Pervasive Learning Environment for Educational Makerspaces with Emerging Technologies and Teaching and Learning Transformation

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ABSTRACT

In 21st century the technological innovation has reshaped our educational system. Different educational methods and environments are used to facilitate students and teachers. Educational makerspaces are also one of them. This new trend has shifted educational system to student centered instead of teacher centered. Pervasive Learning (P-Learning) environment for educational makerspaces is one of the emerging environments for teaching and learning due to price reduction in handheld devices', facility for sharing the technological resources, support, and smartness of smartphone technology. Educational Makerspaces environment provide the facility to teachers and learners to create a virtual environment fully equipped with latest ICT tools to share ideas, to perform experiments and collaborate with each other whenever and wherever they are. Thus, P-learning for educational makerspaces can access and share the resources for teaching and learning material beyond the boundaries of the traditional classroom arrangement. This paper presents the idea of P-learning environment for educational makerspaces which is not limited to a single geographic location or mobile or location-based technologies; rather, it accesses, shares the resources, and facilitates teaching and learning from anywhere and at any time with any handheld device means 24*7*12. The purpose of this paper is to propose a fully equipped makerspace classroom so that the students from remote areas or who cannot afford laboratory expenses can access virtually labs, share their ideas, collaborate with each other, and perform experiments.

Key words: Pervasive learning, Educational Makerspaces, Handheld/Mobile devices, Emerging Technologies, Educational Transformation

1. INTRODUCTION

In 1960 the idea of distance learning was introduced to distribute learning material to help physically disabled, geographically scattered, professionals and others who can't physically attend the class through recorded or live audio / video lectures on TV or radio. With the rapid development in information, communication and technology (ICT) and its utilization for teaching and learning purpose web – based learning system was introduced. This learning system used digital electronic media and tools to deliver learning material and became popular [3;4]. In the last 10 years the usage of handheld devices (e.g., mobile / smart phones, tablet or personal data assistants [PDAs], laptop) is significantly increased [18]. Mobile devices is commonly found to everyone. These mobile devices are used as a medium of teaching and learning because of their mobility and portability [9]. Culture, societies and everyday life of peoples is mostly affected by the technological innovations. Instant communication is also possible due to portable devices and access of databases and information is available at our fingertips. The teaching and learning techniques are also affected by technological innovations. The mobility of individuals has increased our capacity to teach and learn in different situations and environments. Rapid development in mobile technologies has supported more mediums of teaching and learning. Through mobile devices we are connected with each other and with the learning environment so we can access teaching and learning material at any time and at any place. This educational environment is parallel to the traditional environment, the only difference is of fully supported by technological features [22].

P-learning provide an environment to the teacher and learner of their own interest. Due to the instant communication teachers and learners are mostly connected with each other not bounded with time and place. Now teaching and learning is not bounded with the traditional classroom model. This is not the end of traditional classroom model but it shows that ICT has totally affected the teaching and learning mode. This new mode is called web – based teaching and learning paradigm. This paradigm of teaching and learning is due to the innovation in ICT and every one can afford it because it is not expensive. Different blogs, forums and instant messaging

are the facilities provided by the web based teaching and learning paradigm to encourage teacher and learner.

Mark Weiser's was the founder of Pervasive computing [19]. Due to pervasive computing the environment itself becomes smart and provide the learning material to the learner of their interest. The system uses context-aware applications and can detect the location of the learner and then suggest or guide about relevant services of learner's interest [20]. Learner can access online learning material through a laptop or smart phones [28]. Technological innovation and the pervasive computing has removed the boundaries of teaching and learning. One day may be no need to bring mobile or handheld devices but the smart environment will guide the teacher and learner about the resources and their interest [7;1]. This educational environment is also used in educational makerspaces. The aim of P-learning educational makerspace is to create an informative society, where everyone can access teaching and learning material easily at any time and at any place [14].

Currently, the traditional teaching and learning model is under the risk. Because this system fails to share, discuss innovative ideas and exploit the human resources. In urban areas of America school system, the ratio of student –teacher is 40:1 or 60:1 [15; 23].

Most of the industries and universities are investing in technology-based models to increase their productivity. In 2010, the education department of United States presented National Educational Technology Plan (NETP), explains the vision of the department for technology-based teaching and learning model for the 21st century. This model exploits the technological innovation and supports P-learning means teaching and learning can be possible anytime, with any device and at any place. P-learning environment is ideal to use in educational makerspace. In this environment students are motivated to discuss innovative ideas, share, collaborate with others and help each other if they need.

The paper is organized as follows: Section 2 covers technological innovations in teaching and learning. Section 3, a model of teaching and learning for the 21st century, in section 4 discusses about P-learning and Makerspace. In section 5, A proposed educational makerspace classroom model and mobile broadband / wireless devices and pervasive learning are explained in section 6. Finally, we conclude in Section 7.

2. TECHNOLOGICAL INNOVATIONS IN TEACHING AND LEARNING

Technological innovation provides facilities for the improvement of teaching and learning. It provides different modes of communication. Teaching and learning material is

centralized and everyone can access it through authenticated connection. The usage of ICT tools results in more productive and effective for teaching and learning [5]. The interactive features of technology have also improved the teaching and learning the process [11]. Teacher-student conversation in the traditional classroom still has the impact on teaching and learning [28].

Currently, the educational system has teacher centered teaching and learning. The teacher uses different equipment's and tools e.g. blackboard or sometimes internet for teaching purpose. But in this model, students will be centered on teaching and learning. Students can interact with each other and with the teachers or mentors at any time whenever he needs help [27]. Further, currently traditional teaching and learning system are facing too many problems including a huge number of enrollments, cultural, religious and social barriers, unavailability of resources in the classes and difference in facilities in urban and rural areas. Web-based learning has overcome these problems to some extent. Students and teachers can access teaching and learning material 24*7*12 without the limits of time and place [12; 10].

In the 20th century, the teaching and learning were done through recorded radio or TV programs [8]. Then computer as a medium was used for teaching and learning purpose. Next stage was using of hypermedia and multimedia for teaching and learning purpose. The teaching and learning material were stored on CD-ROMs, which can be used multiple times whenever they need [28]. Online teaching and learning became possible due to rapid growth in WWW and Internet. In the late 1990s, different techniques of online learning e.g. e-learning and m-learning were introduced. These teaching and learning modes may lack direct interaction between students and teachers but provide more facilities and ease to the teachers and the learners. M-learning is an advanced version of e-learning, teachers and students use portable devices such as smartphones or laptops for teaching and learning purpose [8]. These are the factors that motivate teachers and students to use web-based system instead of a traditional educational system for teaching and learning [8]. Further, nowadays everyone can afford and have at least one portable or handheld devices [1]. Due to the technological innovation and the support of ICT devices for teaching and learning the traditional educational system is shifted to the web-based (digital) educational system initially to e-learning then m-learning and now to P-learning. Teachers and students can access educational material at their fingertips in a very short time period that leads to lifelong teaching and learning.
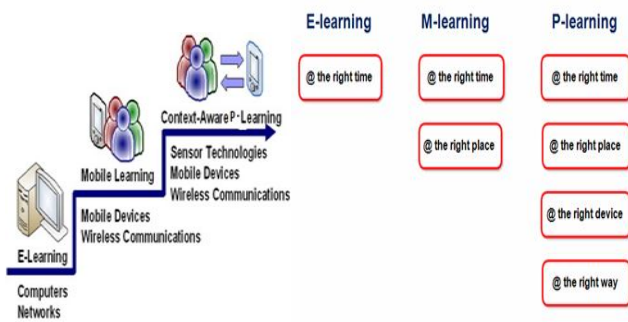
Figure 1: Technological Innovation in teaching and learning

3. A MODEL OF TEACHING AND LEARNING FOR 21ST CENTURY

The intention of this paper is to revise the old traditional teaching and learning system with a new digital educational system supported by ICT tools. This will definitely help the students in this globalized and informative society [3; 17]. This will also provide a facility to the students to manage the time, save rupees and a choice to select their favorable teaching or learning mode. In 2010, Dede proposed following basic features for this new educational system.

3.1 Teaching

Teachers connected through different forums and blogs provide many opportunities for personalize learning. ICT has provided different online platforms with augmented reality and virtual environment for simulation and modeling in the field of history, science and many other subjects. This will motivate and help students to explore complex simulated situations and different experiments [2]. For productive and effective results, the teachers must know the priority, the interest and the aim of students and also the available resources for teaching and learning that can help students to be busy and get meaningful results. Teachers and students have a direct connection, so it will help to polish students mentally, socially, emotionally and morally. This will also help for the self-expression and creativity nature of students [16]. Students design their projects with the help of multimedia and sharing their views and connecting with teachers, students and different communities on different forums, social media, and blogs. This will make students socially and morally strong and motivate students to get deep knowledge about any topic for learning purpose. The teachers must use ICT tools for teaching and learning to get updated, accurate, effective and productive results.

3.2 Learning

For learning, students should not be limited to the traditional teaching and learning system. They can learn at any time at any place with more learning mediums i.e. text, audio or video. Students, parents, and teachers can access huge databases and resources of learning the material from

anywhere (not limited to the traditional classroom) for teaching, learning and assessment purpose. All this is possible due to technology and ICT tools. Due to ICT tools, learning process becomes more productive and meaningful because it provides learning the material in the format of student's interest.

3.3 Assessment

ICT tools also support assessment. Both teacher and student can assess them in teaching and learning purpose. The teachers and students are connected through social networks and they share their views about any problem and the information is online. So they can assess themselves with the help of technology.

3.4 Productivity

Current teaching and learning system is bounded with time and place. The teachers and students have fixed time and place for teaching and learning. This limit the teacher and student's productivity. With the use of technology for teaching and learning, ICT tools are used in the classroom and outside the classroom and the teachers and the students access the educational material at any time from anyplace. It improves productivity for both teacher and the student. Current teaching and learning system bounds with the limited syllabus, same students and with academics. But with the technology used by students or teachers can get help from the professionals and others all over the world. This will also increase the productivity. Further students and teachers have limited school time, resources in the classroom and teachers for teaching and learning purpose. But ICT tools removes all the barriers. This will also increase the productivity of students and teachers.

Teaching and learning model of the 21st century is fully integrated with the technology. The aim is to provide more facilities and opportunities to the students and the teachers. They can access teaching and learning material from anywhere at any time in more than one medium. They can also get help from academics and professionals all over the world..

4. P-LEARNING AND MARKSPACE

Makerspaces are the environments where students learn by doing [26]. They are used in education to create a type of learning that supports constructive learning, where students themselves initiate and discuss innovative ideas. This type of learning is student-driven rather than teacher-driven. Thus the role of a teacher becomes merely guide, support, and facilitate students. Hence, it improves the knowledge and critical thinking of students. Makerspace comprises technology, tools, space, and community to provide the students with digital space to learn, explore, and use the space effectively in their own style. As a consequence, Makerspace inculcates innovative culture in universities. While

makerspace focused on science, technology, engineering, and mathematics in past, at present it can be used in every project of any field. Makerspace education is not only a platform where students can share, collaborate, discuss, innovate, and become technological literate but is alternate for learning in the 21st century [25]. In 21st century, most of the students are interested in using ICT tools for learning, they prefer to learn in an environment where they can explore, share and innovate and collaborate knowledge rather than using ready-made knowledge [6].

4.1 Advantages of makerspace classroom

1. Learning in makerspace classroom makes students intellectually strong. They arrive at their desired results, without any fear of failure, through a series of repeated experiments. Failure in experiments encourages towards the success. Makerspaces philosophy is akin to Edison's approach. Thomas Edison, a scientist, who failed in his initial experiments but finally succeeded to make the bulb. In similar manner, students in makerspaces classroom can ignore failure factor and continues their struggle towards desired goals.

2. Makerspace classroom provides students with the facility to do experiments on new ideas besides the assignments in their syllabus. Makerspace acts like a bridge between students and industries. It lets students do experiments on innovative ideas and show the preliminary results of their projects to industries or governments who might easily consider the projects. Thus makerspace supports creativity and collaboration that leads to the success.

3. Makerspace classroom increases the level of creativity and curiosity in students. Students can easily take the risk for doing experiments on immature ideas that may result to innovative creation. As makerspace classroom is fully equipped with the latest ICT tools and other facilities, it motivates all students of different academics levels. Moreover, it also helps the students who are struggling in their fields, assignments or projects and need help.

4. Makerspace classroom supports resolving the real world problems and issues. Students can identify real world problems, find the solution, and evaluate and validate them through the facilities in the makerspaces classroom before introducing the solution in the market.

5. Students who want to solve a real world problem but lack the facilities and the funds for the equipment, can easily benefit from makerspace classroom. As makerspace classroom provides this facility through different makerspaces located in different countries. Makerspace classroom makes it is easy to get services from other laboratories and work on a task

for which it is too difficult to install a fully equipped laboratory.

6. Students can also attend different practical approach classes through the makerspaces classroom. They can connect with them through the makerspaces classroom. They can discuss or share their ideas with world renowned scientists or teachers. Through this, they can improve their skills and save the money and time.

5. A PROPOSED EDUCATIONAL MAKERSPACE CLASSROOM MODEL

Makerspaces classroom idea is to facilitate both students attending the class physically or virtually. The basic objective is to exploit the human, software, and machine resources in order to improve learning. Makerspace fully supports the idea of learning by doing. Makerspace classroom must be fully equipped with the latest software, hardwares, machines, and the smartboard with internet connection for virtual students who want to use makerspace classroom remotely.

The makerspaces provide a platform to create a virtual community where students can share, collaborate, and get guidance from the experts, mentors, and teachers about a particular topic or problem. They can share human, software, and machine resources with each other. This type of learning is objective or project oriented. Students who are physically present in the makerspace classroom can share their innovative ideas with those who relate to them remotely. If they need any type of help from human resources or they want to use software, they can easily connect with others and get guidance. In a makerspace classroom, we proposed a smartboard for the students who want to participate virtually. Through this smartboard, they can communicate with others in real-time. They can use all type of resources available in the makerspace classroom.

Figure 2: A proposed educational makerspace classroom model (adapted: [1]).

6. MOBILE BROADBAND / WIRELESS DEVICES AND PERVASIVE LEARNING

Dede & Bjerede in 2011 said that currently mobile/handheld devices are fully equipped with following "six senses" [27;13],

1) To know current location,
2) To interact and connect with networks,
3) To locate nearby services and content,
4) To get related information,
5) To enhance the surroundings with information,
6) To know the user's preferences and interest.

The traditional classroom is quickly becoming a thing of the past and is being replaced by the ability of new technology to bring the world's knowledge directly to the student's fingertips. ICT tools have removed the teaching and learning isolation. Now teaching and learning can be done with the support of ICT tools, wireless and mobile devices. The research about P-learning, a virtual platform to education for assessment, educational transformation, emerging technologies is to propose a customized educational system which fulfills the students and teacher needs.

7. CONCLUSION

In this short paper, I have proposed an idea for Pervasive learning environment for educational makerspace by using innovative technology to remove limits and boundaries for teaching and learning. The technological innovation will lead to the educational makerspace (smart) classroom which enables teachers and learners to exploit the available resources and to contact locally and internationally, limiting language, place, and time barriers and establish teaching and learning network at anytime and anywhere.

A model of the 21st century for teaching and learning anytime at any place with any device is supported by pervasive educational makerspace classroom model. Universities should develop technologically innovative educational makerspace classroom that exploits the technology for teaching and learning purpose at anytime, anywhere and with any portable or handheld devices. Platforms of social networks are used to make communities virtually that will support both teaching and learning facilities in and out of universities.

This paper discusses pervasive learning environments for educational makerspace. The integration of mobile learning with pervasive computing technology in makerspace has changed from traditional system to P-learning system. Usage of technological innovations like television, telephone, mobile, smartphones, laptops, and computers etc. seemed different for teaching and learning purpose but later they were accepted and nowadays used in education for teaching and learning.

In future, there will be no need to take mobile devices in hands, but the environments will be so smart to guide and help teachers and students for teaching and learning purpose. Also, teachers and students will change the medium of instructions without any interrupt in the flow.

For learning, place and time are important but it must be learner's choice [24].

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