Online Interactive Module for Teaching a Computer Programming Course

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Abstract: Teaching computing courses is a major challenge for the majority of lecturers in Libyan Higher Education institutions. These courses contain numerous abstract concepts that cannot be easily explained using traditional educational methods. The main aim of this article is to present a conceptual framework for laboratory-based learning designed to teach a computer programming module with the help of an e-learning package. The framework could be used for a single module or one of several modules with a specific aim. The framework should be useful for designers of online learning modules and teachers who are interested in the design of online courses on the Internet. The proposed framework will enable the current generation of students to be better prepared for a workplace where computers, the Internet and related technologies are becoming increasingly ubiquitous.

Keywords: computer programming; e-learning; multimedia; simulation; collaborative learning.

1. Introduction

In the early 1990s, the Department of Computer Science was established at the University of Omar Al-Mukhtar to provide a BSc degree in Software Engineering and Computer Science (Omar Al-Mukhtar University, 2013). The course material is delivered through lectures (school-based learning, or SBL) and reinforced in lab sessions (laboratory-based learning, or LBL). The SBL is based on a teacher-centred approach where experienced lecturers provide theoretical knowledge and information using traditional facilities (e.g. blackboard and chalk), and students receive printed lecture notes and read textbooks. Students then attend LBL sessions in a computer lab, where learning is based on a student-centred approach and they have the opportunity to receive hands-on training in the techniques presented in the lectures by using the technology and equipment available in the computer labs. Recently, "*the academic staffs have observed that students display a lack of practical experience and understanding of the theoretical subjects essential to the success of lab sessions. Internal review reports show a variety of issues concerning the learning processes and traditional teaching methods, limited access to IT, lack of development processes, poor curriculum review and limited links between practical tasks and theoretical content".* (Othman et al. 2013)

Due to large class sizes, especially at undergraduate level, the vast majority of Libyan higher education institutions face significant challenges in adequately assessing student learning and providing feedback to students. Additionally, there are shortages of proper teaching facilities and of science educators who are sufficiently skilled to make proper use of course materials, practical exercises and demonstrations. Some universities have opted to increase the number of faculty members or to alleviate some of the strain by increasing the number of students who use one computer, but the majority of students still display a lack of practical experience and understanding of theoretical subjects during computer lab sessions.

This paper presents a Mayer learning model (see Figure 1) which is used to define a framework for the design and development of an online module for computer programming.

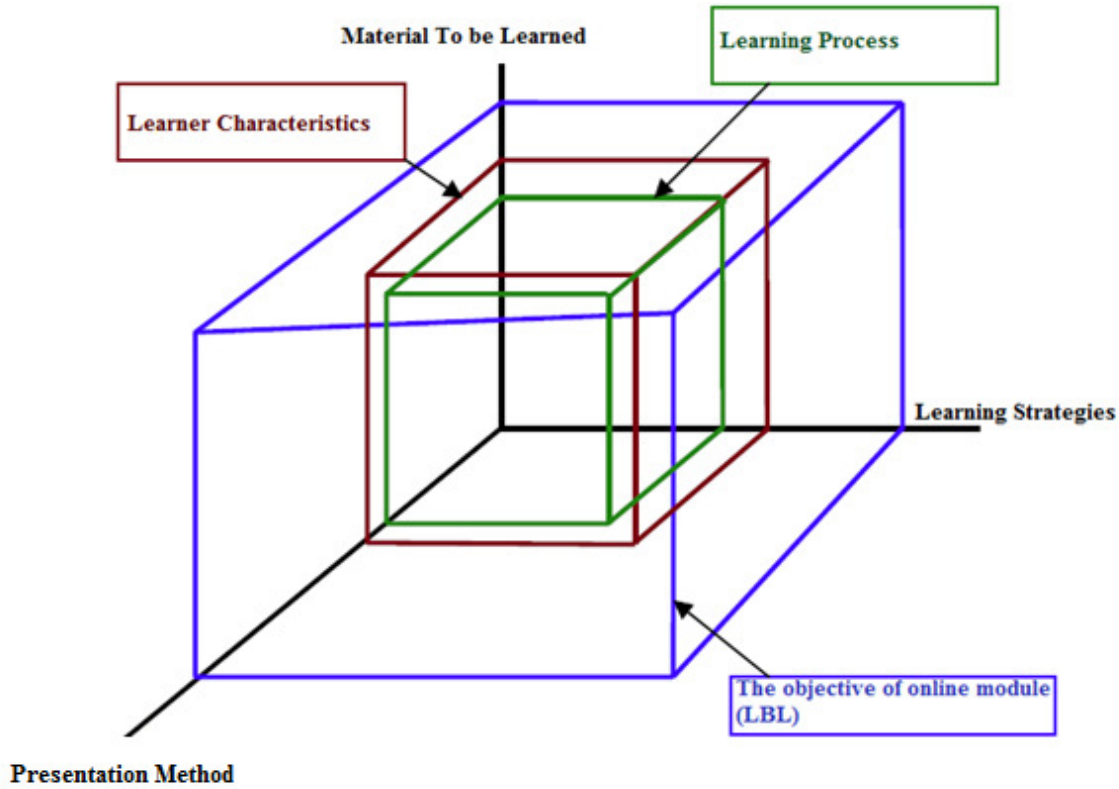


Figure 1: Mayer learning model

2. The proposed framework

The framework is based on the personal experience of the main author as a lecturer in the Department of Computer Science. This could be used for the development of the curriculum and learning modules which will raise the quality of educational attainment for all students. The framework is based on Mayer's model of learning (1989) and the three dimensions which will be presented within this framework are *material to be learned*, *presentation method* and *learning strategy*.

Mayer's learning model contains six elements, as identified in Figure 2. The learning model provides the main elements of the framework, in which the characteristics of the learner, learning material and presentation method are initial elements of the learning process. The other three elements identify the *learning performance*, *learning outcomes* and *learning process*. These will be presented in more detail below.

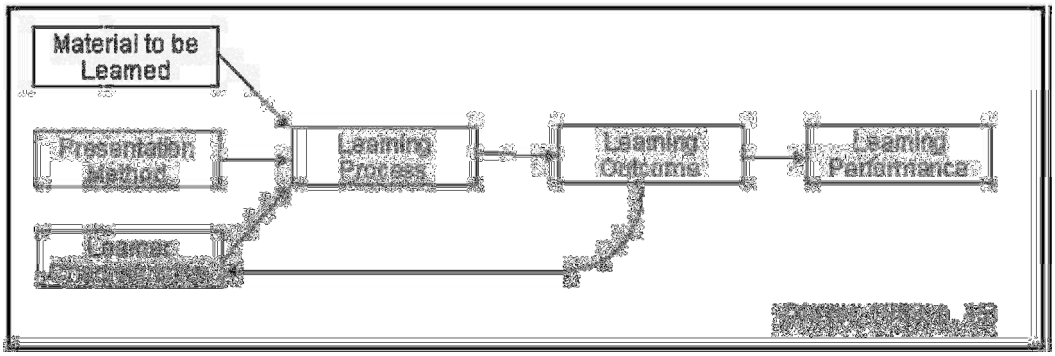


Figure 2: Components of the learning process

2.1. Material to be learned

The *material to be learned* refers to the techniques and conceptual ideas that could be presented in the session. These materials can be regulated and identified by two key headings - technology and concepts. The materials used will be independent of the method used to provide information; effectively, 'what' will be learned is independent of 'how' this material is offered.

The split between technique and concepts will be developed from the idea of a computer programming course provided in two formats. Concepts may be presented, for example, through a project, where students can discuss issues via an online module which is not possible in school-based learning (Parker et al., 1999). Teacher's comments are also a useful source of materials for acquisition of knowledge-based learning, and this approach enables students to review the content of the module at home at any time. Techniques which are usually taught through methods such as the teacher drawing a technical flow chart or demonstrating how to write programming software can be learned via the interactive facilities which are available on the online module.

The authors seek to increase the use of digital tools in computer programming courses, in order to help students organize information and to visualize and understand the internal relationships between different components of the scientific content. This can be achieved through cooperative educational activities, wherein students are divided into small electronic discussion groups to achieve common educational goals. The online module will contain multimedia elements as additional sections. The media elements may include simulations, video, text, animation or audio sequences. This part of the process involves actually composing an LBL module by preparing and producing educational elements and outputs (such as text, audio recordings, video clips, still images, computer software, etc.). This phase often begins with a prototype (a preliminary version of the product), in which the developer and programmer presents a storyboard for each screen that includes any links. This prototype allows design specifications to be checked, which may be modified once it has been presented to a sample audience. Based on the resources and activities, a blended learning approach will be developed to ensure that the learning activities meet the requirements of all computer science students, regardless of their limitations in terms of Internet access. Consequently, a dual delivery method (i.e. CD-ROM based and e-Learning package) could be considered. While the e-learning package can be used for simultaneous interaction, both synchronously and asynchronously, the CD will include multimedia self-learning materials.

The materials within the online module can be categorized as follows (see Table 1):

Table 1: Materials

Type of material	Aim of the material
Simulation	Approximates a real or imaginary experience where users' actions affect their outcomes. Users determine and input initial conditions that generate output that is different from, and changed by, the initial conditions.
Animation	Allows users to view the dynamic and visual representation of concepts, models, processes and/or phenomena in space or time. Users can control their pace and movement through the material, but they cannot determine and/or influence the initial conditions or their outcomes/results.
Tutorial	Users navigate through electronic workbooks designed to meet stated learning objectives, structured to impart specific concepts or skills, and organized sequentially to integrate conceptual presentation, demonstration, practice and testing.
Drill and practice	Requires users to respond repeatedly to questions or stimuli presented in a variety of sequences. Users practice on their own, at their own pace, to develop their ability to reliably perform and demonstrate the target knowledge and skills.
Quiz/test	Any assessment device intended to serve as a test or quiz.
Lecture/presentation	Any material intended for use in support of in-class lectures/presentations. Lecture notes, audio-visual materials, and presentation graphics such as PowerPoint slide shows that do not stand alone are examples.

2.2. Presentation method

Presentation method refers to the method(s) used to present the material to students in various sessions. The style of presentation is the dimension in the framework whereby the academic staff decides how the materials will be presented and how the technology will be organised and structured. E-learning applications offer several flexible methods to deliver materials. This flexibility provides an exciting opportunity for teachers to take selective advantage of technological choices in their presentation. As an example of how presentation techniques can be organized, it will be useful to consider the difference between two methods of presentation. In a traditional laboratory-based learning environment, the materials provided can be presented to students in one classroom by a

teacher who speaks, using a projector or chalkboard. The online learning module, in contrast, places more emphasis on student interaction, having several types of tutorial material (e-tutorials, activities, pictures and videos) instead of a personal face-to-face lecture. Table 2 below explains the main differences between school-based learning and the online laboratory-based learning module.

Table 2: School-based learning and online module presentation method dimensions

Presentation method	School-based learning environment	Online module environment
Who	Student to teacher (one way)	Student to student (several ways) and student to teacher (several ways)
Where	Single classroom	Sometimes dispersed
When	Faculty's choice	Student's choice
How	Lecture and projector	Web page, personal computer, e-mail and discussion board

This table is not intended to give an accurate description of SBL or online module environments, but is offered as an example to show the usefulness of a four-dimensional analysis of training courses. It highlights the main impact which can be offered by the online environment in the delivery and design of an online module. Note that the introduction of an online module can alter where, when and how materials are presented.

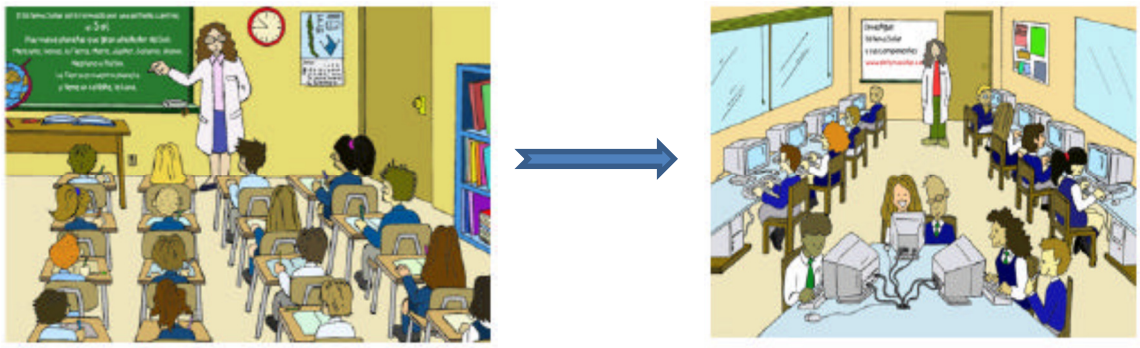


Figure 3: Pedagogical jump for teachers **(**Hepp 2004)

2.3. Learning strategies

Learning strategies refer to the different ways in which material is presented to students by the teacher in order to achieve a goal, and these include the various means adopted by the teacher to adjust the levels and management of learning. This is in addition to the general atmosphere experienced by students and arrangement of the physical characteristics that contribute to the process of communicating the desired concepts and ideas. In our case, it is therefore important to consider learning strategies in building the online module. This means we need to consider the process of delivering knowledge to the learner, creating motivation and developing the learner's desire to research, explore and work towards access to knowledge; a clear method is required to allow him to achieve his goal. An interactive learning strategy depends on the method of interaction between student, lecturer and scientific material, and this concept can be applied through several means such as collaborative learning, e-learning, brainstorming, problem solving, etc.

Cooperative learning - This is a strategy in which students work in small groups in a mutually positive interaction where everyone feels that he is responsible for not only his own learning, but also the learning of others in order to achieve common goals. As a method of teaching and training, it calls for cooperation among learners, and requires them to combine their efforts to achieve the planned learning in an orderly manner. This type of teaching relies on the cooperation of all learners to accomplish the required tasks and achieve the highest degree of proficiency in as little time as possible. The student both learns from the teacher and teaches other learners. (Jacob 1999)

E-Learning - This is a means of supporting the educational process and involves a transition from a phase of indoctrination to a process of creativity and interactional skills development. It aims to create an environment rich in interactive applications, which include all electronic forms of teaching and learning that rely on computer applications, electronic and communication networks and multimedia for the transfer of skills and knowledge.
Brainstorming - This is a modern way to develop the conventional lecture. It encourages creative thinking and creates the potential for learners to learn in an atmosphere of freedom and security which allows the emergence of all opinions and ideas. Here the learner is the main focus of interaction in the classroom, whereby the lecturer presents a problem and the students present their ideas and suggestions for the resolution of the problem, after which the teacher collects the proposals, discusses them with the students and then determines the most appropriate. (Gallupe et al.1991)

Problem Solving - This is the result of detailed procedures followed by the teacher in teaching, educating and training students in the skills of scientific and logical thinking by introducing issues from an unfamiliar perspective in order to challenge ideas. This is a cultural change, and requires the student to reflect, think about and discuss issues to find an appropriate solution under the supervision of a teacher by a specific time (within the lesson). (Dolan and Williamson 1983)
The role of the teacher is to develop the use of problem solving strategies by:

- Identifying the knowledge and skills that students need to conduct research, such as survey and reconnaissance.
- Determining preliminary results or concepts acquired by students as a result of their research and surveys.

Suggested steps to implement this strategy for an online module are:

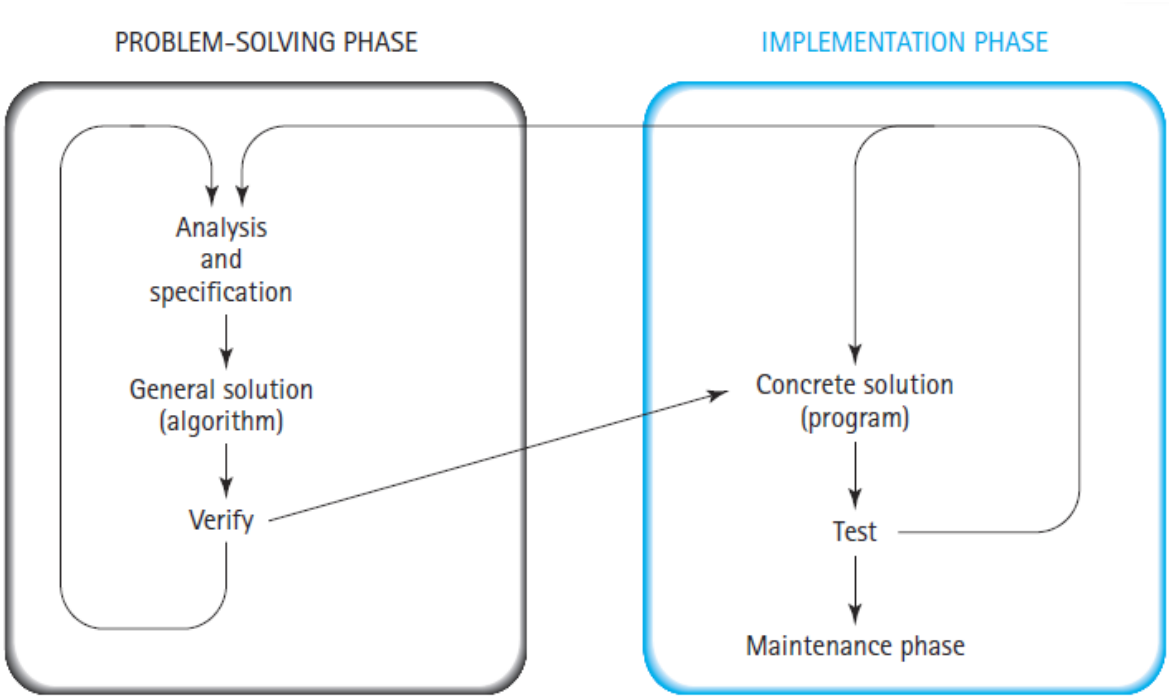
- Teacher poses a particular problem.
- Teacher divides the class into groups and asks each group to study a particular aspect of the problem.
- Teacher monitors performance, provides assistance to groups and corrects concepts if necessary.
- A student from each group presents a summary of the group's findings to the class, to determine the best overall solution to the problem in the lesson.

Figure 4 shows an algorithmic problem-solving technique and computer programming. The aims of this problem-solving method for computer programming are:

- To be able to apply a suitable solution for developing an algorithm.
- To be apple to record the main stages involved in writing a computer program.
- To be able to determine the interpreting and compiling stages and what each one does.

A computer is not, in fact, clever; it cannot analyse a problem and offer a solution. The programmer must develop the instructions to analyse the problem in order to solve it. First, the programmer must analyse the problem, and the second step is to break it down into small pieces and develop each piece in order to find a general solution. This process is called an algorithm, which is a set of mathematical and logical steps needed to solve a problem. In computer systems, an algorithm basically represents a picture of a problem re-written by logic (software) to make the outcome more effective. Algorithms can be exploited in computers to achieve results (output) from given data (input). Therefore, to write a program, the programmer must follow two steps, which are problem solving and implementation. (Weems 2003)

Figure 4: Programming process



Problem-solving phase:

- Specification and analysis: explain and understand the problem and outline the solution which the programmer can use.
- General solution: algorithm identifies the required data categories and the logical sequence of phases which can solve problem.
- Follow the phases to verify if the solution is working correctly and actually solving the problem or not.

Implementation phase

- Concrete program: transform the algorithm into a programming language, which means translating the general solution into a program with instructions which the computer can follow.
- Test: if errors are found, analyse the algorithm again to define the source of errors, and then make corrections.

Maintenance Phase

- After the program has been written, it should be modified during use to correct any errors that appear.

3. Other factors in the framework

As noted above, the framework presents three important dimensions within the design process for the online module; however, there are three additional factors that are not included in the Mayer model, but which will be considered in the design of the online process for our module. These factors are the learning process, learner characteristics and the objective of the online module (LBL).

3.1 Learning process

Based on Bloom's Taxonomy and Kolb's model for the learning cycle, an analysis must be undertaken to determine and develop appropriate teaching and learning styles for the LBL module. This analysis may consist of tests, questionnaires, discussions or the examination of previous school records and documents. Results of the analysis will provide the lecturer with an initial idea about various learners' needs, so that one can decide how to utilize educational multimedia to advance the overall cognitive and emotional growth of learners, whilst also taking into account any limitations in technology.

Examples of students' future skills which should be developed in accordance with Bloom's Taxonomy include:

Remembering - Computer science students will be able to define the C programming theory and its practical uses; they should know the processes and activities involved in exercises; they should recall basic elements of C programming learned in the SBL (e.g., they should be able to recall and understand the term 'global variable', and they should be able to list six reserved words in C programming).

Understanding - Students should be able to understand, explain and describe the programming process. Students should be able to understand the issues (e.g. they should be able to describe the idea of a 'software crisis', and they should able to find the value of X after running the C programming).

Applying - Students should be able to apply appropriate fundamental principles for various activities and collect data for programming. They should be able to use plans, test plans, project plans and flow charts for software programs (e.g., they should be able to write a For Loop that can produce a desired result, and they should be able to write an IF statement to display).

Analysis - Students should be able to solve problems using the basic commands of C programming, and should know how to use tools to solve command problems.

Synthesis - Students should be able to build a program to solve a specific problem, and to implement the activities leading to several programming languages, including codes, designs, requirements and documentation.

Evaluation - They should be capable of evaluating C programming language work for conformity to standards. They should know suitable quantitative and qualitative measures of application, and should be sufficiently experienced to practice those measures in the evaluation of software.

3.2 Learner Characteristics

It is important to identify learner characteristics, and to assess the extent of their readiness to learn the material. A diagnostic test should be conducted to determine the students' range of mastery of the subject matter, and to identify any obstacles to learning. Once a lecturer knows how students approach learning, the lecturer can offer more support and encouragement by building a blended learning environment to meet students' learning needs. The proposed framework will be applied to a computer programming course which is generally attended by students between 22 and 24 years old. Most students lack practical experience and understanding of theoretical subjects that are essential to the success of lab sessions. Students have studied an introductory module during their third year of study, so they should have a clear understanding of the demands of higher education, be familiar with the classroom technology, and have the basic skills to use that technology.

3.3 Objective of the online module (LBL)

The objective is to produce an e-learning package (LBL module) consisting of review questions and lessons with interactive elements embedded in flash animation or java applets. This package could act as a supplement to SBL lessons or as part of an entirely separate online learning environment. In addition, students can keep a record of communication and review via chat or e-mail by using the sound system or in writing via a whiteboard or electronic equivalent of the traditional blackboard. Access to the board is granted if students need to write questions or answers. This is very important, particularly for server-based applications, to ensure that each participant can share interactive elements with everyone. The key reason for introducing this e-learning package is to offer personalised learning to the learners, who will be able to experience the ambience and ethos of the laboratory before joining the LBL activities in computer labs.

3.4 Asynchronous teaching lessons: In indirect education, students get educated on courses which permint them to select times and places that suit their circumstances, by employing some of the methods and tools such as e-learning, e-mail, the World Wide Web (www), file transfer, and CDs. Positive: This kind of education in which the learner chooses a time and place appropriate to them also enables them to refer to learning materials in electronic form at any time. Negatives: the learner is unable to get immediate feedback from the lecturer. It is indirect education which does not require the presence of learners at the same time .However,, there is a global development in both the technology and e-learning, and this has lead to the emergence of various ways and techniques of learning and teaching; for example virtual classrooms. This classroom can work more effectively

offering an easy way to share materials, uploading and reviewing students' tasks, and for holding debates through online chats. The virtual classroom is a teaching and learning environment located within a computer-mediated communication system . A set of software tools that enables the teacher to design activities for the modules is to be considered (such as Author Plus) with which you can design activities according to the inclinations and abilities of the students studying the module. These tools can be used to design individual lessons or entire courses and are suitable for all teachers with basic computer skills.

Personal computer-based flash technology, for instance Camtasia Studio and Adobe Captivate, can be used to make asynchronous lessons. It can simply produce demonstrations and software tutorials in streaming video and flash models for students. Camtasia is also good for making lessons for learning management systems and software packages. When presented in the laboratory, the demonstrated actions are frequently too difficult or too quick to see and absorb. It is a screen recording platform that records both the audio and video elements of any action that can be presented or demonstrated on a computer screen including demonstrations of Java applets, PowerPoint lectures, computer labs assignments, software. This video can be converted to Real Player, Flash, and Media Player, which then can be offered for viewing on the Internet. The microphone, Camtasia Studio and a web camera are all that is needed to make the video. Recording of PowerPoint lessons in video presentations is also possible. The researcher has been developing a complete e-learning solution based on users' requirements. The text content is integrated with the application. Integration of the electronic modules is in progress. After integration, the e-learning package of the training program is to be hosted on the network, and flash technology will based on the personal computer. Furthermore, a flash file is highly compressed which requires only small storage space; also it has a good level of synchronous audio and visual integration. Flash can be good for creating step by step corresponding and animations to make the learning materials more persuasive and memorable. For instance, when programming in C++, the lecturer could encounter mistakes after the software package is compiled. This package software is very helpful for recording the common errors and how these can be corrected in the real application. The course will be completed by the author using PC-based flash technologies like Camtasia Studio. The author suggests these teaching materials will be more effective for students in support of the learning experience in both lab and classroom learning environments associated to normal PowerPoint notes. There are specialized programs and websites on the Internet that can be used to design lessons and create teaching material such as Program Author Plus which is used in the design of lessons and modules of the English language, and the program Hotpotatoes which is used in the design of lessons and modules of the read-only variety, and there are also programs available that can be used in the design of any module in any discipline including Macromedia, Authorware, and programs such as PowerPoint and Netscape Communicator which can be used in the design of lessons and to conduct presentations and can be used on the Internet and outside the network. The teacher completes the entire design process, writing texts, forming questions adding still and moving images, sounds, music, links etc.

4. Specific proposals to address the problems at Omer Al-Mukhtar University

If Omer Al-Mukhtar University wants to address the problems then it needs to produce a strategy plan, which would offer a clear starting point. This plan will define the new environment and will explain the main steps which may include challenges faced by Libyan universities when introducing e-learning, it requirements which are essential to adopt a successful blended learning programme. The strategy plan of implementing blended learning has the following summaries:

- In general, behind each successful project is leadership. Leadership plays an important role in implementing a new project which offers significant support for new training; without leadership the organisational acceptance could be slow. As research has shown that the success or failure of an e-learning operation depends on the structure of the organisation that is expanded by an institution's leaders, to prepare for the adaptation of e-learning, in order to improve teaching and learning methods.
- Leaders at all levels should reinforce participation across the university to implement e-learning.
- Each leader must have ownership of the plan of the change management for adopting blended learning. They should help in performance, execution and full development.
- The University should offer the essential technical infrastructure to build an on-line environment that is accessible to all its students. This means providing good-quality computer rooms and a minimum technological platform, such as necessary access to software, current

browser versions, hardware, etc. As part of adopting a new environment, the University will have to provide suitable technological capability. The system must be fully tested and anticipated problems addressed.

- The University must select the model of on-line environment and the appropriate on-line environment platform Learning Management System (LMS).

- It's essential that the University provides training for the tutors, to give them the essential technical skills necessary to use the system. Since staff development training is the main concern for institutions in implementing any form of new learning methods, it is essential to focus lecturers' training on how to use hardware and software.
- At the beginning of their study, the University should provide necessary training for students to realize a new environment, and to get the essential skills. Quite simply, the University should provide the students with a profile of Internet skills, computers, understanding of Windows and basic typing abilities, and give students English courses to learn English language because most of the e-sources, like software and web content are in English, which makes ICT and e-learning in the Libyan education system more difficult.

5. Conclusions

The availability of new technological opportunities to change the shape of university learning is unprecedented nowadays. In terms of the 'form' which the delivery of this new education will take, however, the effectiveness of all alternatives has not yet been fully determined. There is a wide range of learning opportunities based on location and on the Internet, and these should be designed to be interchangeable, with similar techniques being used to achieve similar goals.
There is a need for further work to assess exactly what may be taught online and how the virtual environment will differ from more traditional techniques of delivery. This paper suggests that the online module will assistassist students to better understand complex and difficult concepts within various computer courses.

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