A Computer-Aided Learning Package for Students of the University of Mauritius

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Abstract: *This research work aims at achieving one of the goals listed in the strategic plan of the University of Mauritius which is to develop e-learning courses for the students. In this paper a computer-aided learning package for students enrolled in Information and Communication Technology (ICT) courses is designed, analyzed, tested and implemented. This work provides a practical and realistic approach to curriculum and student skills development. The e-learning framework has been designed using modern learning theories consisting of cognitive and psychological factors. Functional and non-functional requirements of the proposed e-learning package will be analyzed and designed employing Data Flow Diagrams (DFDs). It is shown through implementation and simulation results that the e-learning system is successfully developed and ready to be used by both the students and lecturers of the University of Mauritius.*

Keywords: Computer-aided learning, software engineering, computer programming, instructional design, database systems

1. Introduction

Electronic learning [1,2] recently known as e-learning is used to refer to computer enhanced learning and it is usually extended to include the teaching materials and hypermedia in general, CD-ROMs or websites, text chat, computer aided assessment and a combination of different methods being used. E-learning is naturally suited to distance learning [3].

With an increasing tendency to create a Virtual Learning Environment and taking into account the quality and relevance of programs being offered, this research paper aims at providing a computer aided learning package as a teaching tool for Information and Communication Technology (ICT) for students of all faculties at the University Of Mauritius (UOM). This ICT module will be handled through a consistent user interface standard.

Students of the University of Mauritius face time-constraints to attend all classes due to the attendance regulation. In this regard an online learning tool is imperative for the students to increase their learning skills. The aim of this work is to provide a practical and realistic approach to curriculum and student development that can be implemented rapidly and cost effectively with the available resources. It specifies an online curriculum for Information and Communication Technology for tertiary students.

The ICT module will contain online tutorials comprising of multiple choice questions and True or False questions for each chapter and correction of these tutorials will be performed automatically by the system. The web application also provides for flexibility since it can cater for introduction of new modules. Moreover, the tutor can add, modify and delete as well as update questions in the bank. The tutor is also allowed to evaluate the student's progress while moving through the module contents.

2. Computer Aided Learning

Latest and emerging pedagogies equipped with ICT technologies bring a change in the educational field and offering exciting opportunities to transform the learning landscape [1-3]. ICT has as objective to create a knowledge nation, which is characterized by learning organizations, learning management systems and e-learning. Recently, e-learning takes the form of online courses which is best suited for distance learning and flexible learning but it can be also used with face-to-face learning commonly known as blended learning [4,5]. The features of e-learning are summarized below:

- Learning is self-paced and students are unbound by time.
- The learning content is designed around the student and no attendance is required.
- Accessible 24/7 to learners and this makes scheduling easy.
- Enhances internet and computer skills.
- Allows users to access learning resources from their own site, while saving bandwidth and improving access quality.

The e-learning framework [4] outlines learning system architecture for pedagogical development and system integration. This framework will be based on standards such as Learning Technologies System Architecture and the IEEE as well as the IMS Global Learning consortium.

The main function of a Learning Design System (LDS) is to allow content creators to quickly analyze and design instructionally efficient learning programs [5]. An LDS is used to produce flowcharts of the entire structure of the e-learning system. The key to developing effective module material lies in combining clear learning goals with pedagogical models. The best solution proposed in this regard is to embed instructional design tasks [6] into a project management tool allowing such tasks to be assigned and tracked.

A Learning Support System (LSS) is a web-based environment for supporting teaching and learning activities. The LSS is used to manage and support a group of students and it is used by tutors to design the curriculum for a module. The tutor uses the LSS to plan the delivery of the materials and the latter provide tracking and usage information to the learning management system. From the

perspective of the student the LSS grants access to the syllabus as laid out by the tutor who can be in the form of a study plan or a schedule of contents with links to the materials in the syllabus.

Instructional design [6] and Instructional system designs are the technologies of education and instruction. The most commonly used model for developing instructional materials is the ADDIE Model [6] which stands for the five phrases contained in the model. These phrases are listed below:

- *Analyze* – analyze learner characteristics and task to be learned.
- *Design* – develop learning objectives, choose an instructional approach
- *Develop* – create instructional or training materials
- *Implement* – deliver or distribute the learning resources
- *Evaluate* – make sure the materials achieved the desired goals

Web development includes all areas of developing a web site for the WWW (World Wide Web). The objectives of web development are summarized below [7-11]:

- Learn about Dreamweaver, Microsoft Front Page, Macromedia Fireworks, Flash and HTML.
- Learn about different web programming languages such as PHP, JSP, JavaScript, ASP, ASP.NET, ColdFusion
- Learn about databases such as MySQL and Microsoft Access.

3. System Analysis and Design

The term "system analysis" is used for the study of systems that include the human element and behavioral relationships between the system's human element and its physical and mechanical components [7,8]. The e-learning framework generally consists of the following:

- Applying learning theories to the actual e-learning system
- Continuous learning and tertiary education
- Defining learning methodology
- Identification of target audience and identifying system entities
- Learning content management system

In this work it is envisaged to apply modern learning theories to the e-learning system. Cognitive and psychological factors will be used in the design process. The continuous learning research field consists of a student who either will learn individually or learning to learn. In system analysis it is also important to define a learning methodology that is, how learning will be carried out and how it will match the different learning paradigms and learner's orientation. In our analysis the platform will be in the form of assessments, courseware design, feedback and motivation. It is impossible to design a website for an unknown audience and without understanding the needs of the users. User identification is important for the proper development and planning of the website, in terms of web application aims and objectives. This e-learning platform consists of an administrator, students and tutors. The

learning content management system acts as a collaborative environment for creating and delivering learning materials. This e-learning platform will provide a project management capability that incorporates an instructional design methodology of choice.

3.1 Module structure

This section gives an overview of the curriculum developed for the ICT module.

1) Introduction
2) Chapter 1: Data and information
3) Chapter 2: Imperative high level languages
4) Chapter 3: ICT and business
5) Chapter 4: Software
6) Chapter 5: Hardware
7) Chapter 6: Project management
8) Chapter 7: Feasibility study and system models
9) Chapter 8: Operating System (OS) and Computer Graphics
10) Chapter 9: ICT and people
11) Chapter 10: Legal compliance for ICT
12) Chapter 11: Communication
13) Chapter 12: Networking
14) Chapter 13: GSM, GPRS, Bluetooth and Wi-Fi
15) Chapter 14: Recent technologies

3.2 Functional requirements [7, 8]

These are statements of services the system should provide, how the system should react to particular inputs and how the system should behave in particular situations. Some examples of functional requirements for the system are:

1) The system shall automatically check user ids and authenticate users.
2) The administrator shall add or delete a lecturer, a student and a module.
3) The system shall support the importation and creation of contents that adhere to the e-learning system.
4) The lecturer shall add, modify or delete questions of tutorials. Question type includes: True/False and Multiple Choice.
5) The system shall automatically grade the student for the tutorial taken. The tutorials shall be timed and the questions shall not be repeated.
6) The system shall provide good answers from the bank of questions, at the end of each tutorial completed.
7) Students shall be able to view their personal progress report and personal details while the lecturer can also query a learner's results.

3.3 Non-functional requirements [7,8]

These are constraints on the services or functions offered by the system.

1) The students shall be familiar with and have unrestricted access to a computer, with a current web browser, a high speed connection to the internet, email capability and Microsoft office.

2) The application will run only on Microsoft windows operating system.

The design phase involves converting the non-functional requirements, functional requirements and services identified into unified design specifications. Program designs are carried out in many ways such as Data Flow Diagrams (DFDs), class diagrams and sequence diagrams to represent functions carried out by human interaction and that carried out by computer.

3.4 System Design

The design phase involves converting the non-functional and functional requirements and services identified into unified design specifications that will be used during the implementation phase. Figure 1 shows a Data Flow Diagram (DFD) for the user type, lecturer and student. The DFD approach [8] puts forward the logic underlying the functions of the system with the following design requirements:

- Registering and deleting users
- Adding and deleting a module
- Modify details
- Module creation
- Read chapters
- Assessment
- Evaluating performance
- View personal details
- Change password
- Forget password

3.5 Interchanging Data on the web

A number of techniques can be used to interchange data on the web; XML, MySQL, Oracle, Access and many other database systems can be used. Microsoft and Oracle being too costly for the database design of the project, MySQL was chosen [10, 11]. Also, MySQL provides many advantages and it meshes very well with PHP, a dynamic web development language.

3.6 User Interface Design

Technology alone might not be able to win user acceptance and subsequent marketability, thus the design of a good user interface which is easy to use and understandable for end-users is fundamental in determining the success of the project, that is, if end users feel that the application is too complex to use and learn or it is too slow and difficult to navigate through, the application will be likely to fail even though it is an excellent product in terms of good coding techniques [12]. Some examples of good user interface design principles that have been used for the web application are shown in Figure 2. The website has been designed efficiently so that the users are less prone to make errors.

4. Implementation of a Computer-Aided Learning Package

The implementation phase involves converting the design specifications into executable programs. Different web

languages or high level languages can be used for coding such as C, C++, Java, Pascal, ASP, ASP.NET, PHP, JSP and ColdFusion. The web language chosen to carry out the application is PHP.

System implementation is the construction of a new application and its delivery into its day-to-day application. During the implementation phase the processes, data and network models are brought to life with technology. Efficient implementation standards [13] include requirements that programmers and web designers discuss design specifications before the coding phase starts. These steps help the programmer to understand program design and functional requirements better.
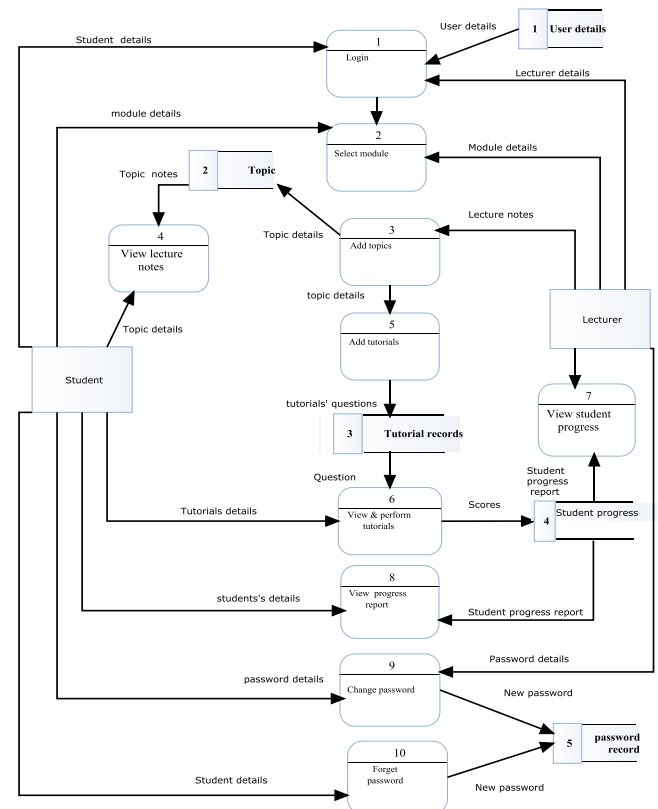

Figure 1: DFD for student and lecturer level

Figure 2: User friendly interface

4.1 Web implementation of the homepage

Figure 3 presents the homepage implemented using a dynamic PHP web page. The web page contained many

tables that were created and linked together to create the above homepage. The web banner has been created in Flash and it is present in all the web pages to provide for familiarity to the users. The Fireworks images have been designed in Macromedia Fireworks and the menu navigation bar has been implemented in Dreamweaver itself. In addition, labels and text boxes were created for the student login section where both the username and password can be entered, allowing students to log onto the system.

Figure 3: Homepage

5.   System Testing and Results

Once the code is generated, the software program testing starts. Different testing methodologies and testing tools are used to discover defects that were committed during the previous phases. System testing involves integrating two or more components that implement system functions or features and then testing the integrated system. System testing has two distinct phases name Integration and black box testing [12, 13].

Integration testing also called white box testing can be described as top-down or bottom-up testing. It verifies that all these components actually work together and correctly and that they transfer the right data at the right time across their interfaces. Due to its large use of codes nested in the implementation phase this testing is not commonly used.

Black-box testing is a method in which test data are derived from the specified functional requirements without knowledge of the final program structure. This method focuses on executing the functions and checking of their input and output data. The tester treats the software under test as a black box and only the inputs, outputs and specifications are visible and the functionality is determined by observing the outputs of the corresponding inputs [12]. The following sub-sections now test the system implemented.

5.1 Student login web page testing

Figure 4(a), (b) and (c) show the student login page with an incorrect or correct login entered. In case an incorrect login is entered the student is redirected to the login page and if the correct login is entered then a welcome page is obtained showing the module contents.
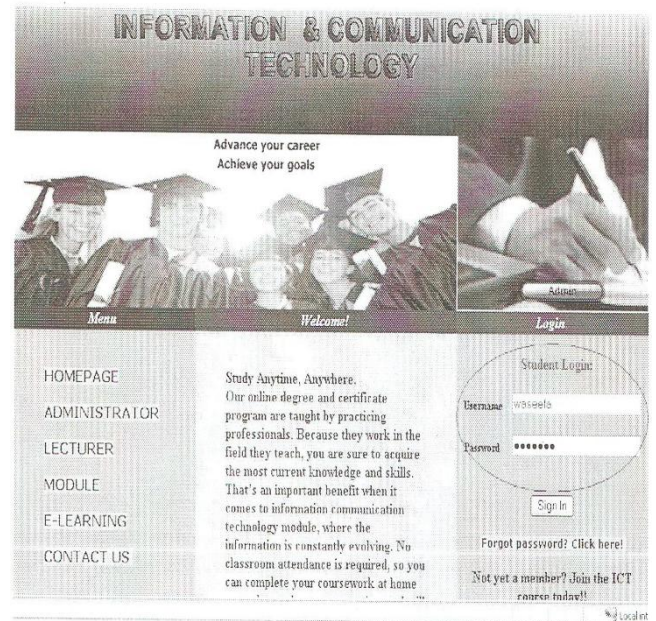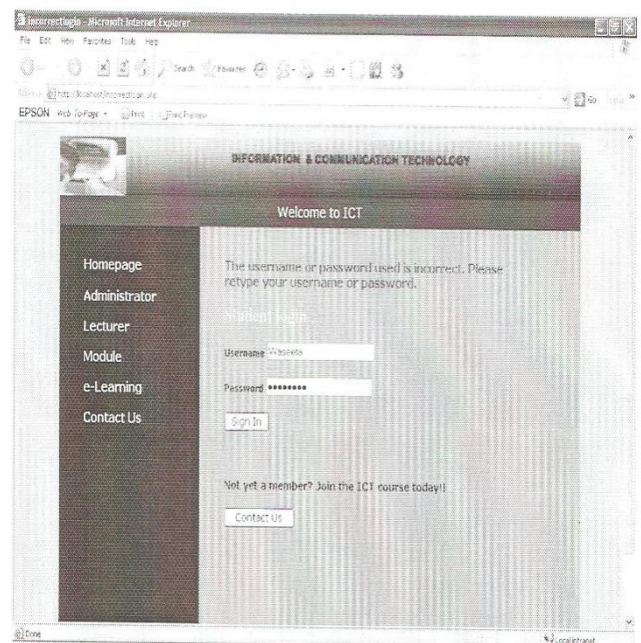

Figure 4(a): Student login web page

Figure 4(b): Incorrect login web page

5.2 Attempting multiple choice questions

After successful login the student is ready to go through the chapters of each module and on selecting the tutorial link the student is provided with multiple choice questions as well as True or False questions. Figure 5 shows the page used for multiple choice questions.
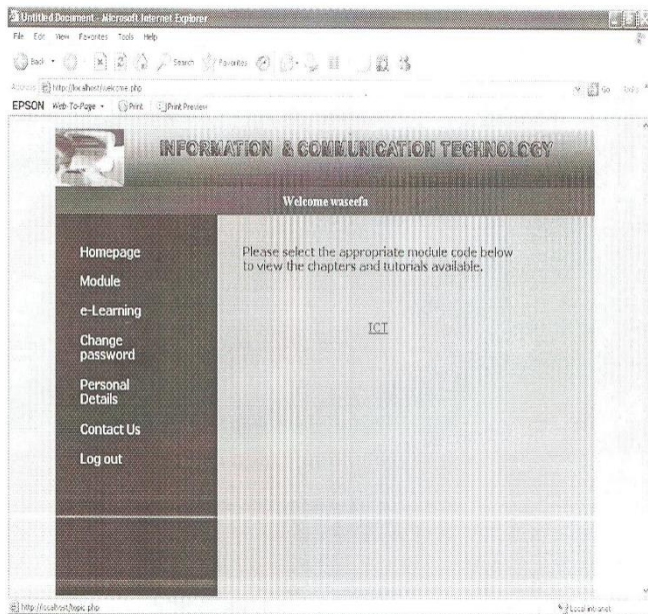
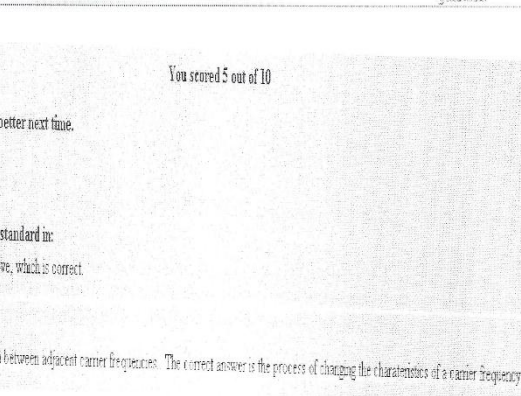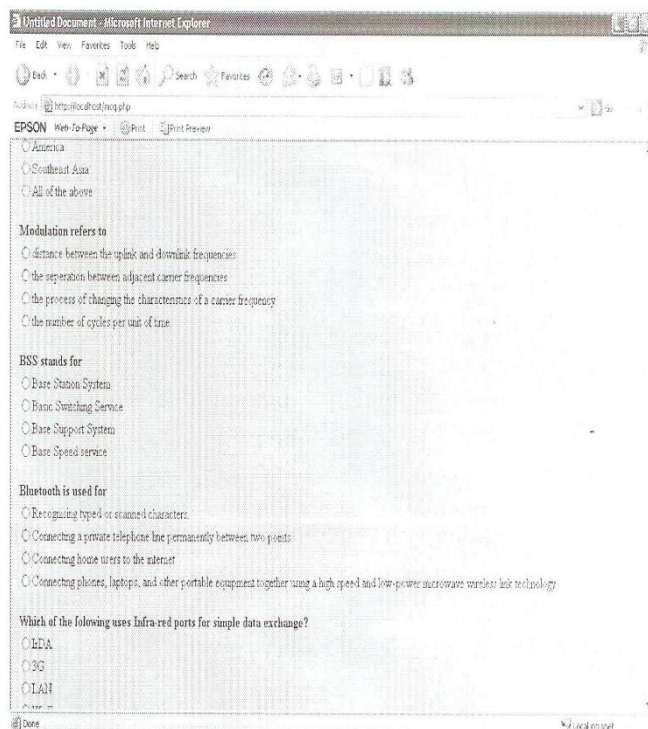**Figure 4(c):** Welcome web page for students

5.3 Administrator Login webpage testing

The administrator has to select the Administrator link in the homepage menu to log onto the system and if an incorrect login is entered the system redirects the user to the log on menu as shown in Figs. 6(a) and (b).
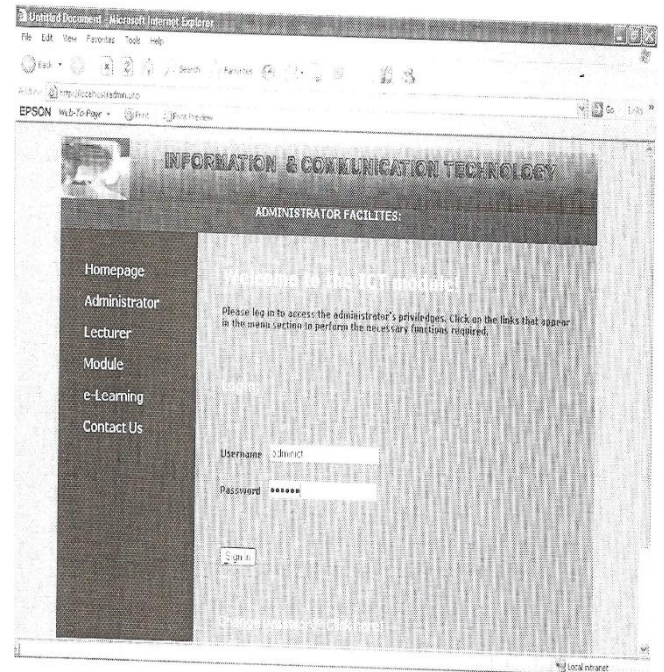

Figure 6(a): Login screen display for administrator

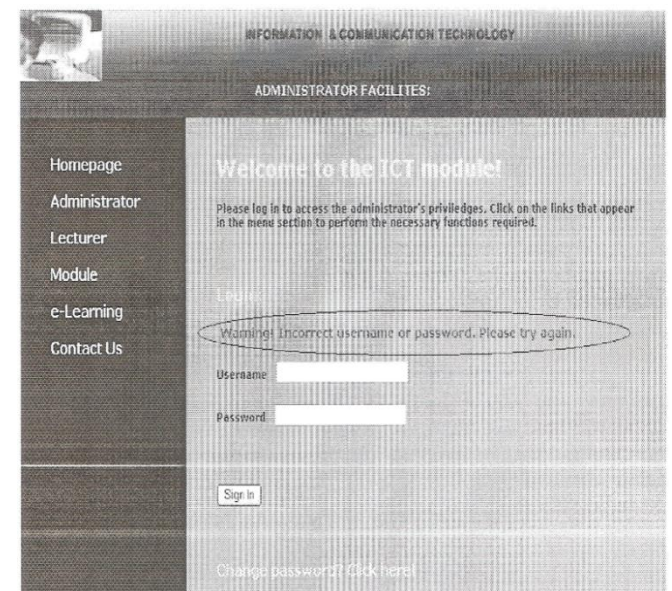**Figure 5:** Multiple choice questions

Figure 6(b): Incorrect administrator login

After login as an administrator as shown on Figure 6(c) the user will select the "ADD LECTURER" hyperlink to register a new lecturer onto the system as shown in Figure 7. The lecturer will be given a login by the administrator to add/modify/delete module contents and also to assess the student performance in a chapter.
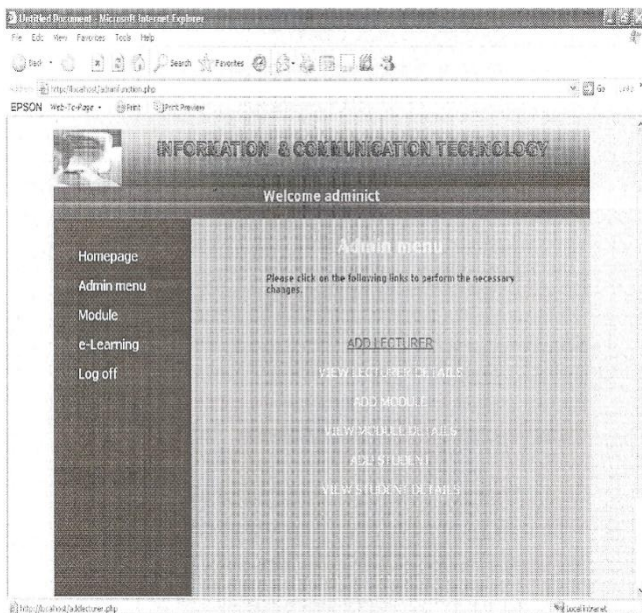
Figure 7: Administrator menu screen display

6. Conclusions

In this paper, a computer-aided learning package in the form of an e-learning system has been successfully designed and implemented for a module named ICT for the students of the University of Mauritius. Various Human Computer Interaction (HCI) techniques have been used throughout the web application to make the user interface user-friendly, easy and simple to use. Database Management System (DBMS) concepts have been used as well, in order to implement the system successfully. Data Flow Diagrams (DFDs) have been used throughout the design stage for both the student and lecturer levels. The designs have been analyzed and tested for all web pages and simulation results show that the e-learning package has been successfully implemented.

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