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Journal of Advances in Technology and Engineering Research

JATER

2022, **8**(1): 40-52

PRIMARY RESEARCH

Embracing ubiquitous learning: Investigating technology adoption in higher education through smart-PLS approach

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Keywords

Ubiquitous learning
UTAUT2
Technology acceptance
Smart-PLS
Context-awareness

Received: 05 March 2022
Accepted: 12 April 2022
Published: 11 June 2022

Abstract

High-tech inventions and advances in smartphones and wireless communications have revolutionized learning technologies such as ubiquitous learning, mobile learning, and electronic learning. Ubiquitous learning is an innovative state-of-the-art technology for learning at your will, anytime, anywhere, using mobile or handheld devices. By providing flexibility and multiple learning mediums, Ubiquitous learning students can overcome obstacles such as poor classroom facilities, cultural and religious barriers, and busy personal and professional lives. This study aims to study the factors influencing whether students accept and use these new technologies, like ubiquitous learning. This research spread the prevailing study on the UTAUT2 and developed a theoretical model of ubiquitous learning acceptance. Furthermore, this study is also expected to help guide learners in crafting and employing courses and executing courses aimed at seamlessly integrating technology. This research adopts quantitative research methods to achieve the desired results, and data for this study will be gathered through a cross-sectional survey. Therefore, the total population is 600, and data collected from four provinces of Pakistan and six university students responded with 301 data to validate the proposed model using an innovative PLS approach and cluster technique. According to the results, context awareness, self-directed learning, hedonic motivation, personal innovativeness, personal compatibility, performance expectancy, and facilitating conditions affected behavioural intention with an *R*-square variance of 52.8%. These empirical findings identify several influences as the most critical factors affecting ubiquitous learning adoption. They make several theoretical contributions to help higher education institutions promote students' adoption of ubiquitous learning while enhancing their practical value.

I. INTRODUCTION

In the 21st century, several new and innovative learning trends have emerged. Information communication technology and IT now impact every aspect of human life. We play an essential role in the workplace, business, entertainment, and education fields. New technologies are integrated into education environments to make them highly intelligent and enhanced, creating a ubiquitous learning experience that considers the user's location, preferences, and interests. It enables everyone to acquire knowledge securely, timely, efficiently, and entirely at all times [1, 2]. Through U-learning, the system eliminates the need for traditional classrooms and communicates with mobile devices to support students learning on the go. Due to the system's flexibility, students can effectively manage their time between education and work.

Additionally, removing the requirement for travelling to and from the classroom reduces transportation-related expenses. Also, essential educational supplies must be obtained. Furthermore, it is suggested [3] that People of all

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ages exhibit different signs of Learning, and learners can learn anytime, anywhere, and at any time. Drawing from the [4] assertion, Individuals born after 1990 underscore the digital mediation of various aspects of their lives. Digital technologies significantly influence how people highlight social interactions, form friendships, and engage in civic activities.

Pakistan's most commonly accepted education system is for students to interact with teachers face-to-face. Scholars need to be physically present in class to learn. Despite it being widely accepted, the traditional model has certain disadvantages. Many people are prevented from furthering their education due to strict guidelines that impose requirements in the classroom, including cultural and regional barriers, among other inevitable circumstances. Online learning was introduced to make Learning available to more groups of people and remedy the associated issues. Thanks to the Internet advancements that established web-based Learning, students can access their academic materials anytime with wireless devices from any location. So, web-based learning development presented in Figure 1 (E-learning, M-learning, U-learning):

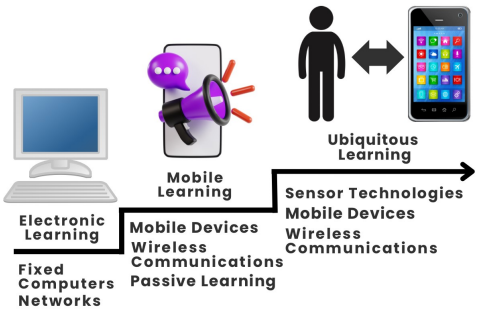

Fig. 1. Web-based learning

In today's world, constant advancements in wireless technology cause the educational system to change continually. Advancements in wireless technology contribute to student engagement and a flexible learning environment [4].

To conclude this introduction, the pedagogical effectiveness of ubiquitous learning has been validated across various settings, including educational settings both within and beyond the traditional classroom, for example [5], and within the framework of lifelong learning. In higher education, certain scholars anticipate that ubiquitous learning will introduce novel strategies, tools, and resources to actualize its potential [6, 7].

U-learning and technology in education will not be widely accepted by students just because of technological developments [8]. Understanding and studying the reasons for accepting or rejecting technologies and systems is essential [9].

Users have repeatedly studied the level of acceptance of technology by information communication systems. In higher education, students' acceptance of U-learning technology is essential, and portable handheld devices, wireless devices, and Information systems services were widely used and accepted based on early studies. The researchers use the UTAUT2 model to develop a theoretical framework and identify the critical acceptance factors from the student's perspective of higher educational institutions in developing countries like Pakistan. Many studies have acquired knowledge regarding the use and acceptance of technology in academic settings, and this study aims to contribute to that body of knowledge. Designers and educators seek to acquire the necessary knowledge and tools to implement technology correctly in the learning process.

A. Problem Statement

In Pakistan's HEIs (Higher Education Institutions), the key factors influencing the acceptance and integration of U-learning should be thoroughly investigated, resulting in significant hurdles to its adoption. The acceptance of U-learning still needs to improve, according to several studies. The current research requires a detailed analysis of the factors shaping the acceptability and use of U- learning technologies in Pakistan's educational system. U-learning can only be successfully implemented in higher education if students accept it as a vital step.

Individuals determine the acceptance and continued use of U-learning in higher education by identifying the critical factors involved. The question determines if U-learning is practical, easy to use, and cost-efficient for education in Pakistan. Additionally, students need to acquire the necessary information to implement U-learning properly. It also de-

ISSN: 2414-4592
DOI: 10.20474/jater-8.1.5

termines the characteristics and necessary designs to support effective U-learning.

B. Research Question and Goals

In this research, the following broadly focused research question is:

- What factors play a crucial role in shaping the acceptance and use of pervasive learning within Higher Education Institutions (HEIs) in Pakistan?
- How can a theoretical model be developed to understand the factors that influence pervasive learning in higher education in Pakistan?
- What methods and approaches will be adopted to validate the proposed research model in the context of the dissemination of knowledge in higher education institutions in Pakistan?

More nuanced and theoretically based results will be obtained to address these questions. Understanding various educational effects of ubiquitous learning.

II. LITERATURE REVIEW

A. Ubiquitous Learning

The proponent of ubiquitous computing argues that it involves integrating computers seamlessly into all aspects of our lives, replacing conventional computers with updated versions. He emphasizes that everyone can access computers of varying sizes and forms [10]. Ubiquitous learning is founded on ubiquitous computing, creating new opportunities for learners and professionals within educational settings [11].

The performance of knowledge work is enhanced by the four beneficial effects of ubiquitous computing. Communication is free from time and space constraints; the organization can access more prosperous signals to make better decisions, making it easier to support [12]. Wireless, available networks, well-designed battery technology, and other software devices accelerate ubiquitous learning. Let's leverage these technologies to embed personalized learning environments into our lives. Ubiquitous learning has traditionally supported tourists and museum guides by explaining environmental facts through electronic guidebooks. Ubiquitous educational and technological knowledge is taking place in academic settings and various other settings.

In classrooms or outdoor studies, students experience the lifting of traditional education restrictions [13]. With the augmentation of mobile devices, learning became ubiquitous and popular. Students use mobile devices, wireless communications, and technologies to gain experience in a real-world learning environment [14].

B. Ubiquitous Learning in Higher Education

Higher education institutions make use of ubiquitous, operated by educators and students, to provide various functions. Computer science classes at some higher education institutions use ubiquitous technology. Learners believe they can gain more hands-on experience and motivation from ubiquitous technology than traditional methods [15]. Despite their myriad benefits, learners experience the development of their inventiveness and problem-solving skills with Ubiquitous Learning. One might ponder why ubiquitous learning is less commonly employed in higher education [16]. Furthermore, the education process can be complicated and costly when integrating ubiquitous technology [17].

Additionally, in higher education, researchers increasingly use ubiquitous learning for specific activities, and the fields making the most significant use of this approach should be examined. Students commonly use ubiquitous learning to teach themselves programming and language learning, as they have rapidly adopted this approach for these activities [18]. Moreover, to obtain better learning effects, [16] declare the characteristics of ubiquitous learning, such as the need for context-aware learning anytime, anywhere, for learners to find information without any constraints. Ubiquitous learning is another characteristic. Educators and learners can learn uninterrupted as they move from one place to another.

III. PROPOSED MODEL FOR THIS RESEARCH AND HYPOTHESIS

In this investigation, we extend the unified theory of acceptance and use model by including context awareness, self-directed learning, and Hedonic motivation. Fig. 2 presents the proposed research model and hypotheses with the seven constructs "Context-awareness", "self-directed learning," "hedonic motivation," "perceived compatibility, "personal innovativeness", "performance expectancy," and "facilitating conditions " are assumed to predict the higher education community's behavioural intention to adopt ubiquitous learning.

ISSN: 2414-4592
DOI: 10.20474/jater-8.1.5

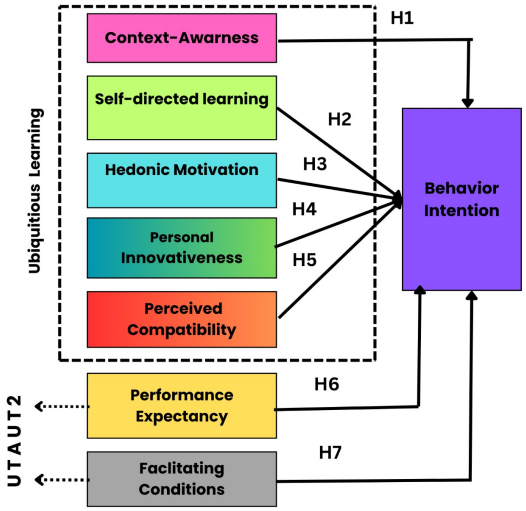

Fig. 2. Proposed research model and hypothesis

For this research, we choose the UTAUT2 model as the primary one for expansion for several reasons within technology adoption research. Many researchers and practitioners have recognized and accepted the UTAUT2 framework for its comprehensive nature. An extended and adapted UTAUT2 model can accommodate the unique nuances and characteristics of different technological innovations and adoption contexts when studied. The revised UTAUT2 significantly improves upon the original UTAUT model [19]. Furthermore, the most widespread theory in information communication and systems study is the extended theory of acceptance and use, known for its robust explanatory influence. Additionally, it explains why the technology is accepted in different contexts and use cases [20]. In this research, ubiquitous learning in higher education extended the theory of acceptance and used a model with constructs like context awareness and self-directed learning.

In the proposed model, we have chosen to include only the subsequent factors from UTAUT2: "Performance expectancy," "effort expectancy," "social influence," "price value," and habit. We have excluded "EE," "SI," "PV," and habit for specific reasons. Firstly, ubiquitous learning technology in higher education provides them with the technology, but they must be financially responsible. Effort efficiency may be less relevant in determining factors [21]. Secondly, social influence may not significantly impact the acceptance behaviour of students. In HE settings, students do not heavily rely on societal expectations to use institutional learning technology for their learning [22]. Thirdly, students are not financially responsible for the ubiquitous learning technology provided by their institutions; thus, factors related to price value may not be relevant to them. The technology's cost-effectiveness or perceived value for money may not significantly influence Students' decisions to use or adopt it [23].

Fourth, in higher education settings, the regular use of ubiquitous learning technology may not significantly influence adoption and implementation. Individuals do not follow established habitual patterns of technology use in their daily lives as in some contexts. Furthermore, higher education students may adopt more variable and adaptable approaches to learning technology rather than relying on habitual routines [24]. Firstly, the model quantifies the relationships among constructs directly by offering a simpler one, excluding moderators' influence on UTAUT2: age, gender, and experience are not considered [25]. Then, using moderators does not affect the context of acceptance [26]. Thirdly, you can create a model generally used in various contexts [27].

A. Context-Awareness

Context-awareness is the independent variable adopted for this research. The system perceives contextual information about the user as a crucial aspect of ubiquitous learning, representing its context awareness [28]. The surrounding environment and the system actively adapt and make dynamic and proactive adjustments to their functionality. Ubiquitous learning technology with the ability to discern contextual cues ubiquitously operates. Therefore, we propose the following:

Hypothesis 1: CA will have a positive and significant effect on behavioural intention.

ISSN: 2414-4592
DOI: 10.20474/jater-8.1.5

B. Self-Directed Learning

Self-directed learning is another independent construct in the ubiquitous learning theoretical model. Learners direct their learning in U-learning and find ways to personalize and sensitively adjust the learning situation to themselves [29]. Students are active and central participants in this process, and their characteristics facilitate or act as barriers to their motivation to use the U-learning setting [30]. Individuals need to understand the role of self-directed learning in terms of personal differences.

Hypothesis 2: SDL will have a positive and significant effect on behavioural intention.

C. Hedonic Motivation

Hedonic motivation is adopted for this research. Individuals derive fun or pleasure, referred to as Hedonic Motivation (HM), from using technology [31, 32]. Students significantly contribute to technology acceptance and use with their hedonic motivation. Students experience higher trust in information technologies when they encounter hedonic stimuli that strongly motivate them [33]. Through numerous studies, educators in various settings have demonstrated that hedonic motivation positively influences behavioural intentions. Ubiquitous learning offers the intrinsic allure of autonomous behaviour, captivating design, entertainment value, enjoyment, and the capability for personalized learning experiences [34]. Students are incentivized towards adoption by all serving as hedonic advantages. Consequently, we propose the following:

Hypothesis 3: HM will have a positive and significant effect on behavioural intention.

D. Personal Innovativeness

An individual adopts innovation earlier than another, which defines their degree of personal innovativeness within a social system. That innovation has been adopted to measure this definition. Another study defines innovation as a fundamental dimension of relevant personality for analyzing organizational change. [35] offers the concept that one can locate oneself within a continuous range of abilities, which enhances the doing of things by assigning adaptive labels to the stages of different things' abilities, emphasizing innovative labels. This idea was developed in the information system and information communication technology field when they conducted a study to define personal innovativeness in the context of ubiquitous learning in higher educational institutions.

Hypothesis 4: PE will have a positive and significant effect on behavioural intention.

E. Perceived Compatibility

In the IS field, users adopt new technology or applications more readily when compatibility is ensured. Probable adopters perceive the intensity of alignment between innovations and their current needs and prior experiences, determining the compatibility. In this research, students' beliefs, values, and lifestyles fit with online learning technologies. Mobile learning programmers in Taiwan established meaningful relationships between usage and compatibility [36]. Furthermore, this knowledge in the field of information and communication technology was utilized when he led a study to define perceptual compatibility in the context of ubiquitous learning in higher education institutions.

Hypothesis 5: PC will have a positive and significant effect on behavioural intention.

F. Performance Expectancy

Individuals believe that a particular technology will help them execute their tasks more efficiently to the extent of performance expectancy [37]. When individuals believe technology will increase their productivity more than traditional methods, they are more likely to use it [19]. The primary determinant of behavioural intention in accepting technology is performance expectancy. Hence, we advance the following proportion.

Hypothesis 6: PE will have a positive and significant effect on behavioural intention.

G. Facilitating Condition

Individuals perceive the essential infrastructure or resources as facilitating the use of technology. Educators perceive the essential infrastructure or resources as facilitating the use of technology [38]. According to numerous studies, various technologies' adoption intention is positively associated with facilitating conditions. With the necessary resources, knowledge, and expertise, students are more likely to incorporate ubiquitous into their instructional endeavours [39]. Consequently, we propose the following:

Hypothesis 7: FC will have a positive and significant effect on behavioural intention.

IV. METHODOLOGY

In this investigation, we administered questionnaires designed to test the hypotheses and acquire the relevant data for this study. Students in tertiary educational establishments throughout Pakistan were the focus of the investigation [40]. The students were delivered a self-administered survey instrument. We adopted a cluster sampling technique because there was no defined sampling frame for par-

ISSN: 2414-4592
DOI: 10.20474/jater-8.1.5

ticipants. This form of probability sampling is efficient and economically viable and, when implemented, is advantageous in obtaining high-quality data [41]. We utilized the Smart-PLS tool to determine the minimum sample size or non-normal data, making it the preferred choice for many researchers, especially in fields where the sample size is often limited.

Therefore, during the field study, we determined that out of 600, a total sample size of 301 was appropriate for conducting the statistical analysis and the demographic profile of the participants is shown in Table 1. The first segment of the research instrument collects information about student demographics, while the second component gathers data related to their academic performance. The second segment assesses the seven elements of the proposed research model through its items. For this research, the seven-point Likert scale has each item rated from 1 to 7 stro, from strongly disagree to agree strongly. Furthermore, we adapted the items to assess the UTAUT2 constructs from [25]. The appendix lists the items corresponding to each construct. This research data was analyzed via PLS-SEM. Ubiquitous learning technology adoption in the higher education decision-making process is influenced and aided by Smart-PLS in ranking the significance of the impacting factors.

TABLE 1
STUDENT DEMOGRAPHICS PROFILE

Characteristics	Value	Frequency	Percentage %
Gender	Male	158	52.5
	Female	143	47.5
Student Qualification	Undergraduate	301	100.0
Experience in using Ubiquitous Learning	0–1 year More than two years	301	100.0

V. RESULTS

A. *Measurement Model*

In this research, the structural model must be evaluated before evaluating the measurement model. Measurement models must be assessed to ensure reliability and effective alignment with theoretical constructs [42]. Evaluation of measurement models includes examination of construct reliability, convergent validity, and discriminant validity. [43] Scrutinize both CR and CA during the assessment of construct reliability in the measurement model with a threshold value of 0.7. CA and CR both exceed the 0.7 threshold, indicating the reliability of the indicators. As illustrated in Table 2, we examine factor loadings and average variance extracted from AVE to evaluate convergent validity by checking if 0.708 exceeds the factor loading threshold and if 0.5 surpasses the AVE cutoff value [44]. The factor loading values exceed 0.708, and the AVE values surpass the cutoff threshold of 0.5, affirming convergent validity.

TABLE 2
RELIABILITY AND CONVERGENT VALIDITY RESULTS

Constructs	Items	Factor loading	Cronbach's Alpha	CR	AVE
Behavior Intention	BI1	0.706	0.743	0.839	0.752
	BI2	0.823			
	BI3	0.727			
	BI4	0.748			
Context-Awareness	CA1	0.9	0.871	0.921	0.891
	CA2	0.897			
	CA3	0.877			
Self-Directed Learning	SDL1	0.746	0.71	0.819	0.729
	SDL2	0.781			
	SDL3	0.846			
	SDL4	850			

ISSN: 2414-4592
DOI: 10.20474/jater-8.1.5

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Constructs	Items	Factor loading	Cronbach's Alpha	CR	AVE
Hedonic Motivation	HM1	0.832		0.884	0.847
	HM2	0.858	0.803		
	HM3	0.85			
Personal Innovativeness	PI1	0.813	0.676	0.805	0.764
	PI2	0.846			
	PI3	0.85			
Perceived Compatibility	PC1	0.845	0.845	0.906	0.874
	PC2	0.844			
	PC3	0.893			
	PC4	0.883			
Performance Expectancy	PE1	0.862	0.904	0.928	0.849
	PE2	0.832			
	PE3	0.856			
	PE4	0.845			
	PE5	0.853			
Facilitating Condition	FC1	0.822	0.692	0.789	0.754
	FC2	0.86			
	FC3	0.887			

To assess discriminant validity, we examined the Heterotrait-Monotrait ratio of correlations HTMT, recommending that the HTMT values remain below a certain number (0.85) [45]. All HTMT values in Table 3 are below the recommended threshold of 0.85, confirming discriminant validity.

TABLE 3
HTMT RESULTS

	Adaptability	Availability Educational	Behavioral Intention	Context Awareness	Facilitating Conditions	Hedonic Motivation	Perceived Compatibility	Performance Expectancy	Personal Innovativeness	Self-Direct Learning
Behavioral Intention	0.517	0.490								
Context Awareness	0.500	0.514	0.268							
Facilitating Conditions	0.310	0.811	0.461	0.715						
Hedonic Motivation	0.610	0.825	0.605	0.304	0.429					
Perceived Compatibility	0.453	0.778	0.417	0.446	0.801	0.720				
Performance Expectancy	0.415	0.688	0.675	0.208	0.464	0.641	0.706			
Personal Innovativeness	0.424	0.443	0.377	0.603	0.813	0.722	0.738	0.666		
Self-Direct Learning	0.621	0.738	0.706	0.528	0.486	0.583	0.542	0.458	0.660	

B. Structural Model

In the subsequent stage, we evaluate the measurement model and then assess the structural model using a two-tailed bootstrap procedure. The computation of the path coefficient (β), t-value, p-value, and coefficient of determination (R^2) is evaluated by the structural model [46] The R^2 indicator, which ranges from 0 to 1, reveals the extent to which the endogenous variables explain the variance in the model. The independent variables in this study cause variation in behaviour intention by a proportion of 0.52%.

The results indicated that context awareness, self-directed learning, hedonic motivation performance expectancy, and facilitating conditions accounted for 52.8% of the variance in higher education students' intention to adopt ubiquitous Learning. In this table, the results of hypothesis testing are displayed. In Pakistan, higher education embraces context awareness, encourages self-directed Learning, hedonic motivation, personal innovativeness, perceived compatibility, and performance expectancy, and provides facilitating conditions.

The independent and dependent variables in the analysis correspond with their respective beta coefficients. Furthermore, a total of seven IVs are used in this study, and the seven independent variables that empirically influence the assets of the dependent variable, behavioural intention, are

ISSN: 2414-4592
DOI: 10.20474/jater-8.1.5

statistically positively associated with behavioural intention. Additionally, these seven hypotheses are statistically significant and support these relationships. Demonstrated in Table four.

TABLE 4
HYPOTHESIS TESTING AND RESULTS

No	Hypotheses	Path Relation	T-value	p-value	Remarks
1	Context-Awareness	CA-BI	9.353	0.000	Accepted
2	Self-Directed Learning	SDL-BI	5.984	0.000	Accepted
3	Hedonic Motivation	HM-BI	3.823	0.000	Accepted
4	Personal Innovativeness	PI-BI	3.256	0.001	Accepted
5	Perceived Compatibility	PC-BI	2.575	0.010	Accepted
6	Performance Expectancy	PE-BI	8.475	0.000	Accepted
7	Facilitating Condition	FC-BI	4.914	0.000	Accepted

VI. DISCUSSION

The results of this study show that satisfaction and confirmation are the five key factors predicting an intention to use ubiquitous learning. This study, like previous ones [47, 48, 49, 50], emphasizes the importance of ubiquitous learning. This research further clarifies that higher education can enhance ubiquitous learning through context awareness, self-directed learning, hedonic motivation, personal innovativeness, and perceived compatibility. Additionally, these findings suggest the need for wireless technology to provide educational content quality in higher educational institutions. Furthermore, excellence of service to students, whether students or professionals. Likewise, this current research seeks to approach the issue from an empirical perspective to gain a better adoption of ubiquitous learning in the context of developing countries like Pakistan.

Consequently, in this study, we have employed the UTAUT2 model as the primary theoretical lens to examine and interpret students' adoption of ubiquitous learning in Pakistani higher education institutions. 52.8% of the variance in the intention to adopt ubiquitous learning in higher education for behavioural intentions was explained by the seven hypotheses. Seven of these hypotheses were supported. In this research, we have proposed seven hypotheses for the theoretical framework of ubiquitous learning in higher education. Table 4 hypothesis testing and displays the results of each hypothesis.

This hypothesis has positive parameter signs between CA and BI. The path estimates are significant at < 0.05 with a t-value of 9.353, higher than 0.000. The results of the H1 study reveal a positive effect of CA on BI acceptance and use of ubiquitous learning technologies in higher education. The results established that context awareness has a positive influence on behaviour intention. This outcome suggests that once students recognize the apparent benefits, from the perspective of improving learning efficiency and deepening understanding of concepts, more engaging educational experiences using increased ubiquitous learning motivation to introduce such technology.

This hypothesis has positive parameter signs between SDL and BI. The path estimates are significant at < 0.05 with a t-value of 5.984, which is higher than 0.000. The results of the H2 study reveal a positive effect of SDL on BI acceptance and use of ubiquitous learning technologies in higher education. The results also supported the hypothesis that self-directed learning has a significant positive impact on behavioural intention. A combination of empirical evidence, theoretical rationale, practical implications, consistency with previous research, and statistical significance likely leads to the acceptance of the hypothesis. This study found that users' insights of ubiquitous Learning showed a much stronger effect on intentions than previous studies regarding the use of mobile learning, as stated as follows [51, 52].

This hypothesis has positive parameter signs between HM and BI. The path estimates are significant at < 0.05 with a t-value of 3.823, higher than 0.000. The results of the H3 study reveal a positive effect of HM on BI acceptance and use of ubiquitous learning technologies in higher education. The results showed that hedonic motivation significantly predicted behavioural intention. When students find interactive learning enjoyable and stimulating, they are more likely to show a willingness to use these technologies in their learning process. Users in educational technology research should not only find methods effective and effi-

ISSN: 2414-4592
DOI: 10.20474/jater-8.1.5

cient but also engaging and enjoyable, as this insight aligns with growing recognition.

This hypothesis has positive parameter signs between PI and BI. The path estimates are significant at < 0.05 with a *t*-value of 3.252, higher than 0.001. The results of the H4 study reveal a positive effect of FC on BI acceptance and use of ubiquitous learning technologies in higher education. The findings of earlier studies supported the results, which facilitated the role of conditions in affecting behavioural intention.

This hypothesis has positive parameter signs between PC and BI. The path estimates are significant at < 0.05 with a *t*-value of 2.575, higher than 0.010. The results of the H5 study reveal a positive effect of FC on BI acceptance and use of ubiquitous learning technologies in higher education. The findings of earlier studies supported the results, which facilitated the role of conditions in affecting behavioural intention.

This hypothesis has positive parameter signs between PE and BI. The path estimates are significant at < 0.05 with a *t*-value of 8.475, higher than 0.000. The results of the H6 study reveal a positive effect of FC on BI acceptance and use of ubiquitous learning technologies in higher education. The outcomes of earlier studies supported the results, facilitating the role of conditions in affecting behavioural intention.

This hypothesis has positive parameter signs between FC and BI. The path estimates are significant at < 0.05 with a *t*-value of 4.914, which is higher than 0.000. The results of the H7 study reveal a positive effect of FC on BI acceptance and use of ubiquitous learning technologies in higher education. The findings of earlier studies supported the results, which facilitated the role of conditions in affecting behavioural intention.

So, Educational institutions should run campaigns to educate the public about effectively utilizing ubiquitous technology in classrooms. Students' desire to use technology and share information socially with their peers who are still adopting it will be boosted by increasing their understanding. Therefore, in this study, the respondents were university undergraduates, and this cluster sampling may have led to the low effectiveness of BI and previous experience. Therefore, this finding may be helpful but needs to be clarified by future research. Furthermore, this finding developed a theoretical model for the extended unified theory for acceptance and use.

The role of BI as an antecedent variable is essential. One limitation of the current literature is that it needs to help explain acceptance in a way that guides development beyond suggesting that system characteristics influence behavioural perceptions of acceptance and intention to use ubiquitous learning. Therefore, it is essential to understand the key antecedents. Acceptance variables can explain individual acceptance and use. This study examines how educational users perceive and interact with ubiquitous learning and how ubiquitous learning elements influence the development of users' behavioural intentions toward U-learning. The findings confirm previous research on adopting ubiquitous learning [26, 53] and offer guidance for designing effective ubiquitous learning technology for ubiquitous learning.

VII. CONCLUSION

A. *Theoretical Contribution*

Firstly, this study makes several theoretical contributions to the discussion of ubiquitous Learning in education and the applicability of UTAUT2 theories. In the newly developing environment, we make one of the few attempts to measure the adoption of ubiquitous technology in higher education using the UTAUT2 framework. Secondly, the question of how individuals' needs and educational-related tasks are met by ubiquitous learning technology remains to be determined. Thirdly, our study assesses the proposed model within the framework of Asian nations, such as Pakistan, providing a novel perspective on adopting ubiquitous learning, unlike existing research, which primarily focuses on individualistic contexts in Asia.

B. *Practical Contribution*

This study's findings have significant practical implications for decision-makers in higher education institutions. Primarily, the empirical analysis provides a comprehensive understanding. Furthermore, Students influence the utilization of ubiquitous Learning in their academic pursuits through the determinants at hand. Motivational variables such as context awareness, self-directed learning, hedonic motivation, Performance expectancy, and facilitating condition elucidate the influence on the level of adoption.

Secondly, specialized ubiquitous can be refined based on empirical findings to cater to specific subgroups within the broader educational landscape. Ubiquitous system designers and developers can adapt to the ever-evolving expectations of users within the higher education milieu using this capability.

Thirdly, CA, SDL, HM, PI, PC, PE, and FC exerted the most pronounced influence on adopting ubiquitous learning in higher education. Furthermore, educational institutions should initiate campaigns to enlighten the public on the effective utilization of ubiquitous technology in classrooms.

ISSN: 2414-4592
DOI: 10.20474/jater-8.1.5

Enhancing students' comprehension amplifies their inclination to employ such technology and encourages them to disseminate this knowledge among peers at nascent adoption stages.

Limitations and Future Work

The study's findings may not be widely applicable as it focuses specifically on undergraduate students. A cross-sectional design limits our ability to capture longitudinal or time-based insights. Secondly, solely relying on quantitative data from Likert-scale questionnaires may overlook nuanced qualitative perspectives. Thirdly, we restrict the validation of the proposed model to a single developing country, Pakistan. Therefore, developing nations must extend this validation.

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ISSN: 2414-4592
DOI: 10.20474/jater-8.1.5

VIII. APPENDIX

TABLE 5
RELIABILITY AND CONVERGENT VALIDITY RESULTS

Construct	Code	Item
Behavior Intention	BI1	I intend to use ubiquitous learning in the future
	BI2	I will use Ubiquitous Learning in the future.
	BI3	I plan to use Ubiquitous Learning in the future.
	BI4	I would recommend Ubiquitous Learning to my colleagues
Context-Awareness	CA1	I can receive useful information at the right time
	CA2	I can receive appropriate information and services relative to my current location.
	CA3	I can receive contextual information that reflects my current situation.
	CA4	I can receive helpful information at the right time
Self-directed Learning	SDL 1	I make my study plan.
	SDL 2	I seek help when faced with Ubiquitous learning problems.
	SDL 3	I manage my time well.
	SDL 4	I have set my Ubiquitous learning goals.
	SDL 5	I have high expectations for my Ubiquitous learning performance.
	SDL6	I make my study plan.
Hedonic motivation	HM1	Using Ubiquitous Learning Technology is pleasurable.
	HM2	Using Ubiquitous Learning Technology is enjoyable.
	HM3	Using Ubiquitous Learning is entertaining.
Performance Expectancy	PE1	Ubiquitous learning methods are useful in learning methods.
	PE2	Using Ubiquitous Learning methods enables me to accomplish tasks more quickly.
	PE3	Ubiquitous Learning improves learning and teaching effortlessness.
	PE4	Ubiquitous learning methods let me learn to relate task more quickly lets me learn related tasks more quickly.
	PE5	Ubiquitous learning methods are helpful in learning methods.
Facilitating Conditions	FC1	I know that it is necessary to use Ubiquitous learning technology.
	FC2	A specific person or group is available for assistance with any technical problem I may encounter.
	FC3	I have the resources necessary to use the Ubiquitous learning system.
	FC4	It is necessary to use the Ubiquitous learning system.
	PC1	The ubiquitous Learning application is appropriate for my needs.
Perceived Compatibility	PC2	The ubiquitous Learning application fits well with how I like to get learning services.
	PC3	I like virtual interaction with the ubiquitous Learning application better than personal interaction with physical offices.
	PC4	The ubiquitous Learning application fits well with how I like to interact.
Personal Innovativeness	PI1	If I heard about a new information technology, I would look for ways to experiment with it.
	PI2	I am usually the first to try out new ubiquitous Learning among my peers.
	PI3	In general, I am hesitant to try out ubiquitous Learning.

ISSN: 2414-4592
DOI: 10.20474/jater-8.1.5