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The Impact of Augmented Reality Technology on Students' Motivation to Learn English

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Abstract: Research into the application of augmented reality in education remains in its preliminary stages, with a notable dearth of studies exploring the impact and consequences of augmented reality within educational settings. This study aimed to evaluate and gain insight into how an augmented reality mobile application influenced the motivation of junior high school students studying English. Intrinsic motivation theory served as the framework for understanding motivation in a learning context. The study employed the Attention, Relevance, Confidence, and Satisfaction (ARCS) model to elucidate the influence of augmented reality on student motivation. The research instrument utilized was a 34-item questionnaire centered around English learning motivation, based on the Instructional Materials Motivation Survey. A cohort of 200 participants engaged with the augmented reality mobile applications and completed both pre and post-tests. The findings indicated a significant enhancement in students' motivation to learn when utilizing the augmented reality mobile application. Motivational elements, including attention, relevance, confidence, and satisfaction, witnessed marked improvements.

Keywords: Augmented Reality, Motivation, Learn English

1. Introduction

Motivation holds significant sway over the results achieved in language learning. It impacts learners' involvement, determination, and their readiness to dedicate energy to acquiring language skills. Researchers have identified various motivational factors contributing to successful language learning, such as intrinsic, extrinsic, goal orientation, and self-efficacy.

In recent times, the progress of science and technology has exerted a wide-ranging and profound influence on the field of education [1,2]. Augmented Reality technology has been suggested as a tool that can enhance these motivational factors in language learning environments. With the rapid popularization and application of information technology, students' ability to acquire and process information has been greatly enhanced. Hence, it becomes of utmost significance to examine the influence of science and technology on students' intrinsic motivation to acquire knowledge.

Augmented Reality (AR) has the capability to introduce virtual elements into real-world settings, promoting real-time interaction [2,3]. Despite this potential, research regarding the integration of AR in education is still at an early stage, with a noticeable lack of studies delving into its role and impact on educational practices. This research is dedicated to investigating how AR influences students'

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motivation to learn English, examining the role of technology in English language acquisition, and its potential to ignite intrinsic motivation and a keen interest in learning English. To assess this, the study gauges the motivation levels of 200 students before and after using a specific AR mobile application. The primary research question revolves around the disparities in student motivation before and after AR mobile app usage. Subsidiary questions delve into how AR mobile apps influence motivation in terms of attention, relevance, consistency, and satisfaction. Data will be collected and analyzed through a questionnaire. This paper is structured as follows: firstly, it introduces the conceptual framework and the theoretical model underpinning the use of AR in education. Next, it elaborates on the research methodology, followed by the presentation and analysis of the data. Finally, it concludes by summarizing the implications, discussing potential applications, acknowledging limitations, and suggesting avenues for future research.

2. Literature Review

2.1. AR

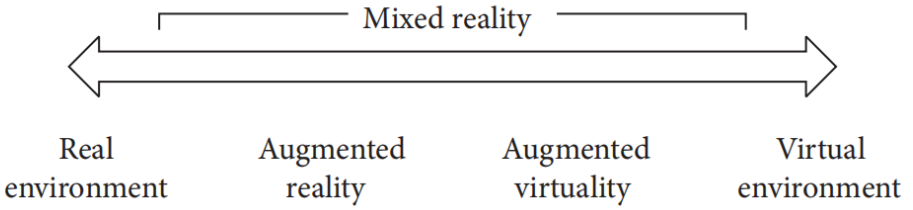

Figure 1: Milgram's mixed reality continuum [1].

AR merges the tangible and computer-generated aspects, where digitally created virtual entities supplement the physical world [2,3]. AR is characterized by three fundamental requisites: the amalgamation of genuine and virtual elements within a real setting, the fusion of genuine and virtual elements with one another, and real-time interaction within a virtual environment [3-7]. Figure 1 illustrates Milgram's spectrum of mixed reality, which categorizes the modes of integrating actual and virtual components [6]. Referring to this spectrum, mixed reality pertains to scenarios involving the integration of tangible and digital entities [6,8]. Positioned nearer to the authentic environment end of the spectrum, AR, as depicted in the figure, can be perceived as a mixed reality technology that emphasizes heightened realism. This technology introduces virtual elements into the user's actual surroundings, allowing for interactive engagement with virtual content [6,8].

2.2. The Intrinsic Motivation Theory

The concept of learning motivation can be elucidated through intrinsic motivation theory [9]. In addition to challenge, curiosity, control, and fantasy, there are several factors that contribute to intrinsic motivation. A positive attitude and a strong sense of willpower are essential for maintaining motivation for learning [9]. Students can benefit from intrinsic motivation if they are not subject to external pressure or are not expected to receive external rewards [9]. Engagement is shaped by a yearning for enjoyment and a sense of challenge.

Importantly, academic endeavors possess distinctive qualities [9]. Research has indicated that AR consistently exerts positive effects on student motivation [8,10,11]. Some studies even demonstrate AR's capacity to boost students' motivation in the realm of science education [8]. AR technology encompasses various elements of fascination, imagination, and autonomy, which could potentially

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contribute to heightened student motivation [1]. It stands to reason that students' motivation can be significantly impacted by engaging and stimulating educational mediums and materials [9].

2.3. Application of AR in English

In the realm of English language learning, AR applications have the capacity to offer visual, auditory, and kinesthetic stimuli, effectively engaging learners and bolstering their motivation. Multiple investigations have delved into the utilization of AR across diverse language learning scenarios, encompassing vocabulary acquisition, grammar instruction, and oral communication practice.

Technology assumes a pivotal role in the sphere of technology-enhanced learning (TEL), significantly impacting the processes of learning and teaching. Its potential resides in the capacity to amplify the effectiveness and efficiency of learning [12]. According to Ahmadi and Reza, technology serves as a facilitator in enhancing students' cognitive abilities and streamlining learning through improved professor-student interactions [13]. Within the classroom setting, AR technology unfolds numerous advantages. It actively engages students by immersing them in distinctive learning environments. As evidenced, augmented reality stands poised to elevate learning effectiveness, facilitating the grasp of spatial concepts through direct interaction with stereoscopic virtual imagery and enhancing learning interactivity.

The contextual learning theory places an emphasis on how interaction and successful involvement in the learning process tie information to the learning context and help students understand what knowledge really means [14]. Learning environments that are contextually tailored have the potential to enhance students' understanding and cultivate strong teacher-student relationships [15]. According to the self-determination theory (SDT), motivation must be the driving force behind learning. Depending on how much their wants are met, people will alter their behavior [16]. According to Ogawa and Walker et al., augmented reality and associated apps are thought to increase students' enthusiasm to study. Moreover, prior investigations have explored the application of AR in educational contexts from the perspective of Flow Theory [17]. These studies have revealed that students exhibit heightened attentiveness when involved in meaningful activities, thereby elevating their motivation.

Chang utilized AR technology in creating the AR Flora system, designed to facilitate classroom observation of plant growth changes [18]. Chen conducted a study involving an augmented-reality-based concept map to support mobile science learning. An empirical investigation was carried out on 71 fifth-grade students in Southern Taiwan. Chen merged the unique aspects of high interactivity, immersion, and authenticity inherent in augmented reality with the game-based learning model, with the aim of attracting more developers to invest in creating augmented reality applications for game-based learning [19,20]. Cen introduced an award-winning educational mobile system based on AIR technology, codenamed AIR-EDUTECH, tailored to aid high school students in learning chemistry. Wang's research was conducted at a vocational college in China, where in-depth interviews were employed for data collection [21]. Marrahí-Gómez sought to analyze and review recent trends in AR implementation within English as a Foreign Language Classrooms (EFL) and present key projects focused on English instruction through AR-based initiatives published in WOS and Scopus in recent years. While many studies have shown that augmented AR technology is beneficial in enhancing students' motivation to learn, there has been little research on how AR technology increases students' motivation to learn English [22].

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2.4. ARCS MODEL

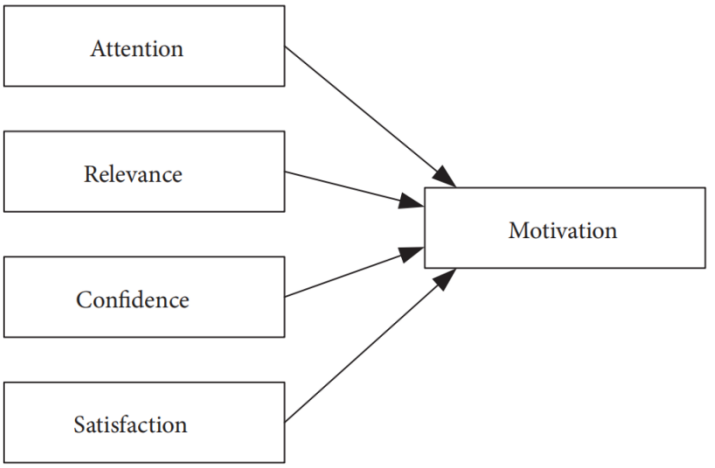

Figure 2: ARCS MODEL [23].

The Attention, Relevance, Confidence, Satisfaction (ARCS) framework was utilized. In order to grasp the impact of AR on student motivation in learning, the author applied the ARCS model of motivational design, as illustrated in Figure 2 [11,23]. Following the ARCS model, the design of AR technology should captivate students' interest, familiarize them with the technology, and leave them content after its use [23].

Considering the insights gained from the above analysis, additional research inquiries were formulated to elucidate how the utilization of AR mobile applications might influence various facets of students' motivation in learning English. The research questions are: 1. Does AR technology affect student's motivation of learning English? 2. Does students' use of AR mobile apps affect English language proficiency in the attention aspect of motivation to learn?3. How does the utilization of AR mobile apps by students affect the relevance aspect of their motivation to learn the English language? 4. How does the utilization of AR mobile apps by students influence the self-confidence aspect of their motivation to learn English? 5. Is there an influence on students' satisfaction regarding their motivation to learn English through the use of AR mobile applications?

3. Methodology

3.1. Experiment Design

The Instructional Materials Motivation Survey (IMMS) was crafted based on the ARCS methodology to evaluate student motivation in learning [11]. The IMMS serves as a tool for pre- and post-assessment, measuring motivational needs and responses, particularly in response to emerging technologies like augmented reality.

This study focuses on 200 junior school students in Hong Kong who are novices to AR technology and have not encountered or utilized any AR mobile applications prior to this research. Throughout this investigation, students will engage with software developed by Joy Aether, aimed at instructing them in AR and facilitating their use of AR to acquire additional knowledge. After one week of learning, they learned to use AR mobile apps and could apply them to English learning, and completed pre-usage and post-usage questionnaires.

In order to gather data for this study, a pre- and post-usage questionnaire was employed as the tool. Based on the previously employed IMMS for the study's design, the questionnaire was a Likert

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subscale. The IMMS was used since it had been used successfully in earlier research to ascertain how AR technology affected student motivation. The pre-usage and post-usage surveys' mean values for each ARCS component were computed using Excel. While the post-usage mean and overall mean for each ARCS component exhibited changes, it was crucial to determine the significance of these mean changes. To assess significance, a statistical analysis was conducted using SPSS. With a significance threshold set at 0.05, p-values less than 0.05 were regarded as significant, whereas p-values exceeding 0.05 were categorized as non-significant.

3.2. AR Mobile Application

Augmented Reality, often abbreviated as AR, entails the fusion of digital data or virtual entities with the physical world, resulting in an interactive and immersive educational encounter. Within the realm of English language acquisition, AR applications offer a multifaceted learning experience, stimulating learners through visual, auditory, and kinesthetic elements, thus amplifying their motivation. Numerous research endeavors have scrutinized the incorporation of AR across diverse language learning scenarios, encompassing vocabulary enrichment, grammar tutorials, and practice in oral communication.

In prior investigations, the AR educational instruments utilized were tailor-made for the respective courses [4,10,11]. In this experiment, the StoryTell AR mobile application was used to allow students to conduct a seven-day AR technology learning, through the application of AR in books and 3D stereo modeling and block programming to present a stereo model of the content of the English learning materials and can add pictures, audio, video, etc. in the presentation of the English textbooks to assist in the learning of English.

DIY-AR Seamlessly Connecting Digital Content and the Physical World for Customized Virtual Reality Applications and Games.

This study aims to enhance students' understanding of and enthusiasm for English language learning, to utilize students' understanding of and enthusiasm for cutting-edge technology, to teach students the ability to self-teach and create virtual reality apps and games, and to inspire students to develop connectivity linking AR technology to English language learning.

4. Data Result and Analysis

4.1. Data Result

Table1: Mean, Standard Deviation, Maximum, Minimum of ARCS Factors.

variable	$\bar{x}$		SD		Max.		Min	
	Before	After	Before	After	Before	After	Before	After
Satisfaction	24.535	39.827	8.796	11.134	35	35	7	8
Confidence	20.079	39.777	7.653	6.986	23	25	14	13
relevance	14.297	22.629	5.963	4.45	46	46	13	17
attention	14.396	28.441	5.538	5.41	43	40	27	27

Table 1 displays the results of the categorical aggregation of summary variables: satisfaction, confidence, relevance, and attention. This table allows for the calculation of statistics like sample size, maximum and minimum values, etc., which are used to examine the overall situation of the quantitative data after grouping. From the table data, it's evident that the mean values of the four dimensions - Satisfaction, Confidence, Relevance, and Attention - underwent significant changes before and after the test. However, the standard deviation exhibited less variation. A smaller standard

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deviation signifies a highly concentrated and less scattered distribution, with the mean being more representative of the whole.

Table 2: Reliability

Cronbach's alpha coefficient	Standardized Cronbach's alpha coefficient	Content	N
0.727	0.858	34	404

When analyzing Cronbach's alpha coefficient (or reliability coefficient), there isn't a universally accepted standard. However, most scholars generally interpret it as follows: a coefficient above 0.9 indicates excellent reliability, between 0.8-0.9 suggests good reliability, between 0.7-0.8 implies acceptable reliability, between 0.6-0.7 indicates moderate reliability, and between 0.5-0.6 signifies less-than-ideal reliability. If the coefficient falls below 0.5, reconsideration of the questionnaire's structure is recommended. Further examination of the item-total statistics table can help identify specific items that contribute to reduced overall reliability. For example, if the "Corrected item-total correlation" value is lower than 0.3 or if the "Alpha coefficient after deleting the item" is significantly higher than the overall alpha coefficient, it might be prudent to consider eliminating that item.

The Cronbach's alpha coefficient for this model was calculated at 0.727 (see Table 2), indicating that the questionnaire's reliability is deemed acceptable.

Table 3: Difference test and Chi-Square test.

	Test (standard deviation)		F	P
	After	Before		
attention	11.134	10.796	0.541	0.587
relevance	6.986	7.653	0.003	0.960
Confidence	5.45	5.963	0.781	0.434
Satisfaction	5.41	5.538	0.642	0.423
Note: ***, **, * represent 1%, 5%, and 10% significance levels, respectively.				

Table 3 presents the results of the chi-square variance analysis, encompassing standard deviation, F-test outcomes, and significance represented by p-values.

1. The author examines whether the p-value for each analytical term is significant ($p<0.05$).

2. If the p-value is significant and leads to the rejection of the original hypothesis (original hypothesis: variance follows chi-square distribution), it indicates inconsistent data fluctuations, meaning the variance does not follow a chi-square distribution. Conversely, if the p-value is not significant, it suggests consistent data fluctuations, indicating that the data indeed follow a chi-square distribution.

The results of the variance alignment analysis indicate the following:

For Attention, the significance p-value is 0.587, which lacks significance and does not warrant the rejection of the original hypothesis. Therefore, the data align with the chi-square variance.

For Relevance, the significance p-value is 0.960, indicating no significance at a level that would justify rejecting the original hypothesis. Thus, the data align with the chi-square variance.

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For Confidence, the significance p-value is 0.434, showing no significance and no reason to reject the original hypothesis. Hence, the data align with the chi-square variance.

For Satisfaction, the significance p-value is 0.423, lacking significance to reject the original hypothesis. Consequently, the data align with the chi-square variance

Table 4: Independent t-test

variable name	variable value	sample size	average value	(statistics) standard deviation	T-test	Welch's T-test	Mean difference	Cohen's d-value
attention	after use	202	39.827	11.134	T=15.317 P=0.000***	T=15.317 P=0.000***	15.292	1.524
	pre-use	202	24.535	8.796				
	(grand) total	404	32.181	12.611				
relevance	after use	202	39.777	6.986	T=27.018 P=0.000***	T=27.018 P=0.000***	19.698	2.688
	pre-use	202	20.079	7.653				
	(grand) total	404	29.928	12.28				
Confidence	after use	202	22.629	4.45	T=15.914 P=0.000***	T=15.914 P=0.000***	8.332	1.583
	pre-use	202	14.297	5.963				
	(grand) total	404	18.463	6.709				
Satisfaction	after use	202	28.441	5.41	T=25.782 P=0.000***	T=25.782 P=0.000***	14.045	2.565
	pre-use	202	14.396	5.538				
	(grand) total	404	21.418	8.907				
Note: ***, **, * represent 1%, 5%, and 10% significance levels, respectively.								

Table 4 displays the outcomes of the independent samples t-test, encompassing mean ± standard deviation, t-test results, significance represented by p-values, and Cohen's d-value for effect size.

1. The author assesses whether the p-value for each analytical term is significant ($p<0.05$).

2. If a term is deemed significant, it leads to the rejection of the original hypothesis, signifying a noteworthy difference between the two datasets. This difference can then be analyzed based on mean ± standard deviation. Conversely, if the p-value is not significant, it indicates a lack of variability in the data.

4.2. Data Analysis

This study conducts descriptive statistics for the dimensions, to confirm that there is no abnormal answer situation for the questions within the ARCS dimension pre-usage and post-usage test, to confirm that the questions are reasonable. Table 2 shows the Cronbach's alpha to confirm that the questionnaire reliability is qualified. This is consistent with previous studies [1,6,10,11]. Thus the pre-usage and post-usage questionnaires are valid for measuring whether students' motivation to learn English was affected by AR. Then this study conducted an exploratory analysis to confirm that the

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questions were in line with the dimensions, then this study conducted a variance chi-square test to determine whether the data fluctuations are consistent across different groups, and Table 3 shows that. In conclusion, this study employed an independent t-test to confirm differences before and after utilizing AR technology, supporting the proposed theory. As depicted in Table 4, the disparity between pre- and post-tests is notably substantial. This suggests a significant boost in students' English learning motivation after engaging with AR technology. Specifically, the mean values for attention before and after use were 24.535 and 39.827, respectively. Since the variance chi-square assumption was not met, Welch's T-test was employed, yielding a highly significant result with a P-value of 0.000***. This statistical significance underscores a substantial difference in attention before and after use, with a substantial effect size indicated by Cohen's d-value of 1.524 (considered very large).

Similarly, the mean values for relevance before and after use were 20.079 and 39.777, respectively. The independent samples t-test, satisfying variance chi-square, yielded a highly significant result with a P-value of 0.000***. This underscores a substantial difference in relevance before and after use, with a very large effect size denoted by Cohen's d-value of 2.688. Moving on to confidence, the mean values after and before use were 22.629 and 14.297, respectively. Again, as variance chi-square was not met, Welch's T-test was utilized, resulting in a highly significant P-value of 0.000***. This emphasizes a substantial difference in confidence before and after use, with a very large effect size indicated by Cohen's d-value of 1.583. Lastly, in terms of satisfaction, the mean values after and before use were 28.441 and 14.396, respectively. Satisfying the variance chi-square condition, an independent samples t-test was employed, leading to a highly significant P-value of 0.000***. This highlights a substantial difference in satisfaction before and after use, supported by a very large effect size denoted by Cohen's d-value of 2.565.

In summary, post-test mean values for attention, relevance, confidence, and satisfaction significantly exceeded those of the pre-test. AR technology positively influenced students' motivation in learning English by increasing their attention, relevance, confidence, and satisfaction.

According to the result, this study found that after learning AR technology, the student’s motivation of learning English was increased. After learning AR technology, the student’s attention of learning English motivation was increased. After learning AR technology, the student’s relevance of learning English motivation was increased. After learning AR technology, the student’s confidence of learning English motivation was increased. After learning AR technology, the student’s satisfaction of learning English motivation was increased.

5. Discussion and Implementations

The immersion and engagement elements provided by AR may motivate students to study more, say Di Serio et al, Gopalan et al, and Wei et al. [5,8,24]. The information gathered suggested that using AR had a positive impact on the target participants' intrinsic drive to learn. With the right technological assistance, students may use AR technology to understand the subject matter more intuitively and clearly, giving them the opportunity to engage with the subject matter more deeply and become motivated.

5.1. Attention

The attention factor served as a gauge for evaluating students' focus on both the pre-learning material, namely anatomy notes, and the post-learning material, the AR mobile application. The observed surge in attention can be attributed to the AR mobile application, which triggered heightened perceptual arousal, resulting in an increase in students' attentiveness [23]. This substantial uptick in attention is highly favorable, given that attention is of paramount importance, particularly in motivating young

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learners [23]. However, it's worth noting that while the utilization of AR technology didn't yield the most substantial enhancement in English learning attention, it still ranked as the second most influential factor. This is chiefly because AR fosters greater interaction between students and their educational content and environment. In an educational context, AR has the potential to transform learning into a gamified experience, incorporating visual instructional materials and integrating game-like elements to captivate students' focus. Consequently, it enriches the sensory dimension of learning, making it considerably easier for students to enhance their attention.

5.2. Relevance

The traditional books used as pre-learning material and the AR mobile application utilized as post-learning material were both evaluated using the relevance factor [11]. By employing terminology and situations that the students are acquainted with, relevance may be built [25]. The study indicated the greatest increase in relevance, which may be due to this application makes students feel more connected to reality, as they must create on already existing materials and then add text, audio, video, pictures, matching, listing, and other features to the learning materials, so students are more connected to actual learning interests.

5.3. Confidence

The element of self-assurance was employed to gauge the students' confidence levels concerning both the preliminary learning materials, the anatomy notes, and the subsequent learning materials [11]. Notably, the research unveiled that the rate of confidence growth was relatively modest. This could be attributed to the relatively short duration of the AR course. The students had only been exposed to the AR program for one week, which limited their proficiency in using AR technology for English language learning and materials. Consequently, students would likely require an extended period to effectively integrate AR technology with their English learning materials.

5.4. Satisfaction

The contentment factor played a pivotal role in evaluating student satisfaction following the utilization of the pre-learning materials and the post-learning AR mobile application [11]. The higher mean satisfaction score indicated that students derived greater happiness from using the AR mobile application compared to conventional English learning materials. Satisfaction here encompasses a sense of achievement, approval, or even enjoyment [25]. The rise in satisfaction levels suggests that students found the AR mobile application engaging and entertaining [25]. Furthermore, students' satisfaction with the acquisition of AR technology knowledge also notably increased. They expressed that their regular learning methods and materials seemed inadequate for comprehending English materials effectively. In contrast, AR technology appeared to provide a superior means of grasping English content and afforded them greater flexibility in designing their English learning strategies.

5.5. Summary

The studies reviewed consistently indicate that integrating AR technology into English language learning can positively impact students' motivation. Firstly, the visual and interactive nature of AR applications captures learners' attention and stimulates their curiosity, leading to increased engagement and motivation. Learners perceive AR as a novel and exciting tool, which enhances their intrinsic motivation to explore and interact with English language content.

Secondly, AR technology provides immediate and personalized feedback, which is known to enhance learners' self-efficacy and goal orientation. Learners can receive instant corrections and

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guidance within the AR environment, allowing them to monitor and adjust their language learning progress. This timely feedback fosters a sense of competence and mastery, contributing to increased motivation and persistence in English language learning.

Furthermore, AR applications offer opportunities for collaborative learning and social interaction. Learners can engage in language activities with their peers through AR experiences, fostering a sense of community and support. The social aspect of AR enhances learners' extrinsic motivation and creates a positive learning environment.

6. Conclusion

The objective of this study was to assess the influence of mobile augmented reality applications on students' English learning motivation. As highlighted by the Research Bureau, there exists a demand for additional investigations into the educational implications of AR usage, specifically in its capacity to bolster student motivation and enhance academic performance. This study spoke about how to use AR and how it can be done quickly with mobile devices. According to the research, AR technology has a good influence on students' motivation to study English. It promotes a more immersive and pleasurable language learning experience by increasing learners' engagement, self-efficacy, and sense of community.

Nonetheless, more extensive research is warranted to delve into the enduring impacts of AR on language proficiency and to confront the obstacles linked to its deployment. On the whole, the incorporation of AR technology presents considerable promise in reshaping the landscape of English language acquisition and instruction.

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