*Corresponding Author' Email: saalsomali@kau.edu.sa
Proceedings of the International Conference on Modern Research in Education, Teaching and Learning, Vol. 1, Issue. 1, 2022, pp. 33-45
DOI: https://doi.org/10.33422/icmetl.v1i1.40

ISSN: 2783-7734 online

Diamond Scientific Publishing

Exploring Academics' Perspectives Related to the Adoption of Augmented Reality Applications within an E-Learning Environment in Higher Education Institutions: The Role of AR Self-Efficacy, Innovation Resistance, Perceived AR Fatigue and Technology Involvement

Sabah Al-Somali
Associate Professor, Faculty of Economics and Administration, King Abdul Aziz University, Saudi Arabia

Abstract

The learning environments is in continuous change and relies heavily on new technologies. Augmented Reality (AR) applications and tools are a novel e-learning tools that could be an essential component to the educational process and can accelerate students' learning in virtual classrooms. Augmented reality applications focus on the student's involvement in the learning process and try to close the gap between student's capabilities and the real-life experience. This paper intends to explore university academics' perspectives and acceptance to use Augmented Reality applications within an e-learning environment in Higher Education institutions. A conceptual model was developed based on Theory of Planned Behaviour (TPB), Innovation Resistance Theory (IRT), Innovation Diffusion Theory (IDT) and Social Cognitive Theory (SCT). PLS-SEM was used to analyse data from 275 university academics in two large universities in Saudi Arabia. The study findings showed that subjective norm, AR self-efficacy (SE), perceived AR fatigue, technology innovativeness and innovation resistance significantly influenced the intention to use AR as e-learning tool. Moreover, complexity showed insignificant results. The implications of this study are discussed and proposals for future research initiative are presented.

Keywords: Higher education; e-learning, augmented reality; Theory of Planned Behaviour (TPB); Saudi Arabia

1. Introduction

The learning environment is in continuous change and relies heavily on new technologies. Augmented reality (AR) applications are becoming more widely available as an educational medium and a novel tool that can accelerate students' learning in virtual classrooms. In fact, to increase the reality of virtual learning environments, AR applications are introduced as a new opportunity for educators and trainers to experience novel approaches of teaching (Emiroğlu &Kurt, 2018). The word "augmented," is derived from the word " augment " which means the addition of anything in which live direct or indirect views of the actual world are augmented with computer generated pictures over user's views of the actual world (Chavan, 2016; Martínez et al., 2014). Moreover, AR augments the physical world with audio, visuals, graphics, and other additions to enhance user's current experience and insight of reality. In fact, AR applications are believed to boost students' motivation and interest, allowing them to obtain a better understanding of contents (Dutta, 2015).

Despite the vast number of research studies that discussed the effectiveness of AR as a learning tool in improving students' achievement of learning outcomes (Chang et al., 2022; Hu et al., 221; Delello et al., 2015), the level of user acceptance is still limited (Jamrus et al., 2021; Martínez et al., 2014). According to Jamrus et al. (2021), the successful implementation of AR in teaching depends on instructors' intention to use AR in their virtual learning and teaching. Therefore, this study is set to explore university academics' acceptance of augmented reality applications within an e-learning environment in Higher Education Institutions (HEIs) in Saudi Arabia. It is noteworthy that, Alkhattabi (2017) examined the main barriers and benefits of AR applications adoption from the perspective of primary schools' teachers and did not develop a theoretical framework for understanding the aacptanceof AR technology. In contrast, the focus of this study is to explore university academics' perspectives related to the adoption of AR applications their e-learning activities and developed a conceptual model based on Theory of Planned Behaviour (TPB) and other innovation adoption theories.

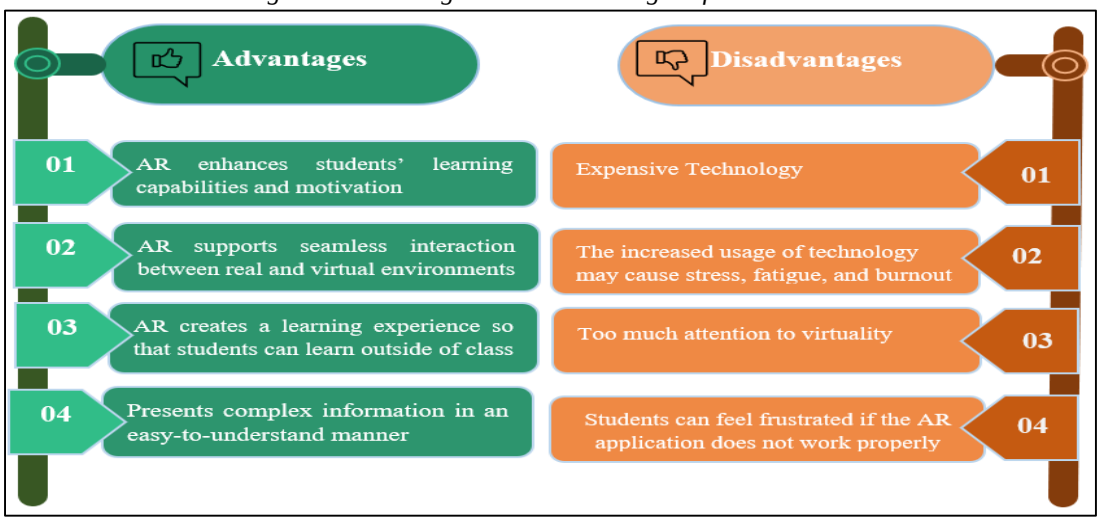
Findings from this research will help higher education institutions to implement comprehensive interactive learning strategies and practices to accelerate students' learning in virtual classrooms and encourage significant learning environment. The next section provides an overview of the related literature on digital transformation, the use of augmented reality applications and theories related to innovation adoption in education. The third section discuss the theoretical background, research model and hypotheses. Section 4 describes the methodological approach employed to conduct this research, followed by a section presenting the results of this study. Finally, conclusions, limitations, suggestions for future studies and managerial implications for the use of augmented reality applications by higher education institutions when adopting e-learning applications are provided.

1.1. Digital Transformation and Augmented Reality Applications

In response to COVID-19, academic communities worldwide were forced to make a sudden shift calling for a digital transformation and shifting from traditional classroom to online learning and teaching (Husain, 2022). Digital transformation (DT) has become a significant phenomenon attracting the interest of both researchers and practitioners. DT refers to the changes experienced by institutions as a result of the implementation of new computer-

based technologies (Vial, 2021). Augmented reality (AR) is one of the modern digital applications currently available and it has wide applications in manufacturing, entertainment, education, tourism, and shopping. It is assumed that the use of AR in education will help in the development in AR applications and will raise students' professional level. Higher Education Institutions (HEIs) have invested significantly in educational technologies such as AR technologies, Cloud learning and massive open online course (MOOCS). In fact, the integration of AR into the education enables teachers to capture learners' attention to gain a better understanding of the concepts they are studying. The use of augmented reality in education for both teaching and learning is growing and gaining popularity among higher education Institutions. Numerous AR studies have been conducted in a variety of educational fields such as mathematics (Li, et al., 2022; Capone & Lepore, 2020), physics (Abdusselam & Karal, 2020; Fidan & Tuncel, 2019), chemistry (Nechypurenko et al, 2018; Habig,2020) and medical education (Dhar et al., 2021; Campisi et al, 2020). In general, AR in education features aspects that enhance learning capabilities such as problem-solving, critical thinking, collaboration, interactive learning experiences, and higher student engagement (Ali, et al., 2022; Uluyol & Şahin, 2016; Saidin et al., 2015). Figure 1 illustrates the advantages and disadvantages of AR in education.

Figure 1: Advantages and disadvantages of AR in Education



Source : (Uluyol & Şahin, 2016; Saidin et al., 2015)

2. Theoretical Background

The research on the adoption of IT and innovative technologies are mainly based on number of theories and models such as Technology Acceptance Model (TAM), Innovation Diffusion Theory (IDT), Innovation Resistance Theory (IRT), Theory of Reasonable Action (TRA), Motivational Model (MM), Social Cognitive Theory (SCT) and Theory of Planned Behaviour (TPB). These theories are multidisciplinary and have been borrowed from different fields such as psychology, sociology, criminology, and economics to explain how IT and innovative technologies are adopted and used (Jokonya, 2017). Table 1 synthesizes existing theoretical frameworks used for studying the use of innovation in education.

Table 1: Theoretical models applied for studying innovation adoption in Education

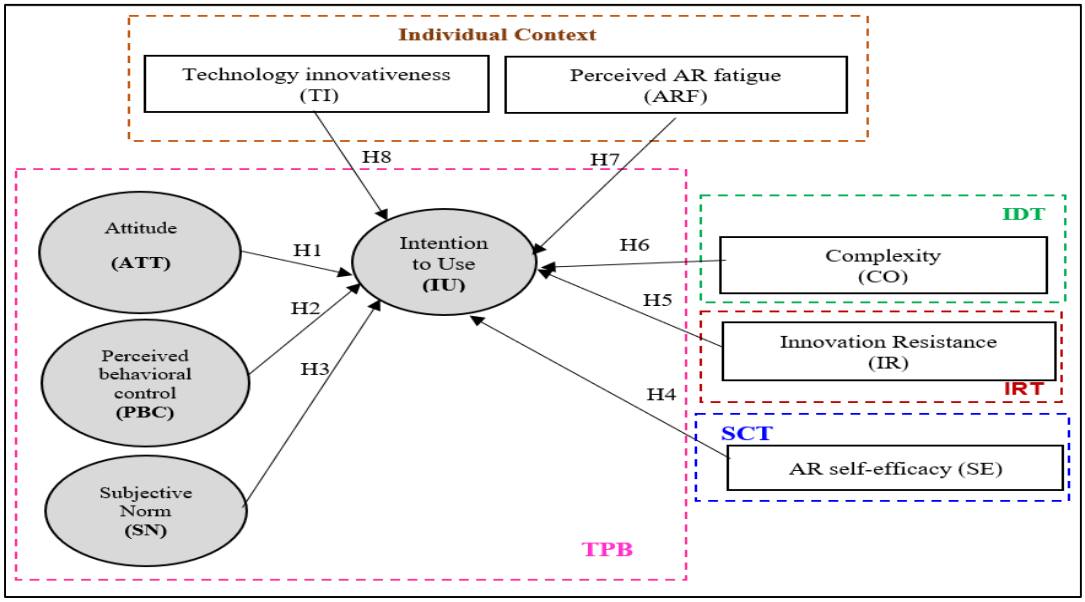
Underlying Theories									
Literature	Innovation	TRA	TPB	TAM	UTAUT	DOI	TTF	Other frameworks	Country
Uymaz & Uymaz (2022)	Augmented reality technology				✓				Turkey
Jang et al. (2021)	Augmented reality and virtual reality			✓					Korea
Al-Fraihat et al. (2020)	E-learning system			✓				DeLone and McLean information systems success model	UK
Sun & Gao (2020)	Mobile-assisted language learning			✓			✓		China
Cheng & Yuen (2019)	Learning management system	✓		✓				Expectation-confirmation model	Hong Kong
Majid & Shamsudin (2019)	Virtual Reality			✓					Malaysia
Teo et al. (2019)	Moodle			✓		✓			Macau, China
Zhao et al.(2021)	Mobile social media for learning			✓					Mainland China
Cheon et al. (2012)	Mobile learning		✓						USA

In fact, the findings of the majority of these investigations, however, are not applicable to higher education in developing Arab nations, particularly from a socio-cultural perspective, because they were conducted in developed nations. Consequently, there is a pressing need for researchers to examine the use of AR applications in higher education institutions in emerging countries that have not been studied previously. Hence, this study set out to investigate the factors that influence the adoption of augmented reality (AR) apps among faculty members in Saudi universities.

2.1. Research Model and Hypotheses

This study developed a framework. The research framework was underpinned by the Theory of Planned Behaviour, Innovation Resistance Theory, Innovation Diffusion Theory and Social Cognitive Theory and previous relevant studies, as presented in Figure 2.

Figure 2: Research model



2.1.1. Theory of Planned Behaviour (TPB and the intention to use AR applications

TPB was introduced by Ajzen (1991) and is one of the most broadly known theories to predict individual attitude and action. TPB posits that attitude, subjective norms and perceived behavioural control predict behavioural intention to use an innovation. Attitude toward a behavior refers to the extent to which a person has a favorable or unfavorable evaluation or assessment of the behaviour (Ajzen,1991). Subjective norm (SN) or social influence describes the degree to which a person believes that his or her important peers expect him or her to use a specific technology or innovation (Rauschnabel & Ro, 2016). As for this study, SN refers to academic's perception of social pressure to use AR applications in e-learning environment. Perceived behavioural control (PBC) is concerned with individual's perception that he/she has control over external factors that may facilitate or constrain the behavioural performance (Rauschnabel & Ro,2016). In this study, PBC denotes the extent to which academic's assessment of self-capacity and perceived control ability in using AR applications in e-learning environment.The TPB has been used in a variety of research in information systems research to predict human behaviour as they are exposed to different innovations. In the e-learning environment, various researchers have empirically confirmed that subjective norm, attitude and perceived behaviour control affect behavioural intention to use e-learning applications (Cheng, 2019; Panigrah et al., 2018). In general, it is believed that the more positive the social support and self-competence to adopt the technology, the smaller the expected resistance to utilize the technology. Moreover, the more enthusiastic a person is about an innovation or technology is, the more likely that person will have the passion to engage in it. Obviously, attitude is regard as an important determinant in predicting and explaining human behaviour. According to above discussions and findings, the following hypotheses are proposed

H1: Attitude toward AR applications has a positive influence on behavioural intention to use AR applications within an e-learning environment.

H2: Perceived behavioural control has a positive influence on behavioural intention to use AR applications within an e-learning environment

H3: Subjective norm has a positive influence on behavioural intention to use AR applications within an e-learning environment.

2.1.2. Social Cognitive Theory (SCT) and AR self-efficacy

Social cognitive theory (SCT) is a widely recognized model for predicting individual behavior and identifying techniques for changing the behaviour (Bandura, 1986). The theory posits that idividual's specific capabilities or self-efficacy affects the behavioral intention. Self-efficacy refers to individual's judgments and beliefs of his/her ability and confidence to carry out a certain behaviour (Bandura, 1986). It is noteworthy that, the use of AR applications within an e-learning environment suggests that individuals to have greater AR capabilities. Consequently, as for this study. AR self-efficacy is a perception of instructor's abilities to use AR and it indicates the degree to which a person has confidence in his/her abilities to use AR applications, make efforts to cope in an online environment and undertake e-learning activities and tasks.

Several studies have applied SCT as a theoretical framework to predict and explain an individual's behaviour in e-learning settings (Wan et al., 2008; Panigrah et al., 2018). Wan et al. (2008) assert that, people who have high virtual self-efficacy are more motivated to put out efforts to be successful, thus achieving superior outcomes. Moreover, Baydas & Goktas (2017) state that educators who have high ICT self-efficacy are most like to use ICT in their classroom. Conversely, a lack of self-efficacy is found to hinder the intention to use technology by educators in classrooms. Based on the above discussion, we posit the following:

H4: AR self-efficacy has a positive influence on behavioural intention to use AR applications within an e-learning environment

2.1.3. Innovation Resistance Theory (IRT) and innovation resistance

The review of orevious research showed that, IRT have been utilized to investigate individuals' resistance toward innovation (Panigrah et al., 2018; Ali et al., 2016). According to Ali et al. (2016), the main sources of innovation resistance to adopt and implement online learning applications are namely: low desire to make a change, lack of awareness and training, poor communication, and lack of trust (Ali et al., 2016). Innovation resistance is a major concern in implementing new technologies and is found to have a negative impact on the technology adoption (Panigrah et al., 2018). Hence, we propose the following hypothesis:

H5: Innovation resistance is negatively related to the behavioural intention to use AR applications within an e-learning environment

2.1.4. Innovation Diffusion Theory (IDT) and Complexity

Innovation Diffusion Theory (IDT) argues that "potential users decide whether to use or reject an innovation based on beliefs that they have about the innovation. Complexity is a significant characteristic of innovation that is used to explain end-user's perceived level of difficulty in learning and comprehending innovations and their ease of use (Rogers, 1995). In fact, when a system is perceived as difficult to learn and understand, it will not be adopted (Rogers, 1995). Moreover, research in e-learning emphasizes the importance of reducing complexity in human-computer interaction (Lee et al., 2011). The disruptive nature of AR is related to the complex nature of the used computing systems such as artificial visuals, motion sensors and audio applications. In fact, to promote and enhance the use of AR applications in

the e-learning environment, the design of a convenient and simple framework for AR is crucial. In addition, the complexity of AR applications in the e-learning environment is significantly increased by lack of IT skills. In general, AR requires ICT knowledge and expertise (Sonnenwald et al. 2001). According to Rogers (1995), complexity is negatively correlated with the rate of technology diffusion. Based on the above discussion, we posit the following:

H6: Complexity is negatively related to the behavioural intention to use AR applications within an e-learning environment

2.1.5. Individual context

2.1.5.1. Perceived AR fatigue

The COVID-19 pandemic accelerated the usage of AR applications in online teaching and learning. Despite advantages of AR applications in education (Uluyol & Şahin, 2016; Saidin et al., 2015), users reported feeling overwhelmed, dissatisfied, or depressed as a result of the continual AR usage which leads to "AR fatigue". Educational institutions should encourage AR users to advance knowledge on AR fatigue to avoid burn-out. In fact, AR fatigue is a negative health outcome of AR usage that should be taken seriously (Jing et al., 2020). Building on the above discussion, the following hypothesis is proposed:

H7: Perceived AR fatigue is negatively related to the behavioural intention to use AR applications within an e-learning environment

2.1.5.2. Technology innovativeness

Rogers (1995) defined innovativeness as the extent to which a person adopts new concepts or new information technology relatively earlier than others. Individuals' innovativeness is treated as a component of human personality trait and is critically important to the adoption of innovations.In fact, some individuals are found to be more innovative than others and as a result, they will accept and use the innovation earlier than the majority of the group. Previous research found that technology innovativeness has been proven to have a critical role in determining individual's willingness and openness to utilize and engage in virtual learning environment. As a result of the rapid developments in information technologies and internet-based technologies, teachers had the opportunity to innovate and implement new technologies such as AR technologies in order to exist in a virtual environment and enhance students' learning outcome. In fact, AR applications have become an important medium for educators. Based on the above discussion, we posit the following:

H8: Technology innovativeness has a positive influence on behavioural intention to use AR applications within an e-learning environment

3. Methodology

A quantitative research method was used to test the research model and survey will be used to collect data. The population of the research is university academics in two large universities in Saudi Arabia. Data was collected utilizing printed copies of the survey to participants and a cross-sectional online questionnaire. Moreover, seven-point Likert scale was used to operationalize each construct (1 indicates "strongly disagree" and 7 indicates "strongly agree"). It is noteworthy that the questions and measurement scales for the research constructs were adopted from previous research within the area of innovation adoption

(Panigrah et al., 2018; Baydas & Goktas, 2017; Lee et al., 2011; Rogers,1995). Moreover, 275 responses (see Table 2) were carried forward for analysis.

Table 2: Demographic profile of respondents

Classification		Number of Respondents	Percentage of Respondents
Gender	Male	146	53.1%
	Female	129	46.9%
Age (yr)	18 -25	26	9.5%
	26 - 35	89	32.4%
	36 - 45	100	36.4%
	46 - 55	49	17.9%
	≥ 56 Years	11	4%
Education	Bachelor's degree	17	6.2%
	Master's degree	138	50.2%
	PhD	120	43.6%

4. Hypothesis testing and Discussion of Results

Smart PLS was applied to test and validate the research model. The results illustrated in Table 3, shows that the proposed research model exhibits an acceptable level of construct reliability and discriminant validity in which Cronbach's alpha and composite reliability (CR) for this study exceeded 0.7 for all constructs, values of Cronbach's alpha were between 0.826 and 0.924. Moreover, the results of the study confirmed the discriminant validity at the construct-level in which the square root of the AVE of each construct exceeds the correlations with any other construct (shown in bold in Table 4).

Table 3: Validity and reliability of constructs

Constructs	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)
Attitude (ATT)	0.909	0.943	0.846
Perceived behavioural control (PBC)	0.895	0.922	0.704
Subjective Norm (SN)	0.868	0.91	0.718
Complexity (CO)	0.905	0.929	0.724
Innovation Resistance (IR)	0.826	0.893	0.737
Perceived AR fatigue (ARF)	0.924	0.946	0.815
AR self-efficacy (SE)	0.883	0.914	0.682
Technology Innovativeness (TI)	0.885	0.902	0.698
Intention to Use (IU)	0.91	0.943	0.847

Table 4: Correlation of constructs values

	ATT	CO	IR	IU	PBC	RF	SE	SN	TI
ATT	**0.92**								
CO	0.871	**0.851**							
IR	-0.005	-0.008	**0.858**						
IU	0.66	0.79	-0.113	**0.92**					
PBC	0.657	0.697	-0.052	0.678	**0.839**				
RF	-0.681	-0.939	0.007	-0.781	-0.642	**0.903**			
SE	0.685	0.797	0.082	0.682	0.635	-0.765	**0.826**		
SN	0.616	0.69	0.072	0.625	0.588	-0.651	0.67	**0.848**	
TI	0.079	0.134	0.67	0.077	0.018	-0.169	0.233	0.129	**0.836**

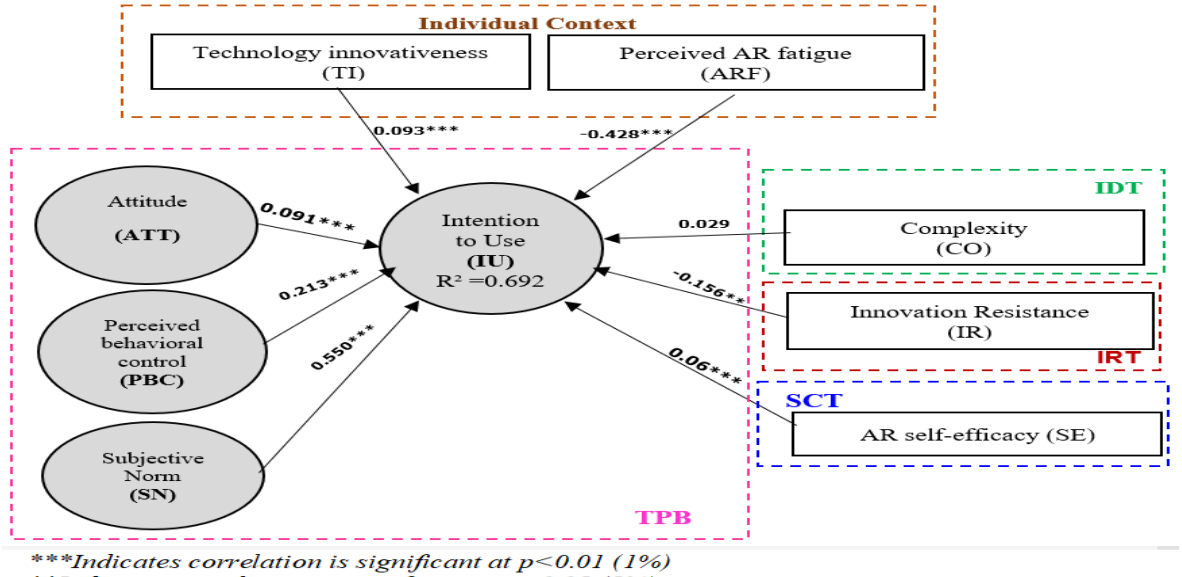
To test the research hypotheses, the coefficients of the underlying associations between variables were examined. Seven out of eight hypothesis namely H1, H2, H3, H4, H5, H7 and H8 were supported. Hence hypotheses H6 was not supported in which complexity did not have a negative impact on the behavioural intention to use AR applications. However, it had a significant influence on the intention to use AR applications. In fact, if a technology is easy to use, users will find it less complex.

Subjective norm (β=0.550) had the highest coefficient indicating a high prediction for the intention to use AR applications. Table 6 provides an overview of the results of hypothesis testing and figure 3 illustrates the standardised path coefficient for each construct. In general, the results of this study offer statistical indication that the proposed model had a high degree of explanatory power (R^2 = 69%) to explain variation in intention to use AR applications within an e-learning environment, indicating that the research model incorporates useful variables.

Table 7: Hypothesis testing results

H #	Hypothesised path	Standardised beta coefficient (β)	T-Value	R^2	Result
H1	Attitudes → Intention to use	0.091***	14.492	0.435	Accepted
H2	Perceived behavioural control → Intention to use	0.213***	15.017	0.452	Accepted
H3	Subjective norm → Intention to use	0.550***	13.040	0.384	Accepted
H4	AR self-efficacy → Intention to use	0.06***	14.953	0.450	Accepted
H5	Innovation resistance → Intention to use	-0.156**	-11.754	0.11	Accepted
H6	Complexity→ Intention to use	0.029**	21.091	0.620	Rejected
H7	Perceived AR fatigue → Intention to use	-0.428***	-20.681	0.610	Accepted
H8	Technology innovativeness → Intention to use	0.093***	3.821	0.020	Accepted

Figure 3: Research model with results



***Indicates correlation is significant at p<0.01 (1%)*
**Indicates correlation is significant at p<0.05 (5%)*

5. Conclusion

In response to COVID-19, academic communities worldwide were forced to make a sudden shift calling for a digital transformation and shifting from face-to-face to online learning and teaching. Higher Education Institutions (HEIs) have invested significantly in educational technologies such as AR technologies, Cloud learning and massive open online course (MOOCS). In fact, the integration of AR into the education enables teachers to capture learners' attention to gain better understanding of the concepts they are studying. This study intends to explore university academics' perspectives and acceptance to use Augmented Reality applications within an e-learning environment in Higher Education institutions. The research model explained 69% of the variance in intention to use AR applications. This study contributed to Augmented Reality litrture by focusing on university academics' intention and acceptance to use Augmented Reality applications and by creating a more comprehensive picture of AR adoption by taking into account a wider range of factors in an integrated framework based on well known IS theories. Indeed, findings from this research could serve as a reference for higher education institutions to implement comprehensive interactive learning strategies and practices to accelerate students' learning in virtual classrooms and encourage significant learning environment. The current study adopted a cross-sectional research design and future research could implement a qualitative approach to capture the experience of instructors and document the opinions of instructors regarding the effectiveness of AR implementation in e-learning environment.

References

Abdusselam, M. S., & Karal, H. (2020). The effect of using augmented reality and sensing technology to teach magnetism in high school physics. *Technology, Pedagogy and Education*, 29(4), 407-424.

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50*(2), 179-211.

Al-Fraihat, D., Joy, M., & Sinclair, J. (2020). Evaluating E-learning systems success: An empirical study. *Computers in human behavior*, *102*, 67-86.

Ali, M., Zhou, L., Miller, L. & Ieromonachou, P. (2016). User resistance in IT: A literature review. *International Journal of Information Management*. *36*, pp 35-43.

Ali, N. A, Sadiq, M. H, Albabawat, A. A. and Salah, R. M (2022). Methods and Applications of Augmented Reality in Education: A Review. 2022 International Conference on Computer Science and Software Engineering (CSASE), pp. 175-181, doi: 10.1109/CSASE51777.2022.9759807.

Alkhattabi, M. (2017). Augmented Reality as E-learning Tool in Primary Schools' Education: Barriers to Teachers' Adoption. International Journal of Emerging Technologies in Learning, 12(2).

Bandura, A. (1986). Social Foundations of Thought and Action: A Social Cognitive Theory, Prentice-Hall, Englewood, NJ.

Baydas, O & Goktas, Y (2017). A Model For Preservice Teachers' Intentions To Use ICT in Future Lessons. Interactive Learning Environments, 25(7), pp. 930–945.

Campisi, C. A., Li, E. H., Jimenez, D. E., & Milanaik, R. L. (2020). Augmented reality in medical education and training: from physicians to patients. In Augmented reality in education (pp. 111-138). Springer, Cham.

Chang, H. Y., Binali, T., Liang, J. C., Chiou, G. L., Cheng, K. H., Lee, S. W. Y., & Tsai, C. C. (2022). Ten years of augmented reality in education: A meta-analysis of (quasi-) experimental studies to investigate the impact. *Computers & Education, 191*, 104641.

Chavan, S. R. (2016). Augmented Reality vs. Virtual Reality: Differences and Similarities. *International Journal of Advanced Research in Computer Engineering & Technology,5*(6), pp. 1947-1952.

Cheng, E.W.L. (2019). Choosing between the theory of planned behavior (TPB) and the technology acceptance model (TAM). *Education Tech Research Dev* ,67, pp.21–37

Cheng, M., & Yuen, A. H. K. (2019). Cultural divides in acceptance and continuance of learning management system use: a longitudinal study of teenagers. *Educational Technology Research & Development, 67*(6), 1613–1637.

Cheon, J., Lee, S., Crooks, S. M., & Song, J. (2012). An investigation of mobile learning readiness in higher education based on the theory of planned behavior. *Computers & education, 59*(3), 1054-1064.

Delello, J. A., McWhoRteR, R. R., & Camp, K. M. (2015). Integrating augmented reality in higher education: A multidisciplinary study of student perceptions. *Journal of Educational Multimedia and Hypermedia, 24*(3), 209-233.

Dhar, P., Rocks, T., Samarasinghe, R. M., Stephenson, G., & Smith, C. (2021). Augmented reality in medical education: students' experiences and learning outcomes. *Medical Education Online, 26*(1), 1953953.

Dutta, K. (2015). Augmented for E-Learning. *Seminar Augmented Reality, Mobile & Wearable,* RWTH Aachen University

Emiroğlu, B. G., & Kurt, A. A. (2018). Use of Augmented Reality in Mobile Devices for Educational Purposes. In I. Management Association (Ed.), *Virtual and Augmented Reality: Concepts, Methodologies, Tools, and Applications* (pp. 254-276). *IGI Global*. https://doi-org.sdl.idm.oclc.org/10.4018/978-1-5225-5469-1.ch012

Fidan, M., & Tuncel, M. (2019). Integrating augmented reality into problem-based learning: The effects on learning achievement and attitude in physics education. *Computers & Education*, 142, 103635.

Habig, S. (2020). Who can benefit from augmented reality in chemistry? Sex differences in solving stereochemistry problems using augmented reality. *British Journal of Educational Technology*, 51(3), 629-644.

Hu, X., Goh, Y. M., & Lin, A. (2021). Educational impact of an Augmented Reality (AR) application for teaching structural systems to non-engineering students. *Advanced Engineering Informatics*, 50, 101436.

Jamrus, M. H. M., & Razali, A. B. (2021). Acceptance, readiness and intention to use augmented reality (AR) in teaching English reading among secondary school teachers in Malaysia. *Asian Journal of University Education, 17*(4), 312-326.

Jang, J., Ko, Y., Shin, W. S., & Han, I. (2021). Augmented reality and virtual reality for learning: An examination using an extended technology acceptance model. *IEEE Access*, 9, 6798-6809.

Lee, Y. H., Hsieh, Y. C., & Hsu, C. N. (2011). Adding innovation diffusion theory to the technology acceptance model: Supporting employees' intentions to use e-learning systems. *Journal of Educational Technology & Society, 14*(4), 124-137.

Majid, F. A., & Shamsudin, N. M. (2019). Identifying Factors Affecting Acceptance of Virtual Reality in Classrooms Based on Technology Acceptance Model (TAM). *Asian Journal of University Education, 15*(2), pp.51–60.

Martínez, H., Skournetou, D., Hyppölä, J., Laukkanen, S., & Heikkilä, A. (2014). Drivers and bottlenecks in the adoption of augmented reality applications. *Journal of Multimedia Theory and Application, 2*(1), pp. 27-44.

Nechypurenko, P., Starova, T., Selivanova, T., Tomilina, A., & Uchitel, A. (2018, October). Use of augmented reality in chemistry education. *In Memoires of 1st International Workshop on Augmented Reality in Education.*

Panigrahi, R., Srivastava, P. R., & Sharma, D. (2018). Online learning: Adoption, continuance, and learning outcome—A review of literature. *International Journal of Information Management*, 43, pp.1-14.

Rauschnabel, A.P.& Ro, K.Y (2016). Augmented reality smart glasses: An investigation of technology acceptance drivers. *Int. J. Technol. Mark., 11*, 123–148.

Rogers, E.M. (1995). *The Diffusion of Innovation*.4th ed. Free Press, New York.

Saidin, N. F., Halim, N. D. A., & Yahaya, N. (2015). A review of research on augmented reality in education: Advantages and applications. *International education studies, 8*(13), 1-8.

Sonnenwald, D. H., Maglaughlin, K. L., & Whitton, M. C. (2001). Using innovation diffusion theory to guide collaboration technology evaluation: work in progress. Proceedings Tenth IEEE International Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises. WET ICE, 2001, pp. 114–119

Sun, Y., & Gao, F. (2020). An investigation of the influence of intrinsic motivation on students' intention to use mobile devices in language learning. Educational Technology Research & Development, 68(3), 1181–1198.

Teo, T., Zhou, M., Fan, A. C. W., & Huang, F. (2019). Factors that influence university students' intention to use Moodle: A study in Macau. Educational Technology Research and Development, 67(3), 749-766.

Uluyol, Ç., & Şahin, S. (2016). Augmented reality: A new direction in education. In Emerging Tools and Applications of Virtual Reality in Education (pp. 239-257). IGI Global.

Uymaz, P., & Uymaz, A. O. (2022). Assessing acceptance of augmented reality in nursing education. PloS One, 17(2).

Vial, G. (2021). Understanding digital transformation: A review and a research agenda. Managing Digital Transformation, pp.13-66.

Wan, Z., Wang, Y., & Haggerty, N. (2008). Why people benefit from e-learning differently: The effects of psychological processes on e-learning outcomes. Information & management, 45(8), 513-521.

Zhao, S., Kinshuk, Yao, Y., & Ya, N. (2021). Adoption of mobile social media for learning among Chinese older adults in senior citizen colleges. Educational Technology Research and Development: A Bi-Monthly Publication of the Association for Educational Communications & Technology, 69(6), pp.3413–3435.