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MODELING AND VALIDATING PERVASIVE LEARNING ACCEPTANCE IN PAKISTANI HIGHER EDUCATIONAL INSTITUTES: A UTAUT-BASED APPROACH

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Abstract
Pervasive learning, mobile learning, and electronic learning are advanced learning technologies that enable students to learn wherever they want, using mobile or handheld devices. This innovative technology offers flexibility and various learning mediums, helping students overcome challenges such as poor classroom facilities, cultural and religious barriers, and busy business and personal lives. This state-of-the-art, innovative technology facilitates learning wherever the desire arises. This research attempts to examine the various aspects influencing students' acceptance and utilization of new technologies, such as pervasive learning. This research broadened the existing study on UTAUT2 and created a theoretical model for the acceptance of pervasive learning. This study should facilitate learners in planning and implementing courses that seamlessly integrate technology. This research employs quantitative methodologies and gathers data through a cross-sectional survey to achieve its targeted outcomes. The entire population is 600, comprising students from four regions of Pakistan and six universities, and data from 301 topics is utilized to validate the proposed model using the new PLS approach and cluster analysis. The findings reveal that the three antecedents of behavioural intention were context awareness, self-directed learning, hedonic motivation, personal innovativeness, personal compatibility, performance expectancy, and conducive conditions (R squared variance – v2 = .528). These empirical findings show several influences that significantly affect the adoption of pervasive learning. To enhance students' adoption of ubiquitous learning and augment its practical significance, they present several theoretical advances pertinent to higher education institutions.

INTRODUCTION

The swift changes in technology direct Pakistani universities to alter their usage of Information and Communication Technology (ICT). Educational institutions now embrace modern flexible learning software instead of traditional teaching to provide learners with anytime-anywhere content access. Pervasive learning has gained extensive use in Western nations but Pakistani higher education institutions

remain attached to their traditional classroom instruction systems. The established instructional models focus on live academic encounters and classroom assets while reducing the chances for students to study independently outside structured learning environments.

Pervasive learning goes beyond the classroom and allows students to learn in spontaneous and continuous fashions in several environments while learning is incorporated into students' daily lives. Unfortunately, in Pakistan, lack of access to technology and infrastructure set the bar for the adoption of such methods low and this prevented students from going beyond formal teaching platforms for learning. According to [1], having continuous access to information and communication technologies will increase student learning, it is a more flexible and integrated method of learning. The research explores what affects Pakistani universities to accept and utilize pervasive learning. By applying the UTAUT model research will discover student attitudes and challenges about pervasive learning in order to develop an educational system framework for Pakistan.

RESEARCH GAP

For numerous years, higher education institutions in Pakistan have employed traditional methods. The COVID-19 epidemic highlighted the necessity for effective, innovative, and technology-based learning methods that provide durability, accessibility, and engagement. Contextual learning, characterized by open learning and the utilization of technology regardless of time and location, represents a favorable approach. Although already adopted in numerous industrialized nations, its application in higher education in Pakistan is constrained by factors such as technology availability, institutional acceptance, and staff training in technological utilization. Despite the increasing interest in digital education, there is a notable deficiency of research addressing the implementation, adoption, and enhancement of pervasive learning within the setting of Pakistan. Addressing this requirement is crucial for enhancing the status and accessibility of higher education institutions in the country.

RESEARCH QUESTIONS:

The following research questions were set to define the relationships based on prior research studies.

RQ1: What are the key factors that influence the acceptance and utilization of pervasive learning in higher education institutions (HEIs) in Pakistan?

RQ2: How can we develop a theoretical understanding of the factors influencing pervasive learning in HEI in Pakistan?

RQ3: What methods and approaches will be employed to validate the proposed research model in the context of pervasive learning acceptance in HEI in Pakistan?

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

RESEARCH OBJECTIVES:

The following three objectives are established

The goal is to develop a theoretical model of pervasive learning in higher education institutions in Pakistan based on the Unified Theory of Acceptance and Use of Technology.

To validate the proposed research model in the context of the acceptance of pervasive learning in higher educational institutes in Pakistan.

To discover the factors that influence the acceptance & usage of pervasive learning in higher education institutions in Pakistan.

LITERATURE REVIEW:

Pervasive Learning in Higher Education

Higher education institutions utilize pervasive systems, operated by instructors and students, to fulfill numerous functions. Computer science courses at certain higher education institutions employ pervasive technology. Students assert that they can acquire greater practical experience and motivation via pervasive technology compared to conventional approaches [1]. Pervasive learning helps students to develop their ingenuity and problem-solving abilities even if it offers many benefits. One might question why the use of pervasive learning in higher education is so infrequent [2]. Moreover, the integration of pervasive technology can be complicated and costly in the educational process [3]. Furthermore, in higher education, researchers appreciate learning for specific purposes more, so it is important to investigate the

yields using this method that has the most significance. As they have quickly embraced this method for these activities, students often pervasively learn to teach themselves programming and language learning [4].

UTAUT 2:

The literature presents various theories with proven models that analyze user acceptance of new technologies and their preferences for utilization. Davis et al. [5] initially formulated the Technology Acceptance Model (TAM), which Venkatesh et al. [6] subsequently enhanced into TAM2. Fishbein and Ajzen developed the Theory of Reasoned Action (TRA), and [7] adapted it to establish the Theory of Planned Behavior (TPB). Researchers looked at and tested each model before making improvements to better understand how people accept and use technology. The researchers concluded that UTAUT has greater explanatory power for IS/IT acceptance compared to other pertinent models and theories. The UTAUT is the primary technological model utilized in the field of technology acceptance, emphasizing critical deployment elements of information systems as outlined by Al-Mamary et al. [9]. A multitude of investigations yield results that corroborate this concept. The literature concurs that UTAUT is an excellent model for analyzing and predicting technology adoption acceptance across many scenarios. The literature ascribes considerable popularity to UTAUT compared to other models such as TRA, TBP, and its subsequent iteration, TAM2 [10]. UTAUT demonstrates greater efficacy and comprehensive explanatory capacity than all other models of user acceptance theory, as indicated in research [11].

Drawing on the theory of UTAUT, the extended version, UTAUT2 was presented in order to capture better consumer technology adoption by adding variables that contribute to behavior beyond workplace settings. In particular, UTAUT2 adds the constructs of hedonic motivation, price value, and habit that recognize the effect of enjoyment, cost-benefit perception, and habitual behavior in the adoption of consumer technology. The additions strengthen the model in explaining everyday choices for the adoption of technology at the individual level, e.g., smartphone apps, web services, and eLearning systems. The base set of moderators (age, gender, and experience) remains in UTAUT2 to make it a better explanatory theory for differences in various groups of users and contexts.

THE THEORETICAL MODEL:

A model proposed in Figure 1 analyzes different external factors that influence student acceptance and utilization of higher education institutions in Pakistan. The proposed model incorporates performance efficacy, facilitation conditions, context awareness, hedonic motivation, self-directed learning, personal innovativeness, Behavioural intention among its external variables

context awareness, self-directed learning, hedonic motivation, personal innovativeness, performance efficacy, facilitation conditions,

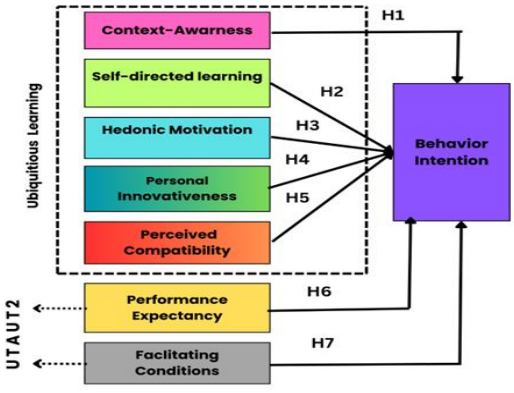

FIGURE 1. THEORETICAL FRAMEWORK

CONTEXT-AWARENESS:

This study will investigate the variable of context awareness. The notion of Pervasive learning integrates the system's contextual awareness, which is considered a crucial element of the system's context[11][12]. The system provides detailed information to the user. They can dynamically and proactively alter the system's overall operation and its surrounding environment, actively adapting to both. Pervasive technology facilitates learning and possesses the capability to identify ambient stimuli. These are the justifications behind the following:

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

SELF-DIRECTED LEARNING :

Self-directed learning is an independent concept within the theoretical framework of pervasive learning. Learners take initiative in controlling their education rather than being guided, actively seeking and judiciously adapting the learning environment to suit their needs [13]. The students are engaged and pivotal participants in the process, with traits that either facilitate or hinder their motivation in utilizing the pervasive learning environment [14]. People should understand the importance of self-directed learning concerning their personal goals.

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

PERSONAL INNOVATIVENESS

When a person accepts new things before others do, it demonstrates their level of personal innovation within a group. Academics use this acceptance to measure personal innovativeness according to this definition [15]. Research shows innovation serves as a basic aspect of specific personality types needed to understand business transformations. Researchers named a system where users measure development skills that provide better performance outcomes and encourage desired labels for different stages. Academics in information technology used this concept to research personal innovativeness during university p-learning.

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

HEDONIC MOTIVATION:

We employ hedonic motivation theory to examine the subject. Individuals derive pleasure from the use of phones and computers, a phenomenon referred to as Hedonic Motivation (HM) [16]. Students endorse technology acceptance and utilize it more effectively due to their appreciation of it. Individuals cultivate greater faith in IT when they encounter activities that elicit intense pleasure. Numerous studies across various educational settings demonstrate that pleasure-driven motivation influences students' behavioural tendencies. The essence of pervasive learning is that it elicits an instinctive reaction by immersing you in captivating designs and enjoyable educational experiences that you value and customize according to your preferences [16]. The advantages of utilizing this approach motivate students to adopt it. Therefore, we recommend the following actions:

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

PERCEIVED COMPATIBILITY

This suggests that compatibility is crucial for users to accept and embrace new technology applications in the Information Science field. Potential adopters therefore judge the degree of compatibility between the innovations and their current requirements and past experiences. In this research, the attitudes and perceptions students have dents have, evaluand values, and the lifestyle that they have towards online learning technologies. Mobile learning programmers in Taiwan have integrated the rationale between usage and compatibility [17]. Moreover, this knowledge in the field of information and communication technology was useful when he conducted a study to provide perceptual compatibility in the social learning environment of Pervasive Learning in higher institutions. Therefore, the fifth hypothesis follows:

Hypothesis 4: PC will have a positive and significant effect on behavioural intentions.

PERFORMANCE EXPECTANCY

People employ a specific technology to perform their work-related activities in a better way, and this belief is often to the extent of performance expectancy [18]. A positive attitude refers to how individuals feel about

adopting a certain technology in their work; when one feels that through technology, they stand to be more productive than through traditional methods of performing the same task, chances are high that one will adopt the technology in doing the job [19]. Performance expectancy is the antecedent with the highest influence on behavioural intention in the acceptance of technology. Therefore, we introduce the following proposition. Therefore, this paper hypothesizes that:

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

FACILITATING CONDITION

People perceive essential buildings and infrastructure components as factors that enhance technology usage. The necessary infrastructure, along with resources, serves as an enabling factor, according to educators [20]. Scientific research indicates that users develop positive intentions toward different technologies when they possess required supportive structures. Students tend to use Pervasive in their educational practices when they have the proper resources and appropriate knowledge as well as expertise [21]. Consequently, we propose the following:

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

RESEARCH METHODOLOGY:]

Study design refers to a systematic plan and methodology for data collection, analysis, and synthesis intended to as certain facts [22]. Consequently, it is essential to identify the population, followed by the establishment of a systematic data collection sequence that is fundamental to the initial phases of research design. A seven-point Likert scale was used in a closed-ended questionnaire administered to higher educational institutions in Pakistan, featuring responses ranging from strong disagreement to strong agreement. The researcher inputs the coded data into SPSS to evaluate Cronbach's alpha for each variable and, subsequently, for all variables collectively. Subsequently, the PLS-SEM executed its measurement model and validation process. The proposed research design enabled the researcher to distinctly delineate each pragmatic step undertaken to complete the investigation within the designated timeframe. According to [23], the research design facilitated the researcher in achieving the study's objectives as out below:

RESEARCH APPROACH:

The research design incorporated quantitative aspects, explanatory and cross-sectional characteristics, and employed cluster sampling procedures within a positivist framework. Thirty-eight items provided substantiation for three primary variables. The study gathered information using closed-ended questionnaires that had seven answer choices to meet the research goals and then analyzed the data using SPSS and PLS-SEM. The performance-efficacy assessment comprised five items for efficacy; three items for facilitation conditions; three items for context awareness; two items for adaptability; three items for hedonic motivation; five items for self-directed learning; three items for personal innovativeness; four items for perceived compatibility; and four items for behavioural intention. The test confirmed internal reliability across all metrics.

POPULATION:

[24] define populations as specific sets of entities, encompassing items, situations, and individuals studied under diverse conditions, particularly for this research. The primary research participants were students from public higher education institutions in Pakistan, who delineated the study's growth. The research employs data gathered from target respondents using a closed-ended questionnaire to arrive at its ultimate result.

SAMPLE:

[25] say that a researcher's main goal is to find a sample that is a valid representation of the whole community. We sent six hundred poll questionnaires to public higher education students in Pakistan. The students returned three hundred and one filled-out poll questionnaires. We could use all the poll results for both analysis and interpretation. We selected 301 students who had completed their studies at public colleges in Pakistan as the sample.

MEASUREMENT:

The quantitative data was collected by giving a closed-ended questionnaire to participants, which was then

analyzed using SPSS and further looked at with PLS-SEM. The survey was created and filled out by the respondents themselves, focusing on how much they agreed or disagreed, using a Likert scale with seven response options for each area. The self-developed and self-administered survey questionnaire used a closed format, focusing on levels of agreement and disagreement. It employed a Likert scale with seven response options for each dimension. The closed-ended questionnaire comprised specific components. The document included a cover letter detailing the research purpose, population description, performance efficacy, facilitation context, awareness, flexibility, hedonic motivation, self-regulated learning, personal innovation, compatibility, and behavioural intents. Nine elements of the study were selected, including 38 items, and data were collected through three variables.

ANALYSIS

Statistical methods can not only help researchers establish the reliability of the models they develop but also help estimate the extent to which the independent variables affect the dependent variable [97]. The main purpose of this study was to explore and identify factors that influence the acceptance and utilization of PL in higher education institutions. The researchers used SEM to conduct structural model and measurement model analyses to test the hypotheses. We used SPSS and Smart PLS as statistical software tools for analysis. We applied structural equation modeling to the measurement model analysis and used the structural model to test the hypotheses.

RESULTS:

TABLE 1. PARTICIPANTS 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

This research study used a seven-point Likert scale, where respondents rate items from strongly disagree to strongly agree, utilizing a numerical range from 1 to 7. We altered the evaluation items according to the extended unified theory of technology acceptance components referenced in [26]. The appendix includes a list of elements for each construct. The research data underwent analysis by PLS-SEM. Smart-PLS identifies the principal elements that affect decisions related to the use of pervasive learning technology in higher educational decision-making processes.

MEASUREMENT MODEL:

The researcher needs to examine the structural model preceding the assessment of the measurement model. The assessment of measurement models needs to confirm their reliability and correct alignment with theoretical constructs [27].

The evaluation of measurement models consists of three phases that include constructability assessment as well as convergent validity examination and discriminant validity evaluation. [28] To check if the measurement model is reliable, we need to look at both Composite Reliability (CR) and Cronbach's Alpha (CA), and they should both be at least 0.7. The indicators demonstrate reliability as both CA and CR exceed the threshold value of 0.7. The table shows information to check convergent validity using two measures: factor loadings and average variance extracted (AVE) from the table [29]. We verify that factor loading values surpass 0.708 and that the Average Variance Extracted (AVE) exceeds 0.5 to substantiate convergent validity. The analysis of factor loading values validated convergent validity, as these values exceeded 0.708 and were accompanied by AVE values exceeding 0.5.

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			
Hedonic Motivation	HM1	10.832		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			

We evaluated discriminant validity and, using the Heterotrait-Monotrait ratio of correlations (HTMT), advised that HTMT values should remain below a specified threshold (0.85) [30][31]. All HTMT values in Table 3 are below the suggested threshold of 0.85, hence confirming discriminant validity.

STRUCTURAL MODEL

Subsequently, we assess the measurement model followed by the structural model using a two-tailed bootstrap approach in the next phase. The structural model helps us calculate the path coefficient (β), t-value, p-value, and coefficient of determination (R^2), where R^2 can be between 0 and 1 for the outcome variable. The independent variables in this study account for 0.52% of the variance in behavioural intention.

The results show that college students' willingness to use pervasive learning depends on their awareness of the situation, ability to learn on their own, enjoyment of learning, expectations of success, and support available, which together explain 52.8% of the differences in their intentions. This table presents the outcomes of hypothesis testing. Universities in Pakistan recognize the context of higher education, promote self-directed learning, hedonic motivation, personal innovativeness, perceived compatibility, and

performance expectancy, and possess the necessary supporting conditions.

Both the dependent and independent variables of the analysis correspond to their respective beta value readings. This study includes seven independent variables (IVs) that affect the dependent variable called 'behavioural intention,' and these variables are important and positively related to 'behavioural intention.' Furthermore, the seven assumptions of the study are statistically significant and contribute to these correlations. This is demonstrated in Table 4.

TABLE 4. HYPOTHESIS TESTING 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

DISCUSSION

This study identifies seven criteria—specifically, pleasure and confirmation—that predict the intention to utilize pervasive learning. This research elucidates that pervasive learning can be augmented in higher education through context awareness, self-directed learning, hedonic motivation, personal innovativeness, and perceived compatibility.

This study aims to apply a positivist perspective to explore potential strategies for implementing pervasive learning in the context of Pakistan, a developing country. We used the UTAUT2 model to evaluate the acceptance and use of pervasive learning in Pakistani higher education institutions. The desire to use it to enhance the behavior of the higher education system was significantly influenced by seven out of fifteen hypotheses.

The parameters of this hypothesis are positive for both CA and BI. The t-value is 9.353, which is higher than 0.000, and the path estimates are significant at less than 0.05. The results from H1 of this study indicate that CA positively influences BI in terms of acceptance and usage of pervasive learning technologies in the field of higher education.

The hypothesis indicates that both SDL and BI demonstrate positive relationships with each other. The path estimates exceed the significance level of < 0.05 with a calculated t-value of 5.984 that surpasses 0.000. SDL proves to exert positive influences on the acceptance of BI for pervasive learning technologies in higher education institutions according to the results presented in the H2 study.

The parameters of the HM and BI hypothesis demonstrate a positive sign. The t-values exceed 0.000, and the estimates demonstrate statistical significance at less than 0.05, with a t-value of 3.823. The findings from the H3 show how HM had a positive effect on the adoption as well as the use of pervasive learning technologies in higher education.

The PI and BI variables show a positive relationship in this hypothesis. Our research findings show the relationship between these variables is statistically meaningful as indicated by a t-test result of 3.252. Our H4 study discovered that first-level centers help students accept pervasive learning technology and use it in their college education.

The study indicates that the relationship between PC and BI has a strong direct link. The path results indicate significance at the 0.05 level because the t-value is 2.575 greater than 0.010.

According to this analysis, PE has a positive effect on BI. The results demonstrate significance at a 95% confidence level, with a t-value of 8.475 surpassing the 0.000 threshold. The H6 study shows that faculty commitment has a positive role in boosting the use of pervasive learning platforms at universities.

The hypothesis dictates that both variables share positive parameter signs. The path estimates show significance at less than 0.05 and have a t-value of 4.914, which surpasses the significance threshold. The H7 study results indicate that Future Contact plays a

positive role in shaping pervasive learning technology acceptance among higher education students. A potential reason for low BI measurement and previous experience effectiveness in this study may be the use of university undergraduates as respondents through cluster sampling. The research findings provide valuable insights, but further studies should clarify and validate them.

Different acceptance variables show how individuals take to pervasive learning. We study how educational consumers connect with pervasive learning systems and what makes these systems influence consumer behavior regarding pervasive learning. Our research results support existing findings about pervasive learning solutions and show developers how to make better pervasive learning technology for this field.

CONCLUSION

This research study endeavored to explore the acceptance and impact of pervasive learning technologies in Pakistani higher institutions, particularly in the aftermath of the COVID-19 pandemic. The objectives were to evaluate the role played by digital tools in enhancing contextual awareness, emotional satisfaction, and goal-setting among learners. Employing a quantitative research approach, data were collected from 301 students through structured questionnaires, utilizing the UTAUT2 model to estimate behavioral intentions as well as technology acceptance.

The findings reflected extensive student favorability towards pervasive assessment and emphasized the importance of contextual relevance, emotional engagement, and institutional commitment in the acceptance of technology. Key hindrances noted were systemic inequalities and a lack of appropriate technological investment. The study proposes integrating IT instruction into all course materials and highlights the need for larger-scale research, involving family and community engagement, to support the future introduction of pervasive learning in Pakistan.

RECOMMENDATIONS

Drawing from the evidence and theoretical contribution of this research, a number of practical recommendations are made for higher education institutions and policymakers in Pakistan:

Embed pervasive learning approaches across all fields of study by integrating digital tools and platforms within the curriculum to facilitate ongoing and context-sensitive learning.

Establish institutional policies that make technology adoption central to teaching and learning, underpinned by frameworks like the extended UTAUT2 model applied in this research.

Offer specialized training to faculty and staff to develop their ability to employ pervasive learning technologies optimally, particularly in facilitating self-directed and emotionally rich learning experiences.

Facilitate infrastructure investment to enable sustained facilitating conditions to enable widespread take-up and sustainability of P-Learning systems.

Call for future studies to extend this model to other locations or learning contexts in other parts of the world, further testing its applicability and extending its theoretical scope.

REFERENCES:

[1] E. S. Almetere, B. W. Y. Kelana, and N. N. A. Mansor, ``Using utaut model to determine factors affecting internet of things acceptance in public universities," International Journal of Academic Research in Business and Social Sciences, vol. 10, no. 2, pp. 142-150, 2020.

[2] M. M. Abbad, ``Using the utaut model to understand students' usage of e-learning systems in developing countries," Education and Information Technologies, vol. 26, no. 6, pp. 7205-7224, 2021.

[3] L.-W. Wong, G. W.-H. Tan, J.-J. Hew, K.-B. Ooi, and L.-Y. Leong, ``Mobile social media marketing: A new marketing channel among digital natives in higher education?" Journal of Marketing for Higher Education, vol. 32, no. 1, pp. 113-137, 2022.

[4] S. Ali, D. DiPaola, I. Lee, J. Hong, and C. Breazeal, ``Exploring generative models with middle school students," in Pro- ceedings of the 2021 CHI conference on human factors in computing systems, 2021.

[5] M. Xenos, ``The future of virtual classroom: Using existing features to move beyond traditional classroom limitations," in Interactive Mobile Communication Technologies and Learning: Proceedings of the 11th IMCL Conference. Springer, 2018.

[6] M. Campbell, S. Saltmarsh, A. Chapman, and C. Drew, ``Issues of teacher professional learning within 'non- traditional'classroom environments," Improving Schools, vol. 16, no. 3, pp. 209-222, 2013.

[7] A. P. Rovai, M. J. Wighting, J. D. Baker, and L. D. Grooms, ``Development of an instrument to measure perceived cognitive, affective, and psychomotor learning in traditional and virtual classroom higher education settings," The Internet and Higher Education, vol. 12, no. 1, pp. 7-13, 2009.

[8] A. Mohammed, R. Ali, and B. Aldalan, ``Using u-learning in developing creative thinking levels among university stu- dents," International Journal of Scientiic & Technology Research, vol. 9, no. 4, pp. 129-133, 2020.

[9] O. Shirokova and M. Tumanova, ``Research processes of transition to u-learning in the sphere of education," in INTED2021 Proceedings. IATED, 2021.

[10] S. A. Aljawarneh, ``Reviewing and exploring innovative ubiquitous learning tools in higher education," Journal of Com- puting in Higher Education, vol. 32, no. 1, pp. 57-73, 2020.

[11] P. Vallejo-Correa, J. Monsalve-Pulido, and M. Tabares-Betancur, ``A systematic mapping review of context-aware analy- sis and its approach to mobile learning and ubiquitous learning processes," Computer Science Review, vol. 39, p. 100335, 2021.

[12] C. A. Graves, T. P. Negron, M. Chestnut II, and G. Popoola, ``Studying smart spaces using an" Embiquitous" computing analogy," IEEE Pervasive Computing, vol. 14, no. 2, pp. 64-68, 2015.

[13] E. Lacka and T. C. Wong, ``Examining the impact of digital technologies on students' higher education outcomes: The case of the virtual learning environment and social media," Studies in Higher Education, vol. 46, no. 8, pp. 1621-1634, 2021.

[14] A. U. Sheikh, Wireless communications: Theory and techniques. Springer Science & Business Media, 2004.

[15] C. Marinagi, C. Skourlas, and P. Belsis, ``Employing ubiquitous computing devices and technologies in the higher edu- cation classroom of the future," Procedia-Social and Behavioral Sciences, vol. 73, pp. 487-494, 2013.

[16] M. A. Virtanen, E. Haavisto, E. Liikanen, and M. Kääriäinen, ``Ubiquitous learning environments in higher education: A scoping literature review," Education and Information Technologies, vol. 23, pp. 985-998, 2018.

[17] N. El-Haggar, L. Amouri, A. Alsumayt, F. H. Alghamedy, and S. S. Aljameel, ``The effectiveness and privacy preservation of iot on ubiquitous learning: Modern learning paradigm to enhance higher education," Applied Sciences, vol. 13, no. 15, p. 9003, 2023.

[18] B. Cope and M. Kalantzis, Ubiquitous learning: An agenda for educational transformation. University of Illinois Press Champagne/Urbana, IL, 2009.

[19] C.-W. Yu, C.-M. Chao, C.-F. Chang, R.-J. Chen, P.-C. Chen, and Y.-X. Liu, ``Exploring behavioral intention to use a mobile health education website: an extension of the UTAUT 2 model," Sage Open, vol. 11, no. 4, p. 21582440211055721, 2021.

[20] K. Tamilmani, N. P. Rana, S. F. Wamba, and R. Dwivedi, ``The extended Uniied Theory of Acceptance and Use of Tech- nology (UTAUT2): A systematic literature review and theory evaluation," International Journal of Information Manage- ment, vol. 57, p. 102269, 2021.

[21] K. Nikolopoulou, V. Gialamas, and K. Lavidas, ``Acceptance of mobile phone by university students for their studies: An investigation applying UTAUT2 model," Education and Information Technologies, vol. 25, pp. 4139-4155, 2020.

[22] K. Tamilmani, N. P. Rana, and Y. K. Dwivedi, ``Consumer acceptance and use of information technology: A meta-analytic evaluation of UTAUT2," Information Systems Frontiers, vol. 23, pp. 987-1005, 2021.

[23] K.-Y. Lin, Y.-T. Wang, and T. K. Huang, ``Exploring the antecedents of mobile payment service usage: Perspectives based on cost-beneit theory, perceived value, and social inluences," Online Information Review, vol. 44, no. 1, pp. 299-318, 2020.

[24] C. C. Lewis, C. E. Fretwell, J. Ryan, and J. B. Parham, ``Faculty use of established and emerging technologies in higher education: A uniied theory of acceptance and use of technology perspective," International Journal of Higher Education, vol. 2, no. 2, pp. 22-34, 2013.

[25] R. Palau-Saumell, S. Forgas-Coll, J. Sánchez-García, and E. Robres, ``User acceptance of mobile apps for restaurants: An expanded and extended UTAUT- 2," Sustainability, vol. 11, no. 4, p. 1210, 2019.

[26] S. Hu, K. Laxman, and K. Lee, ``Exploring factors affecting academics' adoption of emerging mobile technologies-an extended UTAUT perspective," Education and Information Technologies, vol. 25, pp. 4615-4635, 2020.

[27] M. Trojanowski and J. Kułak, ``The impact of moderators and trust on consumer's intention to use a mobile phone for purchases," Central European Management Journal, vol. 25, no. 2, pp. 91-116, 2017.

[28] J. Gómez Gómez, H. Hernández Riaño, and V. Hernández Riaño, ``Scaffolding system for solving problems in engineering education," Revista Ingenierías Universidad de Medellín, vol. 20, no. 39, pp. 35-53, 2021.

[29] D. R. Garrison, ``Self-directed learning: Toward a comprehensive model," Adult Education Quarterly, vol. 48, no. 1, pp. 18-33, 1997.

[30] S. Lee, T. Barker, and V. S. Kumar, ``Effectiveness of a learner-directed model for e-learning," Journal of Educational Technology & Society, vol. 19, no. 3, pp. 221-233, 2016.

[31] D. Oluwajana, A. Idowu, M. Nat, V. Vanduhe, and S. Fadiya, ``The adoption of students' hedonic motivation system model to gamiied learning environment," Journal of Theoretical and Applied Electronic Commerce Research, vol. 14, no. 3, pp. 156-167, 2019.