



Ubiquitous Learning: A Blueprint for Educational Transmogrification

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Abstract

Ubiquitous learning is a new educational framework made possible by the affordances of digital media. This paper explores the dimensions of this proposition. We can use new technologies to learn old things in old ways, but the learner's relationship to knowledge and the processes of learning have not changed in any significant way. The origination of ubiquitous learning, which is also seen as ubiquitous computing, creates new conditions for all working conditions for all educational processes and enhances teaching and learning. In this paper, we offer seven moves which are characteristic of ubiquitous learning; each delving and leveraging the potentials of ubiquitous computing. None, however, is a pedagogical thought or social agenda that is new to the era of ubiquitous learning. The difference today is that there is now no practical reason not to make use of each of these ubiquitous learning moves. The potentials are there, and if we can, perhaps we should. And when we do, we may discover that a new educational framework emerges. And as a new framework emerges, we might find they take a leading part in technological transformation.

Keywords: Ubiquitous Learning, Ubiquitous Computing, Change, Technology, Process

Introduction

New technological developments have made interaction possible with computer systems and applications anywhere and anytime. These applications must be capable of being adapted to the user as a person and their current situation. In 2021, following the COVID-19 pandemic, learners across the globe have had the opportunity to experience online modes of learning. Ubiquitous learning is a new educational prototype made possible by the affordances of digital media. This paper sets out to explore the dimensions of this proposition. At first glance, it is the new devices of the information age that make ubiquitous learning different from ancient classroom and book-oriented approaches to learning. These appearances, however, can deceive. Old learning can be done on new machines. Using new machines is not necessarily a sign that ubiquitous learning has arrived. And some features of ubiquitous learning are not new; they are already in existence. But to focus on the machines for the moment, there is an obvious link between ubiquitous learning and ubiquitous computing. The term 'ubiquitous computing' describes the pervasive presence of computers in our lives; it is a concept in software engineering, hardware engineering, and computer science where computing is made to appear anytime and everywhere. Personal computers and laptops have become an integral part of our learning, work, and community lives, to the point where if you don't have access to a computer, you can be regarded as disadvantaged. In virtual learning, education is reformed, and the barriers of learning are overcome to a reasonable extent. The use of adaptation techniques in learning with ubiquitous computing and virtual learning can make for great advancement in education, providing personalization and adaptation to learners' needs. Therefore, the purpose of this paper is to present basic information about ubiquitous learning and the different uses of UL in different fields of study. This paper proffers solutions to questions on ubiquitous learning, an overview of ubiquitous learning technology key concepts, and its transmogrification to education generally. The paper is organized as follows: theory that supports ubiquitous learning, questions on ubiquitous learning, basic concepts of ubiquitous learning, approaches to ubiquitous learning/ various applicable areas of ubiquitous learning, ways to implement u-learning in tertiary institutions, and conclusion.

Theoretical Background

Theory Supporting Ubiquitous Learning: Ubiquitous learning is a kind of learning operating on the theory of constructivism paradigm. Constructivism supports that learning is the result of its own construction by the teacher/learner as an interaction with the learning environment. It is important to understand that the paradigm of constructivism about learning occupies a strategic position to achieve learning effectively. The use of digital media/resources in learning is becoming more prevalent and developing along with the development of information and communication technology (ICT). Information and communication technology has given rise to various activities that can transform the conventional way of doing things into flexible, personal, and effective activities by utilizing technological gadgets and digital resources.

Questions on Ubiquitous Learning

There are many questions about the concept and the applicability of U-learning, which could provide insight into the concept of U-learning as envisioned by Weiser. The answers to these questions will provide a guideline for planning an effective ubiquitous learning environment.

- a. Do the things we learn through U-learning have any academic value?
- b. Is there any teachers or instructors to explain difficult issues or ideas encountered through U-learning?
- c. Is U-learning a random learning activity?
- d. How can ubiquitous computing be made pervasive in the university environment to guarantee effective U-learning in a student's chosen field of study?

Basic Concepts: Ubiquitous Learning

A. Ubiquitous computing: The concept of ubiquitous computing is called (UC) or (UbiComp), invented by Weiser in 1991. Ubiquitous computing is a prototype of human interaction with computing devices, where a large number of small electronic devices are invisibly integrated into daily life. A set of sensors is used in these machines to allow interaction with our environment and communication functions for the transfer of their data. Ubiquitous computing allows for computing to be accessible to all: access to everything, by everyone, at any time and in any place. The arrival of ubiquitous computing will soon be combined with the development of new technologies in the digital world, especially through revolutionary developments in cloud computing, the technologies of edge computing, multi-cloud computing, the Internet with blockchain technology, and the 4G and 5G technologies.

B. Context-awareness: In ubiquitous computing technologies, context-awareness is always at the heart of the design because the goal is to sense the environment and respond to the actions dynamically. According to Kumar (2010), context is a set of background data about users, environments, and tasks, which may be used to help the user's activities of learning, and context-awareness is defined as applications that automatically generate data and/or suggest actions following the context of the users that are detected by the sensors. In the literature, Dey (2010) described context awareness as a way for devices to be able to detect, sense, then interpret and respond to the user's work environment.

C. Ubiquitous learning: In the literature, we have found several definitions where the most popular ones are: According to Weiser in Lyytinen et al. (2020) envisaged an environment pervasive with technologies that enables people to exchange information and services at anytime and anywhere. According to Yahya et al. (2016) and his colleagues, "U learning is a paradigm of learning that has an environment with ubiquitous computer technology that allows the right learning to take the right place, at the right time, in the right way.

Mishra et al. (2013) reported that the features of ubiquitous learning can be seen as follows:

- I. The system permanently determines the learner's location and environment and records the results in the database.
- II. According to the individual environmental context or location, it offers the right data at the right moment and in the right form.
- III. The system adapts to the needs of the system being used by the learner at any given point.
- IV. The learner will not lose his work anymore; it is permanently stored in the database.
- V. Real-time distribution makes it easy to improve service quality.

Characteristics of Ubiquitous Learning

The main characteristics of ubiquitous learning are as follows: firstly, they are situated in human-centred, personalized environments. What this means is that ubiquitous computing systems, which are enablers for U-learning, are embedded in specific predetermined physical devices which are prevalent or within our environments. According to Chen, 2002; Curtis, 2002 cited in Fekos 2013), the Key characteristics of Ubiquitous Learning are:

1. Permanency
2. Accessibility
3. Immediacy
4. Interactivity
5. Situated instructional Activities
6. Adaptability
7. Context-Awareness

It will be pertinent to elucidate on each of the above characteristics of u-learning.

Permanency: The information remains unless the learners remove it on purpose. Learning materials are always available unless deleted on purpose. This is actualized through cloud computing and the internet.

Accessibility: The information is always available whenever the learners need to use it. Learners have access to any document, information, or any kind of media from any point in the world.

Immediacy: The information can be retrieved immediately by the learners. Wherever a student is, the person can immediately access learning materials through any nearby enabled device.

Interactivity: The learners can interact with peers, classmates, teachers, and experts efficiently and effectively through the different embedded or enabled computing devices. Online collaboration with teachers and/or peers (chats/blogs/forums).

Situated Instructional Activity: It places students in an authentic learning situation where they are actively immersed in an activity while using problem-solving skills.

Adaptability: Learners can adapt by getting the right information, at the right place, and the right way. The definition and characteristics of u-learning are still unclear and being debated by the research community. Researchers have different views in defining and characterizing u-learning, and this leads to misconceptions and misunderstandings of the original idea of u-learning.

Context-awareness: The environment can adapt to the learners' real situation to provide adequate information for the learners. Learning in context is one of the features of u-learning. Context-awareness is the major characteristic that distinguishes u-learning from others. Dey and Abowd, cited in Saadiah and Kamarularifin (2010), defined context-awareness as "the ability of a program or device to sense various states of its environment or itself". Accordingly, location, identity, time, and environment are the primary context types for characterizing the situation of a particular entity.

Stroe (2019) the evolution of mobile technologies has created a change in people's lifestyles that has drawn the focus and attention of experts. Ubiquitous learning (U-learning) is a continuous development of "e-learning" and "mobile learning" (m-learning). The inclusion of mobile learning in the e-learning environment will define u-learning.

- **E-learning (electronic learning):** according to Muhammed et al. (2016), e-learning uses various technology tools based on the web, delivered over the web, or able to use the full web for learning.
- **M-learning (mobile learning):** according to O'Malley et al. (2015), m-learning is a way of learning that takes place outside the classroom, when the learner is not in one place and investigates the benefits of mobile electronic devices.
- **U-learning (ubiquitous learning):** from the paper of Yahya et al. (2016), U-learning is a paradigm of learning that takes place in a ubiquitous computing environment and which allows for learning the right information in the right location, at the right moment and in the right manner. It is a way of learning that provides learners the capability to learn anytime, anywhere.



Learning Paradigm Evaluation

Ubiquitous Learning Approaches

This section x-rays some approaches realized for ubiquitous learning in different domains. It is a description of the most relevant ones, provided below. Djebbari et al. (2014) proposed an approach called Mobilearn, which is developed to obtain knowledge in informal learning places. This application is made via an augmented reality interface with the use of a web service (CMS), by integrating various technologies such as Wi-Fi, RFID tags, NFC, and QR codes. Hwang et al. (2014) proposed a learning approach in a ubiquitous environment called MAIL. The MAIL had two kinds: one named the grid-based approach, which students were able to develop, upload, and share via mobile devices by using RFID sensors, for example, observing the display of apparatus in a school physics laboratory for collecting data. On the other hand, the other concept is named the mapping approach, for example, observing how a simple electrical circuit can be constructed. Students looked at their maps and also browsed with the use of wireless communication networks and RFID. Thus, the MAIL project is an adopting and helpful technology for students to learn, construct, and organize knowledge in a real-world environment. Kuo-Hung et al. (2016) proposed an approach called the MARPAS system for cooking courses; it is an assessment anywhere, anytime. It uses the new technology (augmented reality, AR); it allows students to use diverse methods to observe the cooking processes and do collaborative work. The system uses feedback and can be uploaded to a cloud server to store the work of students. In the paper by Da Silva et al. (2016), the authors proposed a learning system that is open called ULearnEnglish. Their system is to be used on mobile devices under both Ios OR Android. The main aim here is to help students acquire vocabulary of the English Language. ULearnEnglish explores the context of the learner to find new words from their daily life; the pedagogical approach was used in the incidental vocabulary acquisition technique, and it uses the location and profile of the learners to request content.

Boudabous et al. (2021) proposed MASUL, a multi-agent system in a hospital U-learning environment and an intelligent educational system for patients, nurses, visitors, and other health workers, aiming at improving the assistance and education of rescue techniques. The multi-agent system delivers personalized education to patients, nurses, visitors e., by the teacher (doctor). The system consists of three steps: Collecting information via learning devices, selecting and perceiving the data with a different set of agents, and exploiting the cloud computing architecture. With the addition of distributed artificial intelligence (DAI) techniques to ubiquitous computing, Salazar et al. (2015) built a system named U-MAS which is the multi-agent context-aware u-learning system by the employment of mobile devices which allows for various features like the following: adaptation of virtual courses, choice of learning objects based on the student's profile, evaluation of the course, offering the needed assistance to the learners in all fields and the use of context to support flexible learning activities. U-MAS was implemented using JADE integrated through the JENA framework. De Sousa et al. (2016) developed an approach called Youubi, an open-source software developed for a ubiquitous environment to support learning activities. It is a collection of various services that can be included from applications (iDTV, mobile, smart TV, etc.) in API format. It is a platform that enables formal and informal learning using contextual, social, and gamification tools. AcogVirtual is also a proposed criterion for U-learning in Edutech. This paper looks at the design process and analysis process. The implementation of this approach in the U-learning context has created aspects of play and motivation of learners.

Comparative Study

U-learning is now seen as a novel area; it has found its place in various fields. Many innovative approaches have been developed, as seen in the summarized comparative chart; this has increased and is increasing the learning performance of students anytime, anywhere, and anyhow, as the case may be. The table below summarizes a comparative study of outcomes obtained in the recent literature

Criteria	Mobilearn [15]	Mail [16]	U-Mas [20]	Marpas [17]	Youubi [21]	ULearn English [18]	MASUL [19]	AcogVirtual [20]
Year	2020	2020	2021	2022	2022	2023	2024	2025
Domain/ place	Libraries, museums	Botany: Garden	Computer course	Cooking: Kitchen	Biotechnology: Game	Teaching: language	Health: hospital	EduTech
Device or technology used	RFID, NFC, QR, Wireless, smartphone	QR, RFID, Smartphone, PDA, Wireless	Smartphone, laptop, Wireless, internet	GPS, Smartphone, camera, Tablet and personnel computers	Mobile, IDTV, Smartwatch, GPS, tablet, laptop	GPS, Smartphone	Wireless, Smartphone, temperature or heart rate sensor	Wireless, Smartphone, Computer
System design and development	Web service (CMS), XML, JSON, x3D	Repertory grid, Concept mapping	Android, multi-agent system, JADE, ontology, JENA	Peer assessment, real-time performance	Web, Java, service API	IOS and Android Web-based app, JSON, Google Places API	Android OS, multi-agent system, CloudSim, JADE	Web-based app, Google places API
Concept	Guide mobile, Reality context	Mindtool-assisted	Adaption of virtual courses	Assessment	App for Undergraduate, lifelong	Incidental technique for vocabulary acquisition	Web application for assistance, education	Web application for assistance, reality context
Permanence	SIGB	Feedback, e-library	Relational database	Feedback, cloud servers	Database server	Relational database	Cloud computing	Database Server
Using the context of learner	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Discussion

Comparison between the Main U-Learning Approaches: The table above shows a collection of U-learning approaches according to some criteria, especially the domain and the area of use in UL. Thus, we chose some recent approaches; only works published from 2014 to 2022 are chosen, and an adopted-criteria used to evaluate the performance of each method. Furthermore, the researcher tries to explicate clearly all keywords that constitute the definition as well as the characteristics of U-learning. All these were done with the intent of making U-learning a well-understood learning style with suggested approaches to its applicability in the field of education. For Ubiquitous learning to be understood clearly, the following should be borne in mind:

- U-learning is not limited to the classroom setting (no physical barrier)
- It may have a fixed or structured curriculum (this can be planned and uploaded by the university or establishment)
- The type of U-learning Weiser (1991) envisioned is unstructured curriculum, which is the reason ‘learning about anything’ is dominant as one of the characteristics of U-learning.
- You learn anything, anywhere and anytime (Even things that are not related to your field of study).
- Pervasiveness means that the technologies are embedded everywhere (built in) in devices we use every day in different environments.
- U-learning is more related to learning ‘anything’ made possible by ubiquitous computing.
- Ubiquitous learning is made possible through ubiquitous computing.
- Environment is the determinant of what you learn, made possible by the pervasiveness of ubiquitous computing within an environment. Therefore, U-learning is embedded in the context. A learning environment consists of a place and devices that are used to support the learning process, which no doubt influences or determines the learning system or method. It therefore implies that if the learning environment is highly embedded or pervasive with ubiquitous computing devices, then ubiquitous learning definitely takes place.

Ways of Implementing U-Learning in Tertiary institutions

1. First, tertiary institutions should endeavor to install ubiquitous computing devices in all strategic places in the tertiary institutions such as Cafeteria, football field, swimming pool, gardens, parks, hotels, halls, classrooms, ICT centers, libraries, instructional resource center (IRC), walk ways, road signs, car park, school farms, medical centers, table tennis/snooker rooms, theater house, security offices, worship centers, kitchen, indoor sport centers, stadium, workshops, Dean's and HOD's offices.
2. All the installed ubiquitous devices should be connected to the internet network and should be made to function 24 hours.
3. Data of all students, lecturers and staff should be captured and made permanent in all devices. Information in respect to how to locate all the buildings, offices, lecturers' offices and other interesting places within the tertiary institution should be uploaded in all the ubiquitous computing devices.
4. All courses with their respective notes made by the lecturers should be uploaded to all the ubiquitous computing devices embedded in all the physical devices within the context. This will enable the students, wherever they are within the tertiary institution environment (without carrying any mobile device), to access both synchronous and asynchronous learning resources.
5. The school library should be the first place to equip so that students can locate any book they are looking for by themselves through the ubiquitous computing device.

Analysis

After the overview of the approaches (domain application) of ubiquitous learning, we can say that it has become the paradigm in all fields of education systems, namely:

- Ubiquitous learning is based on the use of mobile phones and computers to support and access knowledge in an informal or formal learning environment.
- The goal of ubiquitous learning is to enable learners to participate in and understand all learning activities in the real-world environment.
- The system of learning helps students to interpret their work and integrate the feedback received into their present and future work.
- Mobile augmented reality can be implemented in ubiquitous learning to support personalized functionality and domain-specific content.
- Students can interact with real or virtual information according to needs.

Therefore, ubiquitous learning provides knowledge that is based on the user's contextual background, thus creating a meaningful environment via computer mobile devices for teaching and learning in various fields.



Application domains of U-learning

Conclusion

The emergence of ubiquitous learning is a new field that deals with the efficient distribution of information through mobile devices. This has opened new ways for researchers as well as professional institutions and companies to create and test their approaches and products across the globe. In this paper, we looked at basic concepts, applications, and domains of ubiquitous learning. This paper presents questions on U-learning and possible answers, characteristics, U-

learning approaches/domain and a comparative study between them to highlight their usage and importance, as well as the ways of implementing U-learning in tertiary institutions. Finally, we believe that ubiquitous learning is the most effective way for future human assistance in teaching, learning, and working in all domains of our daily lives, with new concepts and technologies evolving that must be used in their private, public, and professional life.

Suggestions

The following suggestions were made:

1. Tertiary institutions should integrate ubiquitous learning into their teaching and learning processes by providing the necessary digital infrastructure, reliable internet access, and mobile learning platforms that support learning anytime and anywhere.
2. Educational institutions should organise regular training and capacity-building programmes for lecturers and students to improve their knowledge and skills in the effective use of ubiquitous learning technologies and digital learning tools.
3. Government, educational administrators, and technology developers should work together to develop policies, provide funding, and promote the adoption of emerging technologies that support ubiquitous learning, thereby improving teaching, learning, research, and professional development across educational institutions.

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