Development of Telephone-based e-Learning Portal

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ABSTRACT

The proliferation of mobile phones in Nigeria, particularly among the student community, has continued to inspire the development and delivery of e-Learning applications. Most of the existing web-based e-Learning applications do not support nomadic voice-based learning (i.e. learning on the move through voice), and consequently do not provide a speedy access to information or enquiries on demand. Internet access is required to get every bit of information from most school portal system, which is not directly available to everyone. Lack of provision for voice in the existing web applications excludes support for people with limited capabilities such as the visually impaired and physical disabilities.
In this paper, we present a design and development of a prototype telephone-based e-Learning portal that will be used for course registration and examination. This study is part of an ongoing e-Learning project involving the following modules: enrollment, course registration and examination, enquiries/information, messaging/collaboration, e-Learning and library.
The prototype application was developed using VoiceXML for the voice user interface(VUI), PHP for database queries, Apache as the middle-ware and MySQL database as back-end. A unified modelling language (UML) was used to model and design the application.
The proposed e-Learning system will compliment the web-based system in other to meet the needs of students with a range of disabilities such as visual impairment, repetitive strain injury, etc, that make reading and writing difficult. It also makes multiple platforms available to all users as well as boosting access to education for the physically challenged, particularly the sight impaired in the developing countries of the world. In institutions where students are not allowed to use mobile phones or where cost is an issue, then the alternative is the use of PC-phone.

Keywords: Portal, e-Learning, Telephone, Voice, VoiceXML, VUI and UML.

1.0 INTRODUCTION

The recent rapid advances in information technology, including the Internet, have had significant impact on various aspects of the daily living of mankind and the society. One of the aspects that have been highly affected is education. Technological advances and wide availability of personal computers, CDs, the web, broadband access to the Internet, etc, have been used as supporting tools in e-Learning (also known as distance learning or web-based learning)[1].

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Voice applications are developed using VoiceXML, also known as VXML. VXML is a web-based markup language for representing human-computer dialogs, just like HyperText Markup Language (HTML). But while HTML assumes a graphical web browser, with display, keyboard and mouse, the VoiceXML assumes a voice browser with audio output (computer-synthesized and/or recorded), and audio input (voice and/or keypad tones)[2]. VoiceXML technology allows a user to interact with the Internet through voice-recognition technology by using a voice browser and/or the telephone. The major goal of VoiceXML is to bring the advantage of web based development and content delivery to interactive voice response(IVR)[3].

Human-to-human(H2H) interaction is one of the conventional approaches of receiving online e-Learning services involving course registration, e-Learning course materials, etc. Majority of present day web-based e-Learning applications only have support for the web user interface (WUI) through the use of a PC and Wireless Application Protocol (WAP) using the mobile phone, but little or no support for voice. This has motivated a lot of research in the provision of VUI support in the education domain.

The remaining parts of the paper are organized as follows: section 2 discusses the review of related literature. Section 3 contains statement of the problem. Section 4 highlights the research methodology. Section 5 describes the systems design and implementation, while the results and discussion are contained in section 6. Section 7 enumerates the concluding remarks.

2.0 REVIEW OF RELATED LITERATURE

For over a decade, there have been several number of web-based e-Learning applications, all providing e-Learning content and giving feedback irrespective of distance of the participants. One of such applications is presented in [4]. Blackboard was developed in 1997 to allow instructors and facilitators to build and manage learning content and provide an engaging environment for students. Tests, quizzes and assignments are easy to create and deploy using Blackboard. Blackboard also has a variety of tools for evaluating performance which contribute to instructors' efficiency while providing timely feedback and reporting for students.

Similarly, the WebQuizXP [5], allows one to create on-line quizzes, tests and assessments in just a few minutes. ExamWeb [6] allows one to create, deliver and report on a variety of examinations for a variety of purposes. Furthermore, Moodle [7] is a software package for producing Internet-based courses and web sites. It is an ongoing development project designed to support education. Moodle is provided freely as Open Source software (under the GNU Public License), GNU is an acronym for "GNU's Not Unix".

A study was carried out in [8] on the development of an interactive e-Learning management system (e-LMS) to be used by Tanzanian secondary schools. The e-Learning management system (e-LMS) is a client- server, web-based system with a three-tier architecture: the client, application and database tier. The research was aim at supporting teaching and learning functions by allowing creation and storage of learning materials, making them available, easily accessed and sharable among students from different secondary schools in Tanzania in a more organized way.

A number of systems have been proposed to change web-based educational applications from being a static application to mobile. The spread of the use of mobile devices and technologies offers great opportunities for the e-Learning community. In [9], the potentials of m-Learning environment was explored by introducing the concept of mLab, a remote laboratory environment accessible through the

use of handheld devices. This has been complemented by the proliferation of multimedia learning applications for the Personal Digital Assistant (PDA)[10].

Another alternative to traditional methods of interacting with a desktop computer using a speech recognition system was presented in [11]. It uses voice input through a microphone, such that it can reduce the reliability on standard keyboard and mouse input. A speech recognition system based on desktop computers consists of the following: (i) a microphone, for the person to speak into, (ii) a speech recognition software, (iii) a computer to take and interpret the speech, and (iv) a good quality soundcard for input and/or output. Using this method, a person can "speak", via a microphone, to a computer. The computer translates the spoken words into either text, usually for automatic insertion, secretary-style, into items (such as word processing documents) or commands to execute functions in the computer e.g. print a document, open a file.

The description in [12] contains some important factors to consider when introducing and using speech recognition for students with disabilities. It was reported that speech recognition programs have been used successfully by students with a range of disabilities. The application is PC-based and has been shown to provide an effective means of writing and recording work, and in some cases, have produced significant improvements in basic reading, spelling and writing skills. A chat application was developed in [13] for communicating between the deaf and blind. The goal of the project is to incorporate current speech recognition (speech-to-text) and speech synthesis (text-to-speech) technology into a chat room that is both free and does not require any additional equipment besides a desktop computer. The system was developed using C++ and run on client and server with a graphical user interface (GUI) for the client. The system may also be used in educational settings, regardless of students' or teachers' disabilities, as a teaching aid.

The novelty of the approach presented in this work in contrast to existing approaches is premised on the use of voice on mobile and land phones to provide access to learning contents in a web server.

3.0 STATEMENT OF THE PROBLEM

Majority of present day e-Learning applications have support for the web user interface (WUI) through the use of PC, while others are based on mobile devices such as Wireless Application Protocol (WAP) phones and Personal Digital Assistants (PDAs). The need to reduce access barriers has necessitated a lot of research in the provision of voice user interface (VUI) support in the education domain through mobile and land phones. Some of the problems of the present e-Education systems are discussed below:

For most learners, communicating with each other is quite simple. There are many options available: telephone, electronic mail, chat room, instant messaging, etc. However, this becomes a more difficult task for those with disabilities. A blind person cannot communicate through mail or electronic means that require being able to see the screen. Lack of provision for voice in the existing e-Learning applications has excluded support for people with limited capabilities such as the visually impaired and physical disabilities that affect either data entry, or ability to read (and therefore check) what they have entered, since these applications are visual in nature and require sight to see the computer screen and manipulate the computer keyboard. More so, it excludes people who have medical history of reacting to repetitive strain injury as a result of seating too long in one place using the keyboard. The existing system does not have support for people with textual interpretive problems e.g. dyslexia, to enter text verbally, and others who have problems of identification of characters and words.

The present PC based e-Learning system excludes people who have little keyboard skills or experience, who are slow typists, or do not have the time or resources to develop keyboard skills.

Most of the existing web-based e-Learning applications does not support nomadic voice-based learning (i.e. learning on the move through voice), and consequently do not provide a speedy access to information or enquiries on demand. Internet access is required to get every bit of information from most school's portal system, which is not directly available to everyone.

Therefore, the primary objective of this paper is to design, develop and deploy a prototype telephone-based e-Learning portal that will be used for course registration and examination, as part of an ongoing e-Learning project involving the following modules: enrollment, course registration and examination, enquiries/information, messaging/collaboration, e-Learning and library.

4.0 RESEARCH METHODOLOGY

The client application for the telephone was developed using VoiceXML for the VUI. PHP and Apache constituted the middle-ware and MySQL database as the back-end component. VoiceXML was chosen because it is a foundation platform for developing and operating voice automation applications [14]. PHP, Apache and MySQL database were selected because they are free and open source software [15]. After developing the application, the VoiceXML code was deployed to a voice server for access using a telephone.

5.0 SYSTEMS DESIGN AND IMPLEMENTATION

The interaction and data flow involving the course registration and examination module is presented in this session using Unified Modeling Language (UML) collaboration diagram and class diagram. The UML is a visual language that provides a means to visualize, construct and document the artefacts of software systems [16]. The software and hardware architectures of the e-Learning system are also contained in this session.

5.1 Requirements and Modelling

Figure 1 contains the class diagram for course registration and examination module. The Class diagram has five classes – Student, Course, CourseRegistration, ApproveRegdCourses and Examination. Each class has three compartments, the top compartment contains the class name, the second contains the attribute names and format, and the third compartment contains the operations to be carried out on the attributes. The lines labelled with a directed arrow connecting two classes shows association between the classes as follows: (i) "* get course list 6..8" means all students must register for between 6 and 8 courses, (ii) "* take part in 6..8" means all students must take part in examination for between 6 and 8 courses, (iii) "6..8 approve 1" means between 6 and 8 registered courses by students must get 1 approval from level adviser, (iv) "* get course list 6..8" means all students must get between 6 and 8 list of courses, preparatory for registration, (v) "* take part in 6..8" means all student must take part in examination for between 6 and 8 registered courses, (vi) "* go through 1" means all registered courses must go through examination. The rest connectivity follows with the same interpretation.

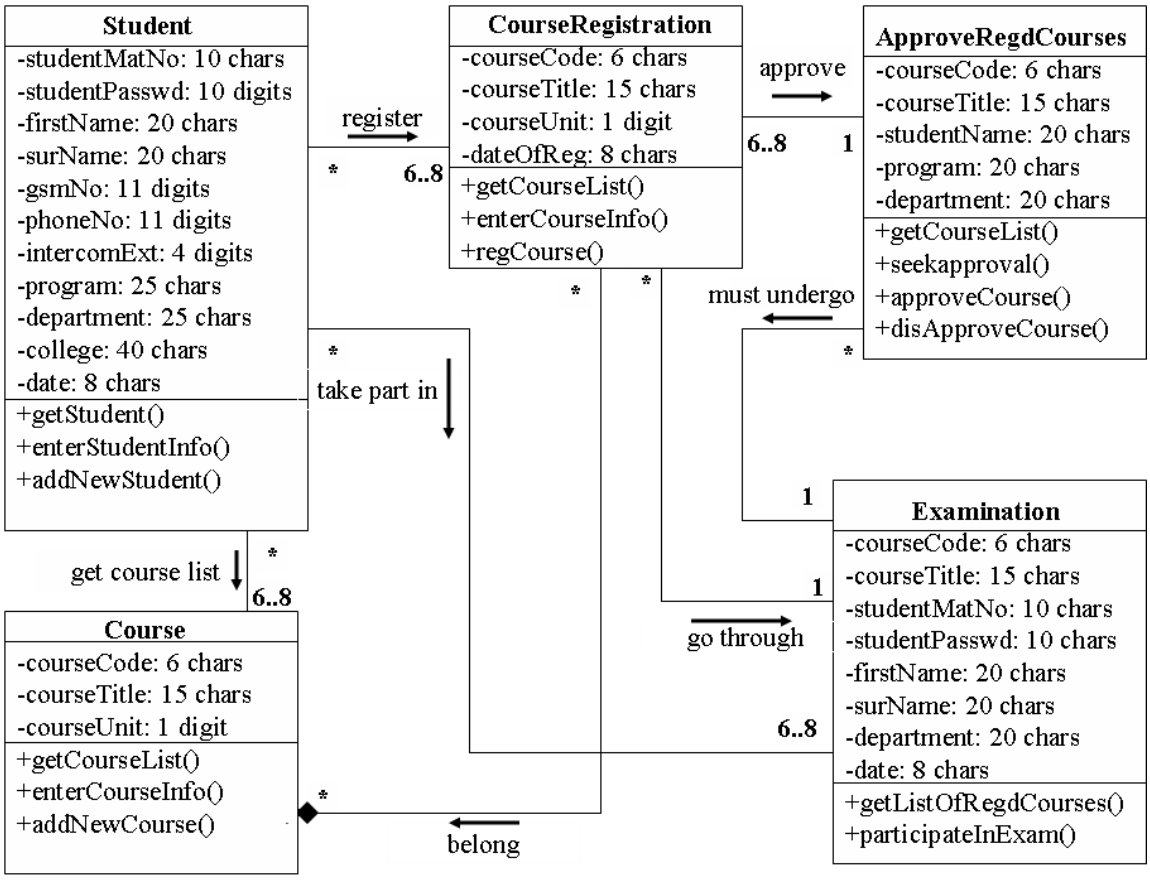

Figure 1. Class diagram for *Course Registration and Examination module*

The cooperation between the different actors in the *Course Registration and Examination* module is modelled with UML collaboration diagram in Figure 2. The collaboration diagram reveals the internal details of *Course Registration and Examination*. The UML is a visual language that provides a means to visualize, construct and document the artefacts of software systems [16].

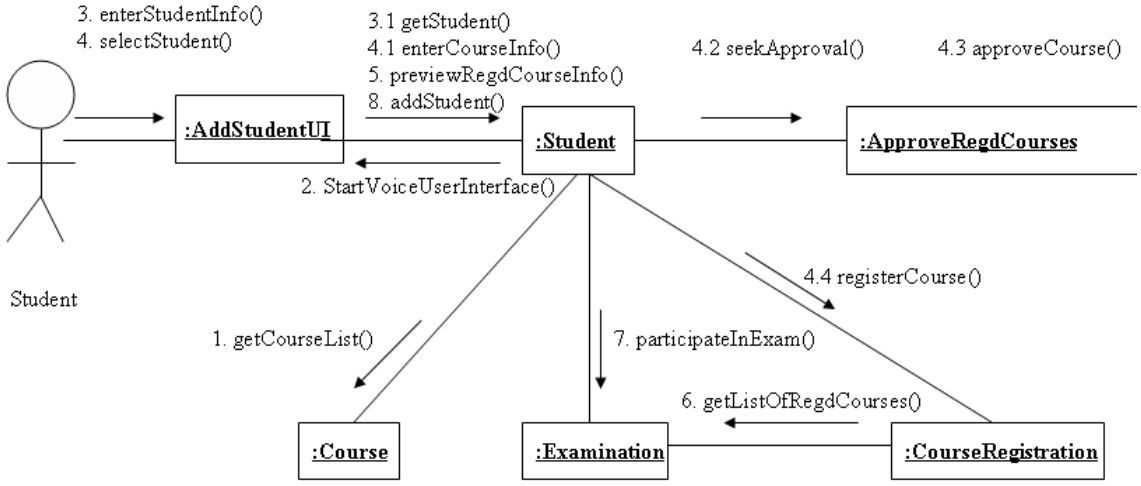

Figure 2. Collaboration diagram for *Course Registration and Examination module*

5.2 The Architectural Framework

Software Architecture

Figure 3 gives the logical overview of the architecture of e-Learning system. The architecture shows the location of each of the module in the system. It consists of the client interface, middleware and database services. The database is separated from the client through the middleware, here referred to as the business logic tier.

The presentation tier
The presentation layer provides client access to the e-Learning system through the middle ware. The components of the client's interface are enrolment and Course Registration and. These components do not store or process any form of data. They only provide an interface for the middle layer and the data layer. Data or files or voice browsers are not stored on the mobile phones due to resource constraints associated with hand-held devices. The application is developed to use telephone and allows voice browsers (running in the voice gateway) to be used as the interface. The information from the database is presented in a compatible form to the client using voice. The voice browser simply receives any call into the application and submits to the voice gateway for further processing.

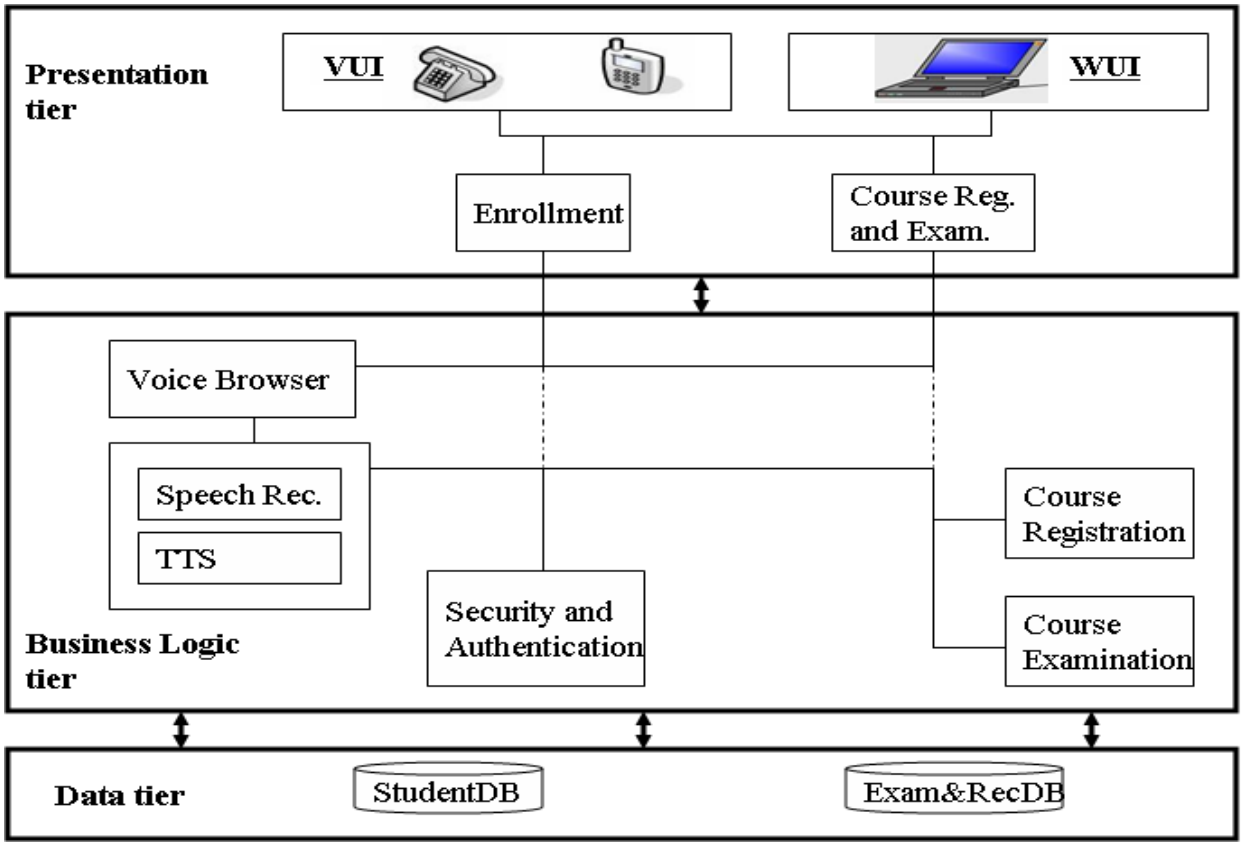

Figure 3. Overview of a three-tier Telephone-based e-Learning Architecture

The business logic tier
The servers hold all the application. The presentation tier communicates with the voice gateway component of the middle-tier through the voice browser. The middle-tier contains the voice gateway and the application logic. Users access the application from various mobile telephone devices and land line telephone, anywhere, anytime. Once a user has been authenticated, the user's query is translated

by the automated speech recognition (ASR) to text and passed to the database server for execution. A user can only access the module for which he or she is authorized. The client application interfaces with the application layer using the voice gateway.

Data tier
The database server provides data services and data base management system function. The data tier is responsible for changing, adding, or deleting information in the database within the system. We have used MySQL database for the implementation of the data layer.

The Hardware architecture

This architecture consists of client device, server and database. The client includes the web and hand-held devices such as mobile phones and personal digital assistants and land telephones. The server contains the voice server and application server. The database server contain MySQL database.

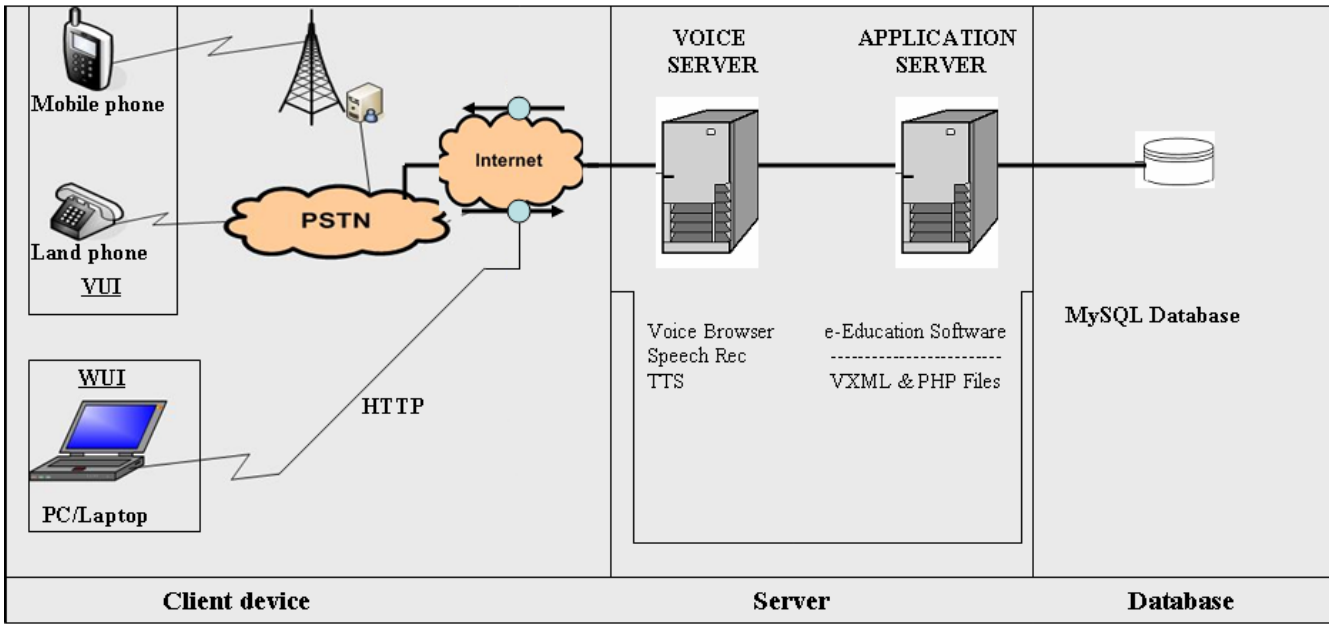

Figure 4. Overview of a 3-tier e-Education Telephone Web System Architecture

5.3 Pseudocode

Every authenticated user of the application will undergo some questions and answers section, which will be matched against the content of the grammar, and the result received by the user through voice. Figure 4 describes a pseudocode for course registration and examination module.

```
BEGIN
  SYSTEM PROMPT 'Welcome to Covenant University e-Education system';
  //Caller suppler a username and password
  SYSTEM AUTHENTICATES A CALLER;
  SYSTEM PROMPT menu selection;
  SYSTEM REPORT Student information from database;
   WHILE NOT EOF DO
      //Caller select a menu option;
      IF menu option is REGISTRATION THEN
          SYSTEM process and report registration information;
      ELSE
      IF menu option is EXAMINATION THEN
          SYSTEM process and report examination information/result;
      ELSE
      IF menu option is EXIT THEN
         SYSTEM report good bye message and exit;
      ENDIF
   ENDDO
END
```

Figure 4: Pseudocode for course registration and examination module

5.4 Testing and Deployment

Testing is a vital stage in the development of any system. The VoiceXML-based application was deployed and tested using sample student data. The user logs onto the system using a "username" and "password" specific to their registration profile.

6.0 RESULTS AND DISCUSSIONS

The VoiceXML application was deployed on a voice server and accessed from any telephone using the format:<source country code><destination country code><destination area code><generated voice network 7-digit number>.

Dialling: 009-1-213-7846674 from any mobile or land phone will connect and execute the application. The default username is "*admin*" and password is "*admin*". Figure 5 shows a sample conversation between the system and a user through a land or mobile phone.

Once connected, the system will be prompted with a welcome message and go ahead to authenticate the user's name and password before any transaction can take place. The system will ask for the services demanded by a student and go ahead to process the request, either course registration or e-Examination as depicted in Figure 5.

SYSTEM:	**Welcome to Covenant University e-Education Portal.**
SYSTEM:	**What is your user name?**
USER:	**admin**
SYSTEM:	**What is your password?**
USER:	**admin**
SYSTEM:	**You have successfully login. Select any of the following options. Say one for course registration. Say two for examination. Say three to exit.**
USER:	**One**
SYSTEM:	**Welcome to course registration session. Your login information are as follows. Full Name: Azeta joy Emmanuel. Matriculation number: 04CJ01277. Year of study: 3. Session registered: 2007/2008. Program of study: B Sc Computer Science. Semester: Alpha. Carry over courses: None. Compulsory courses: CSC311, Discrete Mathematics, 3 units. CSC312, Data structure and algorithm, 3 units. CSC313, computer programming 4, 2 units. CSC314, System administration, 2 units. For the following Elective courses, listen and say "select" or "deselect" at the end of each line. CSC316 logic programming, 3 units, say "select". CSM216 Information system analysis and design, 2 units, say "deselect".**
.	
.	
USER:	**Two**
SYSTEM:	**Welcome to examination session for CSC314 Systems Administration. There are 2 multiple choice questions. Instructions: Answer all the Questions. Say a or b or c for each question. Question one: Which of the following does not involve a disaster recovery plan? a. data backups and redundancy. b. uninterruptible power supply. c. virus free system. Question two: One advantage of disk mirroring is a. both drives use one controller. b. fault tolerance c. parity stripe. Now the result: you scored 1 out of 2. Good bye.**

Figure 5. Sample conversation between the system and a user through a telephone

MatricNo	Name	courseCode1	courseTitle1	courseCode2	courseTitle2
04CHO0345	Jonathan Ojomo	CSC211	Computer Programming with C	CSM211	Pure Mathematics
04CJ01277	Azeta Joy Emmanuel	CSC311	Discrete Mathematics	CSC312	Data Structure & Algorithm
05CY01867	Adelabu Kayode	CIS112	Computer Animation	CSC111	Introduction to Computer Studies

Figure 6. A sample list of registered courses by student's matriculation number

7.0 CONCLUSION

In this paper, we have successfully designed, developed and deployed a prototyped VoiceXML-based course registration and examination module, as part of an ongoing e-Learning project, that will

facilitate access using the telephone to connect normal students and people with different forms of disabilities.

This telephone-based e-Learning application, when fully developed with all the education system modules will be used successfully by students with a range of disabilities. Successful use of voice application requires considerable time, energy and commitment from teaching staff, management, parents and, especially, the student. The voice-based e-Learning will be helpful for people with physical access difficulties (e.g. repetitive stain injury, arthritis, high spinal injury) that make writing difficult. It can also be effective for students with reading or spelling difficulties (e.g. dyslexia) and for those with visual impairment.

The prototype system has two fully developed modules: Course registration and examination as shown in Figure 5. Similarly, the details of course registration as contained in the database for the individual students are shown in Figure 6.

In research and university context, this work, in addition to providing a basic platform for e-Learning, will also present a design and architectural framework that can be referenced for academic purposes.

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