In M. C. tom Dieck and T. Jung (Eds). Augmented reality and virtual reality the power of ar and vr for business, (pp. 99-110). Switzerland: Springer.https://doi.org/10.1007/978-3- 030-06246-0_13

Liu, L., & Horton, J. (2019). The effect of game-based mobile learning on students' motivation and physics achievement. *Journal of Educational Technology Development and Exchange*, 12(1), 1-14.

Martín-Gutiérrez, J., Mora-Cantallops, M., &Raso-Sánchez, F. (2017). Augmented reality to promote biological science learning: A systematic review. *Journal of Educational Technology & Society*, 20(3), 110-122.

mobile augmented reality in primary science teaching. *Education and Information Technologieshttps://doi.org/10.1007/s10639-024-12481-w*
Mundy, M., Hernandez, J. & Green, M. (2022). Perceptions of the effects of augmented reality in the classroom. *Journal of Instructional Pedagogies*,115https://doi.org/10.1057/s41599- 023-01852-2
Mustapha, A., Mohammed, A., Egigogo, A. R., Kutiriko, A. A.&Dokoro, A. H. (2020). Factors Affecting the Utilization and Adoption of Technology in Education. https://www.intechopen.com/chapters/66544
Nikou, S. A. (2023) Factors influencing student teachers' intention to use
Owusu-Darko, I. (2023).The perception of teachers on integration of information and communication technology (ICT) Into mathematics teaching and learning. *European Journal Of Education And Pedagogy*, 4(3), 65-77
Özdemir, S. (2020). Teachers' views on the use of educational games in teaching. *Turkish Online Journal of Distance Education,* 21(4), 49-61.
Pombo, L. & Marques, M. M. (2019). Improving students' learning with a mobile augmented reality approach – The edupark game. https://www.researchgate.net/publication/335515045
Resendez, A. L. (2019). "*Teachers' perceptions and practices on using educational technology as an instructional tool in the classroom*". Theses and Dissertations. 570. https://scholarworks.utrgv.edu/etd/570
Sari, M., &Kocakoyun, S. (2018). The effect of mobile learning through game-based activities on student motivation and engagement. Journal of Educational Technology & Society, 21(4), 1-12.
Sari, M., &Kocakoyun, S. (2018). The effect of mobile learning through game-based activities on student motivation and engagement. Journal of Educational Technology & Society, 21(4), 1-12.
Sweller, J. (2019). Cognitive load theory and educational technology. Educational Technology Research and Development, 67(3), 551-559.
Veridiano, M. A. C &Brondo, J, M. (2023).Perceived technology integration of Filipino teachers teaching in the U.S.A. *World Journal Of Advanced Research and Reviews* 17(3),471-479
Wang, Y., Chen, N. S., & Liang, T. H. (2021). Effects of mobile game-based learning on science education: A meta-analysis. Journal of Educational Technology & Society, 24(1), 1-14.
Xu, L., Yang, Y., & Chen, Y. (2019). The effect of augmented reality on physics learning: A systematic review. Educational Research Review, 28, 100291.
Zhang, X., Li, H., & Wang, X. (2020). Teachers' views and practices on the use of augmented reality in education: A survey in China. Educational Technology Research and Development, 68(6), 2741-2762.