

Effective Integration of Advanced Mobile Technology for Course Delivery in Information Technology Programs

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Abstract

Integration of mobile technology is now inevitable in every sphere of life including academic environment in higher education. Mobile technology, which includes mobile devices and applications (apps), is a new instrument in changing the traditional teaching and learning method. Many educational opportunities are made possible because of the unique characteristics and positive impacts of mobile technology on instruction and the learning process. This establishes a new area in learning, called *Mobile Learning*. Consequently, increasing numbers of higher education institutions are integrating emerging mobile technology as instructional tools for academic learning. Also, the majority of the students are the generation who have grown up and are living in the world of mobile technology. Therefore, it is important for instructors to know how to keep up with the rapid growth of ever changing mobile technology. Instructors need to know how to integrate the emerging mobile technology in their classes. Understanding the value of mobile technology in education can help instructors and administrators in higher education institutions to improve instructional process, which in turn, will lead to students' academic success. In this context, the purpose of this paper is to describe the effective integration of mobile technology in course delivery. The paper specifically focuses on the types of mobile technology that can be used in teaching courses in Information Technology programs. The paper also addresses the factors that affect adoption of mobile technology in learning process to achieve effective learning for students.

Introduction

The advance in mobile technology is changing teaching and learning process. Mobile technology is increasingly becoming a critical component in the educational environment and opening more opportunities for learners. Consequently, many Higher Education Institutions (HEI) are utilizing mobile technology as an effective learning tool. The use of Internet-enabled mobile technology in learning offers students the opportunity to learn anytime and anywhere [1]. The range of technologies available to support teaching and learning in higher education continues to grow exponentially. Therefore, instructors need to be well informed and familiar with different available technologies and systems that are suitable to be used for designing and delivering courses [2].

Mobile Learning or m-Learning

As the advent of mobile technology has deeply impacted the learning environment, it is becoming a valuable tool for learning. Recent developments in mobile and wireless networking technology removed time and space constraints in facilitating learning. The promising paradigm of mobile technology embedded the learning process into the everyday life environment. Consequently, the term *Mobile Learning* or *m-Learning* is starting to appear in educational environment. The world is becoming a *mobigital virtual space* where learning and teaching digitally is possible anywhere and anytime [3]. Today, when timely access to information is vital, mobile devices such as laptop, tablet, phablet, smart phone, iPod, digital camera, Personal Digital Assistance (PDA), e-Reader, etc. have become common devices used by younger generation, especially by college students. Mobile devices with software applications connected to wireless networks, e.g., 3G, 4G, Wi-Fi, Bluetooth, etc. provide students access to learning resources allowing them to work on course materials and interact with instructors as well as other students.

Define Mobile Learning

In scholarly literature, *Mobile Learning* or *m-Learning* is defined as an extension of e-learning, which is performed using portable mobile devices such as laptops, iPad, PDA, smart phones, etc. However, m-learning is anytime, anywhere seamless learning that represents more than a mere extension of traditional learning or e-learning. A common definition of mobile learning is the use of portable devices with Internet connection in educational contexts. Mobile learning provides unique learning experiences for learner in both formal and informal environments supporting various pedagogies with the unique characteristics of mobile technology [4]. Certain important characteristics of mobile learning are: *portability*, *wireless networking connection* and *ubiquity*. The most important characteristic of mobile learning is *ubiquity* that refers to its ability to be materialized whenever and wherever needed using handheld devices [3]. *Ubiquity* is more than just being mobile, and refers to the interconnectedness of the mobile device with its environment and other devices allowing learning continuity in any situation [4]. Mobile technology provides ubiquitous learning spaces and experiences across different situations or contexts [5]. Thus, mobile learning can be defined as a personal, unobtrusive, spontaneous, anytime, anywhere method of learning that allows learners continuous access to educational materials [6].

Mobile learning happens when a learner is not in a fixed, predetermined location and learns by taking the advantage offered by mobile technology [7]. Thus, the term mobile learning refers to the learning takes place in multiple locations, across multiple times using portable device such as wireless laptop, PDA, tablet, e-Reader, smart phone, etc. [8]. Some literatures define mobile learning as an extension of e-learning that happens anywhere, anytime, supported by mobile devices equipped with wireless technologies. However, the transformation of E-learning into m-Learning requires consideration of some issues during the design and development of course content [9].

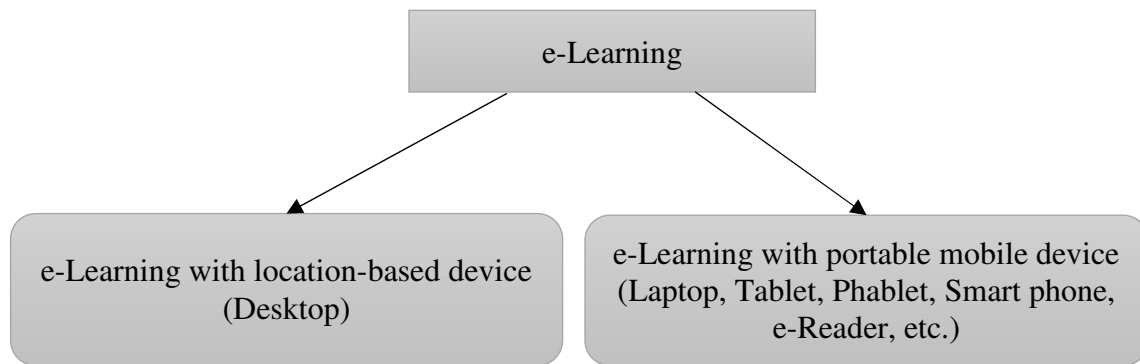


Figure 1: e-Learning transform to m-Learning

Mobile Technology as Learning Tool

In mobile learning course content is delivered using portable and handheld devices with a set of applications with similar functionalities [10]. The idea of learning through mobile devices has gradually become a trend in the e-learning environment as mobile devices are getting more capable of performing the functions necessary in academic learning [3, 11]. A number of different web-enabled mobile technology devices being used for academic learning purposes are laptop, notebook, e-Reader (Kindle, Nook, etc.), tablet, phablet, smart phone, etc. Besides, the software applications such as web 2.0, cloud computing, blogs, wikis, social media, etc. are being used as mobile learning tools.

Mobile Learning Systems Architecture

Mobile learning system needs to be designed on *client-server* based architecture to avoid running overload on mobile devices. In the client side, mobile devices such as tablet, phablet, PDAs, smart phones with wireless networking can access course content stored in the server. Students can learn anywhere and anytime using mobile devices connected to the server through middleware architecture. Within this client-server architecture, the server stores Learning Management Systems (LMS) with course content and other learning resources [12]. All those learning materials can be downloaded in the client mobile devices as per learner's request.

Middleware: The middleware architecture supports basic frameworks for students' learning allowing transmission of different course content such as graphics, text, images, voice, etc. between server and client. Mobile learning systems are designed to support learning applications using a wide variety of platforms and technologies in different types of mobile devices and communications in a geographically distributed global environment. Therefore, to implement a mobile learning system that properly supports the educational goal of running multimedia and streaming files, a learner-centered course design approach requires the

design of application software that is compatible with middleware architecture configuration [12].

Table 1: Mobile Technology as Tool for Mobile Learning

Mobile Technology	
Hardware	Software
<i>Server-side</i> (Stores course content and other learning resources)	<i>Mobile Operating Systems</i>
<i>Client-side</i>	<i>Middleware</i>
<i>Mobile Devices:</i> Laptop, Net book, E-reader (Kindle, Nook, etc.), Tablet (iPad), Phablet, Smart phone (iPhone, Android, Windows), PDA, etc.	<i>Application Software</i> <i>Learning Management Systems:</i> Blackboard, Canvas, Angel, SAM, Connect, etc. <i>Digital Apps:</i> Web 2.0, Cloud computing, Blogs, Wikis, Google drive, Podcast, Screencast, Voice thread, Social Media, etc.

Mobile Devices

In the mobile learning environment, the mobile devices are classified by the hardware size and the type of wireless network communication such as 3G, 4G, WiFi, IEEE 802.11, Bluetooth, etc. [11, 12]. In mobile learning, besides laptop, tablet and phablet are also being used popularly among other mobile devices.

Tablet: There are five main tablet manufacturers: Apple, Samsung, Motorola, HP, and Blackberry. Each manufacturer has specific tablet configurations with its own set of special characteristics and own specific sets of hardware that offer optimal features to appeal to a broad number of users [13]. A *Phablet* is a mobile device designed to combine or straddle the size and format of smartphone and tablet.

Mobile Operating Systems

Like any regular computer operating system, mobile operating system is the software platform in a portable handheld mobile device (tablet, phablet, smartphone, etc.) on top of which other applications run. The mobile manufacturer selects the mobile operating systems for a specific mobile device. The mobile operating system is responsible for determining the basic functions and features such as keyboards, communication with applications, wireless connectivity, text messaging, audio, video, etc. available on the mobile device. Mobile operating systems also determine which third-party applications can be used on a specific mobile device as there are a multitude of applications available to be used in mobile devices [13]. Some of the most common and well-known mobile operating systems are following:

iOS: A mobile operating system, developed by Apple Inc., used as a default operating systems for iPhone, iPad, and iPod. The iOS is a basic version of Mac OS, a UNIX-like operating systems.

Android: An open-source mobile operating system and an application framework supported by Google. Android is based on the Linux operating system. The Java programming language forms the core of the Android operating system. All Android applications have the same operating system's rights and privileges and can make use of the majority of the devices' functionalities, such as access to imbedded camera, multimedia, and other features [12, 13].

Windows: The operating system for Windows phone was developed using Microsoft's .NET framework. Applications written in any of the .NET languages compile to a common byte code that runs over the .NET virtual machine. Programs written for one Windows mobile device work on any mobile device running the same version of the operating system [13].

Mobile Applications

The mobile application is software in mobile devices that can provide a mobile platform for students in learning. The mobile learning applications include media player supporting streaming video and audio files. The mobile learning application, basically the running tools, supports the following course options: visualized collaborating processes, class discussion, lectures, tests, quizzes, assignments instructions, and grades. To access learning content in a mobile device, the required learning application needs to be downloaded in the mobile device. Numerous useful mobile applications are available to integrate in the learning process. Following are a few examples:

Web 2.0: Emerged in mid-1990s, Web1.0 immensely expanded the access to information and started the *Open Educational Resources (OER)* movement in education. Later the Web 2.0 version created more far reaching revolution in access to information. Web 2.0 tools such as blogs, wikis, social media, tagging systems, mashups, and content-sharing sites are examples of user-centric information infrastructure. Web 2.0 that facilitates innovative explorations and experimentation emphasizes interactive participation and understanding.

Blog or "Web log": A digital tool blog or "Web log" is an online collection of personal commentary and links. Since blogs offer peer-to-peer knowledge sharing in the blog platform, it can be used in class to capture and disseminate student and instructor-generated course content and knowledge. Instructors can use blogs to allow students to express their opinions and promote dialogue in their learning disciplines. Blogs can also provide a forum for discussion to explore learning areas. Students often learn as much from each other as from the instructor or textbook. Structured exercises and clear goal set can enhance the educational value of blogs. Instructors can set guidelines and expectations to maximize blogs' educational benefits in collaborative and interactive learning.

Social Media: Increasingly, social media is becoming an important learning tool that enables students to interact, learn, and engage in class. Social media that can be used for academic learning and instruction purpose are: YouTube, LinkedIn, Facebook, Twitter, etc.

Table 2: Tools for Using in Mobile Learning

<i>iAnnotate</i> - Annotate and review PDF documents on the iPad
<i>Notesplus/Evernote</i> - an app for taking notes in iPad
<i>AudioNotes</i> - combines the functionality of note-taking and voice recording apps
<i>Dragon Dictation</i> – Voice recognition app allows using voice to dictate text message or email
<i>Pocket</i> – Read It Later App to save articles, videos and other content for later
<i>TurboScan</i> – Portable document scanner turns iPhone into a full-featured powerful scanner for documents, receipts, notes, photos, whiteboards, and text in PDF or JPEG format.
<i>Kindle</i> -Enables users to browse, buy, download and read e-books, newspapers, magazines and other digital media via wireless networking to the <i>Kindle</i> Store.
<i>Stanza</i> – e-Reader for e-books and digital publications.
<i>DocsToGo</i> - Docs Anywhere for word, spreadsheet, presentation in iPad
<i>Splashtop</i> – Remote desktop software app allows mobile device clients to display all the content types that a host system supports, including Flash videos.
<i>Educreations</i> - Interactive Whiteboard and screencasting tool for teaching and learning
<i>gFlashPro</i> - Flashcards & Tests – Create and share Flashcards for test study
<i>Adobe Connect Mobile</i> - Host, share, collaborate, teach, and train from anywhere, anytime
<i>Diigo</i> - Save and tag online resources for easy access anytime, anywhere
<i>Skype</i> - For online communication, has been used in classes at various levels, providing many possibilities for teaching and learning
<i>iClicker</i> – create an intuitive student response system that focused on formative assessment and pedagogy.
<i>Ideament</i> – Concept Mapping App allow brainstorming new ideas, illustrating concepts, making lists and outlines, planning presentations, creating organizational charts, etc.
<i>Doodle</i> – for scheduling for remote class meeting

Evaluation Criteria to Select Mobile Tools in Course Delivery

A growing number of instructors and students are adopting mobile devices and using applications (apps) without any formal guidelines to evaluate the effectiveness of apps for their course discipline. Any instructional strategy of a course in an academic program can be supported by a number of contrasting technologies, similarly any given technology can support different instructional strategies of different courses of different academic programs. But for any given instructional strategy for a course in a program, some technologies are better than other technologies. Therefore, before deciding which tool should be used in a

class, a set of evaluation criteria need to be considered [14]. The literature suggests following relevant criteria that could be applied to evaluate mobile tools before deciding to adopt in course design [15]:

Accessibility: The tool is compatible with Windows and/or Mac; and accessible by all different web browsers such as Internet Explorer, Google Chrome, Mozilla Firefox, etc. Also the credibility of the app developers is important.

Usability: The tool is easy to use with *Help* link. The design of the tool is user-friendly and simple to install. The tool is not desirable if any other software is required to be downloaded and installed on the computer. The tool also makes it easy to track students' class assignment activity.

Performance: The tool is possible to embed into the LMS used for the class. The tool can be customized or extendable to fulfill class requirements.

Relevancy: The tool must be relevant to the course content to ensure effective learning. Also the text, visual and audio content of the tool should be at the appropriate level of the class.

Creativity and Collaboration: The tool must allow creative learning process. The tool should provide opportunities for different types of interaction (visual, verbal, written) among students and instructors. The tool increases the perception of connectedness and encourages collaborative learning.

Privacy and Intellectual Property: The tool keeps information private, especially protects students' personal data. The tool allows instructor and students to retain their intellectual property rights or copyright of the course content they create.

Durability: The tool will be around for a while – will not be changed or obsolete soon in the fast changing technology world.

Cost and fee: The tool should be affordable to students: free or minimum cost for purchase and/or update. Expensive tools will be an extra burden on students.

Integration of Mobile Technology in Delivery of Information Technology Courses

Computer lab assignments are fundamental aspects of student learning objectives in Information Technology programs. In most of the Computer Networking courses in Information Technology programs, hands-on lab exercises tend to be very specific that require operating systems configuration in computer devices and changes in the local area network. This requirement needs privileged access into specific and exclusive computer labs. However, it is not always possible to provide such exclusive computer labs to the students for a particular class as in most Higher Education Institutes (HEIs) the computer labs have to be shared by different students from different classes, even different programs or disciplines. The HEIs provide many computer lab facilities with desktop computers, but students have

limited access to those computers because most of those location-based special computer labs are reserved for teaching classes and are usually unavailable or not always available to students for hands-on computer lab assignments required in their classes. The limited access to computer lab makes it impractical, if not impossible, for students to complete complex hands-on lab exercises that require extra time beyond their class period in exclusive computer labs.

While there are constraints of exclusive computer labs, most of the students are now constantly carrying and extensively using their web-enabled mobile devices [8]. With increasingly improved hardware, software, networking infrastructure and systems for mobile technology and decreased costs, mobile technology is becoming more affordable and sustainable in learning [7]. As mobile technology becomes better, faster, and cheaper, and HEI continuously struggle to reduce the expense associated with exclusive computer labs, Learning Management Systems (LMS), Virtual Machine, and cloud computing can be alternatives needed in courses in Information Technology programs [16].

Virtualization

Recent progress in computing, multimedia, and networking technology provide an opportunity to build a self-growing, unit sharing virtual environment for teaching and learning [16]. Therefore, the issue of exclusive computer labs for courses such as Computer Networking, Systems Administrations, and Operating Systems in Information Technology programs can be lessened by use of Virtualization. The Virtual Machine technology allows each student in those classes to build his/her own virtual computer network, as required by lab exercise assignments, without interfering with the physical structure in computer lab and thus not disturbing other activities running in the lab.

Virtualization is a combination of hardware and software architecture that creates Virtual Machines allowing a single physical machine to act as several machines. The recent advances in Virtual Machine technology create growing interest in using it as an important tool in design and development of courses such as Computer Networking, Operating Systems, and Server Administration in Information Technology programs. Virtualization allows students to install the virtual machine in their laptop and work on their lab exercises from anywhere, anytime without accessing the exclusive computer lab. Today, most students have enough computing power in their laptops to execute several virtual machines simultaneously, allowing them to reproduce the hands-on lab class experience anytime, anywhere in their laptop.

Cloud as Platform

With rapid growth of wireless networking, mobile technology, and cloud computing, cloud based mobile learning has become a potential method in education [17]. Due to its ability to deliver computation and storage resources as services, cloud computing is a promising infrastructure that can provide great values to mobile learning. The main advantage of cloud

computing is the flexibility it offers to create, share, save and collaborate course content from anywhere, at any time [16].

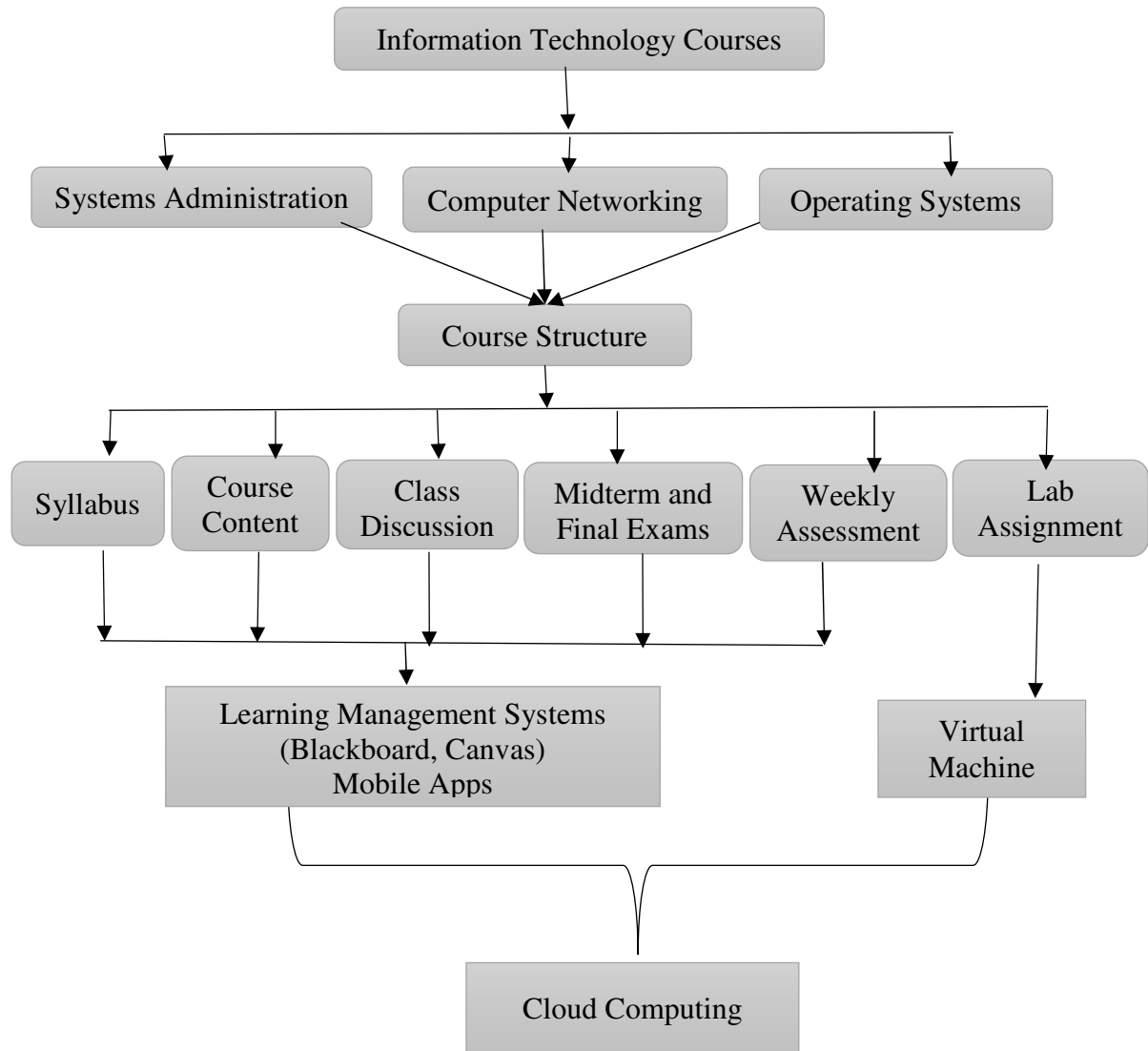


Figure 2: Integration of mobile technology in course delivery

The common characteristics of cloud computing are on-demand scalability of highly available and reliable computing resources, secure access to data and services from nearly anywhere inside or outside the campus [18]. Cloud computing has changed the way applications are developed and accessed. More and more complex applications such as word processors, spreadsheets, multimedia presentations, and database systems are now delivered as services over the Internet on a scalable infrastructure. All of the applications can be accessed from a web browser in mobile devices, while the software and files are hosted in the

cloud. This enables students in Information Technology courses such as Computer Application to work on their homework assignments using mobile technology. Students can work on their lab assignments from anywhere and anytime. They do not need to install content management systems such as SAM, Connect in their mobile devices as those systems are stored in cloud server. As clouds enable wider accessibility to any learning platform with internet connection, instructors and students are now having better access to the learning platform from anywhere, anytime [19]. HEIs can take advantage of cloud computing to provide students free or low-cost alternatives to expensive learning tools [20].

Benefits of Using Mobile Technology in Learning Process

Literature in mobile learning suggests the benefit of mobile learning in various aspects such as personalization, course context sensitivity, ubiquity and pedagogy [4]. One of the strongest arguments in favor of mobile technology is the mobility or accessibility from anywhere, anytime. The mobile technology facilitates mobile learning that enables learner and instructor to extend learning beyond traditional location-based classroom and computer labs, and provides increased flexibility with interaction opportunities. The mobile technology-based course delivery or mobile learning provides: 1) Anytime and anywhere access to learning content, 2) Enhanced student-centered situated learning, 3) Just-in-time learning or review of course content, 4) Differentiated and personalized learning, and 5) Collaborative learning process enhancing interaction between students and instructors [4, 8]. Mobile technology can impact learning outcomes by improving access to course content while maintaining the quality of education. Using mobile technology in learning can also ensure an immediate feedback that provides continued motivation for those students who are not motivated by traditional learning methods.

Challenges of Using Mobile Technology in Learning Process

The benefits of using mobile technology in learning do not come without challenges. There are some unique problems in mobile learning caused by mobile hardware and wireless network limitation [6]. The learners may not be inclined to completely accept mobile learning unless those limitations are properly addressed. The restrictions or limitations found in using mobile technology in learning include [6, 21, 22]:

Screen size: The most pronounced limitation is the small screen size with poor resolution, color, and contrast of the mobile tools that makes learning activity challenging for some students. The tiny screens, small keyboards in mobile devices causes text input difficulties.

Compatibility: The rapid proliferation of mobile applications has outpaced the traditional software applications that cannot be applied directly in mobile devices. There is a wide variety of devices with different characteristics, but not all applications are adaptable to all different devices. This lack of standardization and issue of software interoperability also causes challenges in mobile learning.

Battery life and Memory: The mobile devices have technical limitation such as small memories, short battery life, limited computation capabilities, etc. Limited battery lives of mobile devices can be a serious issue in learning from anywhere and anytime. Also low storage capacity in mobile devices will not allow students to store or even download large course files.

Download speed and Internet access: Low bandwidth and limited processor speed can slowdown overall learning process.

Conclusion

Mobile technology is being used increasingly to facilitate learning with new approach in learners' everyday life situation [13]. This method of learning is called *mobile learning*, which refers to learning using mobile and handheld devices with wireless network connection. Mobile technology is changing learning process by enhancing 24x7 access to course materials, just-in-time information sharing, continuous interaction and collaboration among learners and instructors. Thus, mobile technology can be a successful tool in involving students in effective pedagogical activities anywhere and anytime. Mobile technology brings new opportunities in the learning environment with its most unique feature *mobility* that offers learners freedom and self-regulation in their learning process. Students can obtain course content using mobile technology that provides various advantages such as portability, connectivity, and interaction with fellow students and instructors.

However, along with all the benefits, there are some drawbacks that may impede the adoption of mobile technology in learning. Some technical limitations can challenge the delivery of courses using mobile technology. Screen size, processing power, device compatibility, storage capacity, etc. are the issues in using mobile technology in learning. Also, student preparedness for using mobile technology for their entire learning process has not been fully explored yet.

Therefore, the factors affecting using mobile technology in learning need to be considered in course delivery. The main criteria that must be considered to adopt mobile technology successfully is the constraints and quality of services of mobile devices and applications. To make mobile technology-enhanced learning or mobile learning an effective delivery method that meet course objectives, the constraints of mobile technology need to be addressed during course design. Institutional support is also needed for training faculty and staff in designing courses in mobile format and for providing technical support. Finally, a number of available e-learning system contents are not suitable for mobile devices yet. Software developers, learning application designers and practitioners need to address this issue during their software design and development.

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Biography

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