Investigating the Psychological Influence of an Augmented Reality Application on E-Learning amid the COVID-19 Pandemic: An Examination of College Students in Asia

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Abstract

The COVID-19 epidemic has significantly changed the educational landscape, prompting the development of online learning strategies to maintain education. Augmented reality (AR) apps have become a well-liked tool as educational institutions look for efficient solutions. This study looks into how an AR app affects college students' propensity to use digital resources during the epidemic. A conceptual model was created to investigate the attitudes and intentions of 135 Filipino college students concerning the usage of augmented reality (AR) applications for e-learning, drawing on the planned behavior theory. It was decided to use structural equation modeling to examine the student data. The results show that although subjective standards have no effect on students' adoption of AR applications for e-learning, attitudes and a feeling of control over their behaviors do. This shows that students' individual views and sense of control over their learning are more important in influencing their behavior while utilizing augmented reality (AR) applications. This research demonstrates that, in response to the obstacles given by the epidemic, pupils are accepting of novel instructional techniques, such as AR apps. By delivering an immersive and engaging experience that improves learning outcomes, augmented reality (AR) applications provide a possible answer to the challenges encountered in online learning. The results of this study have relevance for educational organizations and policymakers in developing and putting into practice efficient e-learning methods both during and after the epidemic. Institutions may improve student engagement, motivation, and overall learning experiences by incorporating augmented reality (AR) applications into online learning systems. Future studies may look at the unique features of AR apps that make them useful for e-learning and the long-term effects of AR integration in the classroom.

Keywords: augmented Reality, Teaching and Learning, Psychology

Introduction

Health care, education, and economics have all been significantly impacted by the worldwide COVID-19 epidemic. The COVID-19 epidemic, which the globe Health Organization has classified as a global pandemic, has had catastrophic effects on millions of people and economies all over the globe (Alahdal et al., 2020; Smith & Judd, 2020). The highly contagious virus has been contained with intensive lockdown measures, which have affected social, economic, and educational activity, most notably schools (Hasan et al., 2021).

Universities and colleges have used digital platforms to maintain the continuation of academic programs as a result, and educational institutions have quickly transitioned to online learning.

Educational organizations like the Commission on Higher Education and the Department of Education have established virtual channels like e-learning and on-air courses to support distance learning (Khan, 2020). Both public and private schools have used virtual classrooms, video conferencing systems like Zoom, and online collaboration tools like Google Classroom. The switch to online learning, however, presents difficulties for students, especially in STEM fields where real-world experiments are an essential element of the curriculum (Sarwar et al., 2020). Some students find it challenging to adjust to and manage the new learning environment due to the novelty of online learning and the lack of in-person contacts and hands-on experiences (Noor et al., 2020; Shahzad et al., 2020).

Discussions on overhauling the educational system and using technology to develop more resilient learning models have been inspired by the COVID-19 pandemic (Dua et al., 2020; Mishra et al., 2020; Pennington et al., 2020; Stambough et al., 2020). In this context, despite the drawbacks of remote learning, the inclusion of information and communication technologies (ICT), such as augmented reality (AR), shows promise in improving the quality of e-learning and giving students useful hands-on experiences. In order to create an immersive and engaging learning environment, AR technology superimposes computer-generated features like as 3D pictures, movies, avatars, and interactive elements onto the real-world environment (Bili et al., 2020). Despite its promise and applicability, AR has not been widely used in education (Voitik& Maslov, 2019).

Examining college students' impressions of using augmented reality applications for online learning during the COVID-19 epidemic is the goal of this research. In order to provide students and teachers a first-person virtual reality experience of course content on smartphones, the study makes use of Google Expeditions, an augmented reality tool created by Google LLC. The Theory of Planned Behavior (TPB) is used to look at how students feel about using AR apps in online learning, as well as their subjective norms, perceptions of behavior control, and intents. Despite the fact that TPB has been utilized to investigate students' attitudes and intents while using AR applications in the classroom, there is little study on students' views especially with relation to augmented reality apps (Cabero-Almenara et al., 2019). Structural equation modeling and other research techniques are used to evaluate the model as well as explore how the parts of TPB interact.

Psychological Implication

According to the study's results, adding augmented reality (AR) applications to online learning environments may benefit students psychologically. Students' motivation, pleasure, and overall learning experience may be improved by the immersive and engaging features of AR technology. Educators may design dynamic, engaging learning environments that help students learn and retain information by using the advantages of augmented reality technology. The precise features of AR applications that contribute to their usefulness in e-learning should be further investigated, and it's also vital to take into account any possible difficulties and moral dilemmas that can arise from their use. The research emphasizes the significance of students' perceptions of augmented reality applications in affecting their adoption of these e-learning technologies. Positive attitudes may increase students' motivation and engagement, such as the perception that the applications are beneficial and effective in enhancing performance and effectiveness in studying. This shows that teachers should concentrate on encouraging favorable attitudes toward augmented reality technology by highlighting its advantages and highlighting how relevant it is to students' learning objectives. Second, the research highlights the impact of students' perceptions of behavioral control or agency in affecting how they embrace AR applications. Students are more likely to accept and successfully use augmented reality (AR) applications for e-learning when they feel they have the knowledge, control, and self-confidence to do so. By giving them clear instructions, materials, and assistance to improve their technical know-how and self-efficacy in utilizing AR applications, educators may help students feel more in control of their learning. Furthermore, the limited effect of subjective norms on students' adoption of AR applications raises the possibility that social norms and peer pressure may not have a substantial impact on students' behavior in this situation. This suggests that rather than depending entirely on social impact, educational institutions should pay greater attention to individual-level elements, such attitudes and perceived behavioral control.

What is Augmented reality?

According to several studies (Fidan &Tuncel, 2019; Bili et al., 2020; Sirakaya&Sirakaya, 2018), augmented reality (AR) technology is changing the face of education by providing special tools that encourage communication and engagement between students and teachers in e-learning systems. With the massive distribution of smart devices like smartphones, tablets, and PCs, it is now possible to overcome the drawbacks of conventional learning techniques by using their visual capabilities. This skillful use of technology creates fresh opportunities for improving the educational process. In several research (Cai et al., 2020; Fidan &Tuncel, 2019; Karagozlu et al., 2019; Liu et al., 2018; Radu & Schneider, 2019), the effect of utilizing AR applications on students' desire to study has been examined. They show that augmented reality apps are superior to more traditional teaching techniques for students across a range of topic areas. Furthermore, they draw attention to the fact that certain students can find it difficult to understand the necessary background information while taking regular online courses. By introducing 3D objects into online lessons, augmented reality may close this gap and strengthen the relationship between students and teachers. Augmented reality gives students the ability to actively engage and interact with virtual items by mimicking the elements of a virtual environment in the real world. This improves their spatial awareness and makes studying more engaging.

Augmented reality's potential pleasures

Augmented reality (AR) provides users with an immersive environment that encourages enjoyment and exploration by allowing users to build virtual objects with real-world features (Picot-Coupey et al., 2020). The hedonic value of AR, according to Mathwick et al. (2001), is a key element that prompts users' cognitive and emotional reactions, resulting in interactive encounters with virtual objects in real-time. According to Kuehn (2018), students' logical and emotional learning experiences have a substantial impact on their propensity to use AR-based learning. Hedonic values have a substantial influence on students' participation in a course because they feed the attraction of learning actual information and the drive to do so (Moorthy et al., 2019). The hedonic value changes users' perceptions of behavioral control, which in turn shapes their attitudes and intentions toward augmented reality, according to research by Mittal et al. (2020). Students' comprehension of the elements affecting their course choices is improved by this increase in the course's worth. The use of such techniques in augmented reality has been studied. The most recent advancements in augmented reality (AR)-based applications give a new view on the environment and bring excitement, freedom of expression, enjoyment, and hedonic pleasures. In the context of online education, augmented reality's hedonic value increases student engagement and has positive effects (Fan et al., 2020; Perannagari& Chakrabarti, 2019).

Augmented reality's practical applications

Augmented reality (AR) offers practical applications that contribute to the logical and functional aspects of learning, significantly influencing users' behavioral intentions. It serves as a promising avenue for advancing e-learning platforms, as it enhances the visibility and simulation of content (Cheng, 2019; Cody et al., 2018). Research has shown that students' perceptions of e-learning and their willingness to engage with it are positively impacted by the presence of AR, which improves the visual presentation of virtual-based courses and sparks excitement and participation in online education (Virata& Castro, 2019; Cabero-Almenara et al., 2019). The utilitarian value of AR in a real-world context increases awareness and fosters a positive attitude, ultimately strengthening the belief in its usefulness and influencing students' behavioral intentions (Cabero-Almenara et al., 2019). With the global outbreak of the COVID-19 pandemic, schools worldwide had to transition to online instruction, making students' realistic expectations of the course crucial, and the utilitarian value approach becomes even more significant (Cabero-Almenara et al., 2019). While previous research has explored the impact of hedonic and utilitarian values in different contexts related to AR, there remains a gap in the field of e-learning research specifically examining the influence of AR on students' behavioral intentions during the COVID-19 pandemic.

This study aims to address this gap by testing the following hypotheses:

H1: Exposure to augmented reality improves students' perceptions of e-learning.

H2: Students have more favorable perceptions of e-learning when using augmented reality.

H3: The use of augmented reality enhances students' sense of behavioral agency in relation to e-learning.

The Predictive Processing Model

According to the Predictive Processing Model, an individual's behavioral intentions are influenced by three factors: attitude toward behavior, subjective norms, and perceived behavioral control, as outlined in the Theory of Planned Behavior (TPB) (Lung-Guang, 2019) (Predictive Processing Model). (Nasar et al., 2019) Attitude refers to a person's favorable or unfavorable emotions toward performing particular actions. Izuagbe et al. (2019) examined the influence of students' optimistic attitudes on their participation in online education as part of their examination of the role of attitudes in e-learning systems. However, the specific attitudes of students toward e-learning using augmented reality applications remain largely unexplored, despite the significant impact that technologically-based e-learning can have on students' intentions to actively engage in coursework. Subjective norms, which are influenced by the opinions of others in an individual's social milieu (e.g., family, friends, peers), also play a significant role in determining an individual's perceptions of appropriate behavior (Nasar et al., 2019). Empirical evidence has demonstrated that subjective norms have a significant impact on students' intentions regarding e-learning, with their peers' subjective norms having an especially significant effect on their attitude toward virtual learning systems (Rejón-Guardia et al., 2020). However, little research has examined how subjective norms, particularly within the context of COVID-19, may have impacted augmented reality-based e-learning systems. Perceived behavioral control focuses on the influence of an individual's beliefs about their own capabilities on their behavior (Lung-Guang, 2019). Previous research (Sugandini et al., 2018) has highlighted the significance of perceived behavioral control in students' intentions and effectiveness in e-learning or online course participation. Despite the urgency of the COVID-19 pandemic, there is a paucity of research employing the TPB framework to examine students' attitudes toward augmented reality-based e-learning or online courses. Nevertheless, TPB has been adapted to numerous disciplines, including healthcare, marketing, and technology, providing insights into observable behaviors associated with the adoption of new systems (Nasar et al., 2019). The following hypotheses are proposed in light of these considerations: Students' prospective e-learning behavior is positively predicted by their attitudes.

H4. There is a positive relationship between students' subjective norms and their propensity to engage in e-learning.

H5. Students' perceptions of their own behavioral control are positively correlated with their intentions to engage in online learning.

Attitude, subjective rules, and the way people think they have power over their actions all act as mediators.

The impact that attitude, psychological standards, and perceived behavioral control have on the acceptance of e-learning and the possible benefits it could give for learning and teaching from a distance is very important. When new technology is added to e-learning, people who aren't familiar with it may find it hard to use, which can lead to low adoption rates. Lung-Guang (2019) says that external factors affect user intentions, which need to be managed by the Theory of Planned Behavior's categories (attitude, subjective standards, and observed behavioral control). Also, the Theory of Planned Behavior (Lung-Guang, 2019) says that the effects of belief-based factors on purpose are handled by the theory's structures.Previous study, like that done by Lew et al. (2019), has used the three aspects of the Theory of Planned Behavior to look at the direct and indirect effects of external factors on e-learning. They found that the Theory of Planned action helped explain part of the link between mental traits and plans for future action. They also noticed that the Theory of Planned Behavior was the link between being honest and having a bigger goal. Gkargkavouzi et al. (2019) did another study and found that the aspects of the Theory of Planned Behavior had a big effect on the link between social standing and behavior. But (Lew et al., 2019), there isn't a lot of study on how the Theory of Planned Behavior models act as a bridge between engaging technology and e-learning practices.

Based on these things, the following ideas are put forward:

H7: The effect of how students feel about augmented reality on their plans to use e-learning is influenced by factors outside of the classroom.

H8: Students' introduction to augmented reality affects whether or not they want to use e-learning. This link is regulated by students' individual values.

H9: The effect of virtual reality on students' plans to use e-learning is tempered by how much control they feel they have over their behavior.

The goal of these theories is to find out how the Theory of Planned Behavior structures affect the link between augmented reality and Asian students' plans for e-learning.

Plan for studying

This research's study outline was made by looking at what was already known about the COVID-19 pandemic and how augmented reality apps are used in online education. The Theory of Planned Behavior (TPB) was used to see how virtual reality apps affected how Filipino college students felt about e-learning. In this context, the TPB aspects mentioned in Hypotheses 1, 2, and 3 are directly affected by augmented reality. So, Hypotheses 4, 5, and 6 (H4, H5, and H6) say that there is a link between TPB components and the desire to do e-learning. The TPB factors in H7, H8, and H9 act as middlemen between augmented reality and the desire to use e-learning.

Methodology

Data collection

This study included 135 students from a state university in the Philippines, which is in Asia. G*Power 3.1 software was used to figure out the sample size by looking at four variables, an effect size of 0.15, a power of 0.95, and a two-tailed test. This gave a minimum necessary sample size of 89. In this study, however, a bigger sample number was used. The teachers set up a WhatsApp group so they could tell the kids about changes and tasks. To find people for the study, the group sent out an online poll. Participants were also told to put the Google Expeditions app on their phones so they could use virtual and augmented reality in their studies. Participants were asked to answer questions about Google Expeditions to make sure that they had a good time.

Data analysis

Structured equation modeling (SEM) was used in the work to test the offered theories. SEM is a type of statistical modeling that is often used in the social sciences and management to figure out how well a model fits the data and to predict structure coefficients. In this study, Smart PLS software was used for both covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM) methods. PLS-SEM was chosen because it can show both direct and indirect complicated links between constructs, confirm theory frameworks, and compare path coefficients. To look at the links between hidden variables, the PLS method estimates two models: an inner measurement model and an outer structure model.

Measurement model

The study looked at e-learning in the setting of augmented reality by using the theory of planned behavior (TPB) and its four parts (attitude, subjective standards, observed behavior control, and goal). Tools for measuring each part were taken from other studies. Augmented reality was judged based on how useful and fun people thought it was. TPB categories, such as views toward e-learning, resistance to e-learning, social norms, perceived behavioral control, and desire to learn, were tested using a five-point Likert scale that went from 5 (extremely likely) to 1 (extremely unlikely). Cronbach's Alpha, composite reliability, and the average variance were used to test for convergent validity. With utility and hedonic loadings above 0.98, the augmented reality model was very reliable. All effect sizes were above 0.5, with an average range of 0.636–0.819. Cronbach's alpha coefficients and reliability coefficients for all categories were above the cutoff of 0.6. The discriminant's validity was proven when the square root of the average variance retrieved was higher than the correlation values.

Structural model

Using Smart PLS software (v3.2.9), partial least squares structural equation modeling (PLS-SEM) was used to look at the structural relationships between the different parts. To figure out the direct and secondary

connections, the study used bootstrapping with 5500 subsamples and t-statistics. The most important parts of the structural model's study were the path coefficients and R2 values, which showed how strong and important the connections between the factors were.

Hypothesis testing

Through a scaling study with 5500 repetitions in SmartPLS, the connections between augmented reality (AR), attitude, subjective standards, observed behavioral control, and e-learning goals were looked at. AR partially described mood (R2 = 0.698), subjective rules (R2 = 0.532), and observed behavioral control (R2 = 0.522), according to the results. The TPB dimensions and AR explained 67.2% of the differences in e-learning goals as a whole. Hypotheses 1, 2, 3, 4, and 6 were found to be true. But the results for theory 5 were not clear. Concerning secondary links, hypotheses 7 and 9 showed full mediation effects, while subjective norms did not act as a mediator between AR and e-learning goals. Notably, the study found that AR has a big secondary effect on people's desire to do e-learning as a whole.

Table 1. Complete validity and reliability.

Measurement Items	Loadings	α	CR	AVE
Augmented Reality (AR): The Value of Utility	0.981	0.885	0.913	0.636
UVL1. This virtual reality app helped me do a better job of judging my work during e-learning.				
UVL2. How useful this virtual reality app is thought to be for e-learning.	0.772			
UVL3. Using this virtual reality app can make e-learning more successful.	0.856			
Hedonic Value of Augmented Reality (AR)	0.980			
HVL1: The virtual reality app in this e-learning experience made me feel good.	0.828			
HVL2. This virtual reality app made the e-learning experience exciting.	0.835			
HVL3. The e-learning experience with this virtual reality game was fun.				
Attitude	0.795	0.767	0.866	0.683
ATU1: Using this virtual reality app made me like e-learning more.	0.785			
ATU2: Using this augmented reality app for e-learning should be a pleasant experience.	0.875			
ATU3: How wise do you think it is to use this virtual reality app for e-learning?				
Personal Standard	0.817	0.762	0.863	0.679
SN1: The idea that important people think this virtual reality app is enough for e-learning.				
SN2: The belief that other students would be ready to use this virtual reality app for e-learning.	0.832			
SN3: The belief that important people would like to use this virtual reality app for e-learning.	0.743			
Perceived Control over Behavior	0.702	0.680	0.819	
BC1: Confidence that you know enough about augmented reality to use this app for e-learning.				
BC2: Belief that you have enough control over this virtual reality app to use it for e-learning.	0.798			
BC3: faith that you have enough faith in yourself to decide to use this augmented reality app for e-learning.	0.787			
With e-Learning in Mind				
INT1: Planning to use virtual reality apps for online learning.	0.813	0.716	0.841	0.638
INT2: Plan to use virtual reality apps in the future for e-learning.	0.751			
INT3: The goal is to use virtual reality apps for e-learning.	0.831			

Note: α Note that the symbol stands for Cronbach's Alpha, CR stands for Composite Reliability, and AVE stands for Average Variance Extracted.

Discussion

With the theory of organized behavior as a guide, the goal of this study was to look into how augmented reality could be used in e-learning during the COVID-19 pandemic in Asia. The results showed that

college students' views and how much they thought they could control their actions affected their plans to use augmented reality apps for online learning. But when subjective values were taken into account, the effect of students' plans for e-learning was not statistically significant. When augmented reality apps are used in online education, virtual items can be shown in a real-world setting on smartphones and computers. This can help students learn more. It makes sense to think that using virtual reality would make people more interested and, as a result, help them learn more. Due to the pandemic, there is a pressing need to change to online learning. Schools should rethink their methods and use virtual reality to their advantage. Garzón and Acevedo (2019) have talked about how online classes can make the teaching process more efficient. Augmented reality apps can show 3D pictures, movies, and voice notes that students can use to connect with the course material. Also, virtual reality is newer than standard online classes, which can make students feel better about their learning experiences. But the study makes me wonder if college students' subjective norms will change as a result of virtual reality being used more and more in online learning. Iwanaga et al. (2021) found that most educational institutions still use old technologies like Zoom and Google Classroom for online classes, which may not be interesting enough for a large part of their intended audience. To figure out why this is happening, we need to do more detailed study. Students can learn more and be less resistant to e-learning if they have meaningful learning experiences. Since the COVID-19 outbreak began, many online learning sites have sprung up. Sahin and Yilmaz (2020) say that augmented reality apps can help students understand basic ideas and give them virtual help with actual tasks. Augmented reality is defined by the way that virtual things are added to the real world. This can make users' bodies react and help them handle information better.

Conclusion

In the end, this study looked at how likely college students are to use virtual reality apps for online learning. Students wanted to use virtual reality a lot in their online learning, the results showed. It was found that using virtual reality software had a good effect on students' views, psychological rules, and how much control they felt they had over their behavior. Traditional online learning methods, like video lessons, can still be hard for students, especially with the COVID-19 pandemic still going on. Higher education organizations and students around the world still have trouble with e-learning because of cultural differences and the complexity of the technology involved. It's important to remember that this study only looked at students in their first year of college at public Asian schools. This makes it hard to apply the results to other educational situations and students at different levels. In the future, researchers could look into the pros and cons of using virtual reality technology to teach students of different ages and backgrounds in different school settings. For a full picture, these kinds of studies may use both qualitative and quantitative methods.

Recommendations and Implications

The results of this study show that augmented reality has a good effect on college students' views, psychological rules, and feelings of power over their behavior when it comes to e-learning. Adding virtual reality to online education has a lot of promise to improve how students learn. But for successful application, it is important to deal with technical and behavioral obstacles. By using virtual reality and investing in the infrastructure and support it needs, schools can make online learning experiences that are more interesting and successful. More study and development will help bring virtual reality technology in online schooling to the next level and make it work better.

The results of this study show how adding virtual reality technology to online schooling could be helpful. Schools and colleges should think about adding virtual reality apps to their online learning tools to help students learn more. By taking advantage of how dynamic and intense augmented reality is, teachers can create interesting and interactive content that gets students involved in learning and helps them understand course materials better. Also, institutions should give both teachers and students training and help to make sure that augmented reality tools are used well in online learning settings.

The study also showed that complicated technology and cultural differences still make it hard for e-learning and virtual reality to be widely used in higher education. Institutions should put money into strong technology systems and give resources to make sure that augmented reality apps work well. Also, efforts should be made to get rid of culture hurdles by making sure students, teachers, and stakeholders know about and understand the benefits of augmented reality technology. Getting people to accept augmented reality in online education can be made easier by making a setting that is welcoming and accepting of technology advances.

This study gives useful information about how augmented reality could be used in e-learning, but more research is needed to find out all of its pros and cons. Researchers could look into the long-term effects of augmented reality on how well kids learn, how engaged they are, and how motivated they are to learn. Also, study could look into how well augmented reality works in different fields and levels of schooling, as well as in different cultural settings. Also, because technology is always getting better and augmented reality is always changing, there needs to be constant study and development to make augmented reality tools in online education easier to use, more accessible, and more effective.

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