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A Phone Learning Model for Enhancing Productivity of Visually Impaired Civil Servants

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ABSTRACT
Phone-based learning in civil service is the use of voice technologies to deliver learning and capacity building training services to government employees. The Internet revolution and advancement in Information and Communications Technology (ICT) have given rise to online and remote staff training for the purpose of enhancing workers productivity. The need for civil servants in Nigeria to develop capacity that will enhance knowledge is a key requirement to having competitive advantage in the work place. Existing online learning platforms (such as web-based learning, mobile learning, etc) did not consider the plight of the visually impaired. These platforms provide graphical interfaces that require sight to access. The visually impaired civil servants require auditory access to functionalities that exist in learning management system on the Internet. Thus a gap exist between the able-bodied and visually impaired civil servants on accessibility to e-learning platform. The objective of this paper is to provide a personalized telephone learning model and a prototype application that will enhance the productivity of the visually impaired workers in Government establishments in Nigeria. The model was designed using Unified Modeling Language (UML) diagram. The prototype application was implemented and evaluated. With the proposed model and application, the visually and mobility impaired worker are able to participate in routine staff training and consequently enhances their productivity just like their able-bodied counterparts. The prototype application also serves as an alternative training platform for the able-bodied workers. Future research direction for this study will include biometric authentication of learners accessing the application..

Keywords- Able-bodied, Civil Servants, Phone Learning, Productivity and Visually impaired.

1. INTRODUCTION

There are various advancement in technology and several e-learning applications such as Moodle, Sagai, Blackborn, etc, are now available on the Internet. Unfortunately, the visually impaired workers are not among the beneficiaries of these technologies. Rather, what the visually impaired workers require for online learning is assistive technology to provide auditory access to the e-learning functionalities on the web. Using the web technology as a tool for training development is one of the key factors to improve productivity. Investment in human development, employee training and technological modernization are areas that deserve serious attention in worker's productivity. This is because, one of the most efficient and effective methods of improving workers productivity is simply to train them in the skills they need to perform their job duties [1]. There is no doubt that the goal of e-learning in the workplace is to enhance individual and organizational performance [2].

Enhancing the capabilities of individual staff members is the key to improving overall workforce performance. It is a well - known fact that low productivity is a national economic development problem especially in the public sector.

Phone learning technology is a type of e-learning that is often referred to as voice-enabled learning system. It is the use of land or mobile phone to access learning content on the Intranet or Internet depending on network coverage availability. It uses technologies such as speech recognition and text to speech (TTS) conversion to create a user interface that enables users to navigate through a dialogue system using telephone and voice commands. Phone applications have been developed in several areas such as in e-learning [3,4], banks transactions [5] and a lot more. Some other e-learning phone-based applications that have been implemented includes: [6,7,8,9]. Generally, there is dearth of phone application in the domain of e-learning and the few existing once lack sufficient intelligence to provide personalization services beyond learners' queries and request.

Personalized learning is an attribute of independent or autonomous learning. Autonomous phone learning platform is one of the ways management could use to encourage higher productivity for the visually impaired workers. For instance, as a staff of a government institution, one may be scheduled to attend training at the Federal government head quarters in the capital city. The cost and logistics involved in such trip may be saved when the staff is made to simply dial a telephone number to connect to the training materials and receive the lecture through voice interaction.

When government employees that are visually or mobility impaired are not left out in the scheme of training, productivity is indeed enhanced to their benefit just like their able-bodied counterparts. This research, aimed to provide a personalized Phone learning assistive technology to enhance the productivity of the visually impaired employees, and also serve as an alternative training platform for the able-bodied workers in the Nigerian civil service. In workplaces, employees are adults who have good self-concept, and usually they have a clear understanding of their learning needs and can learn independently [10]. Through e-learning systems, learners can study course contents in an independent manner. They can also decide when to study, the sequence of the content to study, and the amount of time to spend for self education, without time and space barriers [11]. Recently, e-learning systems have been increasingly adopted by organizations for employee training for reasons of cost reduction and convenience.

2. PRODUCTIVITY AND E-LEARNING IN CIVIL SERVICE

Technological advancement have given rise to the online staff training that hold great promise for productivity enhancement [12]. This advancement brought about the need for employees to develop capacity and enhance knowledge for competitive advantage. Globally, an average employer of labour will expect the workforce to be productive. Productivity as a concept means different thing to different people. Productivity is defined as the efficient use of resources such as labor, capital, land, materials, energy and information in the production of various goods and services [13]. Productivity is the relationship between the amount of one or more inputs and the amount of outputs from a clearly defined process [1].

Productivity is thus, of fundamental importance to the individual worker of whatever status, to the organization whether commercial or not, to the national economy at large, to the upliftment of the welfare of the citizen and the reduction if not total eradication of mass poverty [14,15]. In addition, it is recognized as a panacea for a country's economic woes or ills, it is an attitude of the mind, it is a springboard for economic growth, it improves overall standards of living. Indeed, nations of the world now anchor their development policies and planning strategies on productivity and sustainability. Against this backdrop, the concern for productivity improvement especially in the public sector has increased with intensity, culminating to the establishment of the National Productivity Centre (NPC) under the Federal Ministry of Employment, Labor and Productivity [16,17].

NPC is a parastatal charged with the statutory mandate to implement productivity improvement program aimed at making productivity the driver of our economic activities both in the public and private sector. The functions of NPC include inter-alia capacity building and training services to client organizations, both private sectors and civil service. The increasing practice of using e-learning in the civil service has however propelled a gap between two group of employees - the physically challenged particularly the visually impaired and the able-bodied employees. Several technology-based application exist for training such as web-based mobile learning, etc, but they do not consider the plight of the visually impaired in their interface design and methodological approaches. There are pedagogical issues when group of people engage in e-learning. The knowledge level of the learners differs, hence there is need to deliver learning content to learners based on individual knowledge level and physical ability to access the learning content. This type of e-learning service delivering is often referred to as learning content personalization based on users' profile.

In a competitive work environment, finding ways to use employee training program to help enterprises adapt to changes in the external environment is an important issue [10]. With the prospect of cost-effective investment in training, many enterprises have adopted e-learning systems for employee training to assist in their human capital management in recent decades [18]. Through the use of e-learning systems, employees can transfer what they have acquired from the training to their jobs and thereby increase their productivity [19]. This helps employees' renewals of knowledge and skills while also reducing knowledge gaps between what the organisations have and what the employees need in order to have competitive advantage.

3. PROBLEM STATEMENT

A number of voice-based learning technologies exist such as: [20,4,6,7,9]. Their biggest disadvantage is the rigid structure that they impose on the end user. While it is convenient to use mobile telephony application, it can be extremely slow when the user is forced to drill through several layers of options before finding exactly what he/she wants [21]. The usage of Phone application is more rigorous when the visually impaired learner is involved as a result of their sight impediment. Some level of learning content adaptation using Artificial Intelligence (AI) is required to serve the purpose of personalization for the visually impaired group of learners. This study, thus, provided a personalized voice-based learning system otherwise known as 'Phone learning' to deliver learning content through voice response that suits individual visually impaired user, by simply dialing a mobile telephone number.

4. THE PHONE LEARNING MODEL

The Phone learning model shown in Figure 1 was designed using Unified Modeling Language (UML) deployment diagram. The assumptions of the model are as follows: i) There exist some visually impaired civil servants as employees in the Nigerian civil service, ii) Government employees in Nigeria make use of mobile phones as their means of communication, and iii) Government employees in Nigeria are required to attend routine training outside their work station. The model shown in Figure 1 has components that require specific description. The visually impaired civil servants connects through a mobile phone to the Phone Gateway. The text to speech (TTS) and automatic speech recognition (ASR) executes the call interaction with a caller. The Phone Gateway communicates via web protocols (HTTP) to Phone application server. The web application server queries the database via apache to dynamically retrieve information and the TTS translate the lecture content from text to speech for the caller to hear.

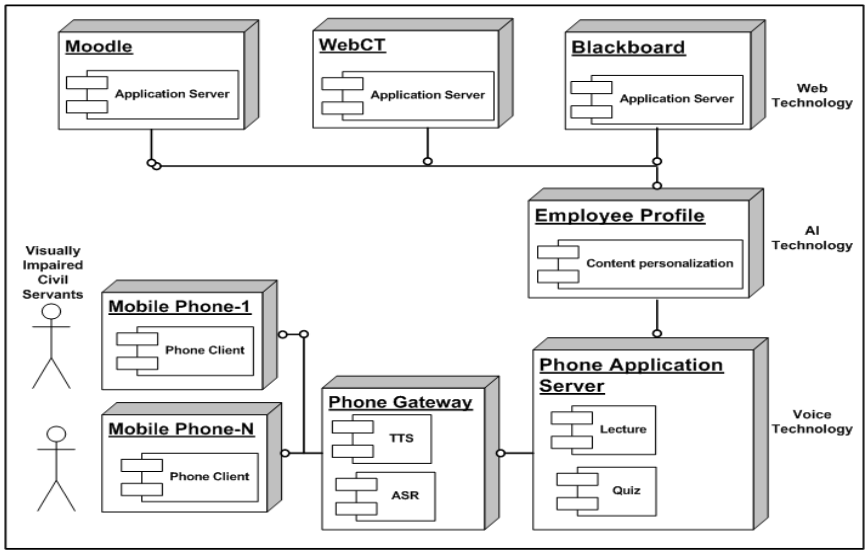

Figure 1: A Phone Learning Model for the Visually Impaired Civil Servants

The upper layer (web technology) represents the learning management system (LMS) comprising Moodle, WebCT and Blackboard. The middle layer (AI technology) represents the intelligent personalization of learning content using individual employee profile. The bottom layer (voice technology) comprise of voice interface, phone gateway and the phone application server. The implementation of the AI technology is contained in [20] and it uses case-based reasoning (CBR) and stemming algorithm.

4.1 The Phone Interface Design and Implementation

Authenticated user of the application will undergo some questions and answers session, which will be matched against the content of the database, and the result received by the caller through interactive voice response (IVR). The partial call flow for the phone learning application is shown in Figure 2.

```
IVR:      Welcome to Phone learning application. To login,
          you must enroll and register to obtain user name
          and password.
IVR:      What is your password?
Learner:  Say [password]
IVR:      Say "1" For lecture
IVR:      Say "2" For Quiz
          IF Voice Response = '1' THEN Call LECTURE_MENU;
          IF Voice Response="2" THEN Call QUIZ_MENU;
LECTURE_MENU
IVR:      Say "1" For MS-Word processing lesson1
IVR:      Say "2" For MS-Excel Spreadsheet lesson2
IVR:      Say "3" For MS-Powerpoint presentation lesson3
QUIZ_MENU
IVR:      Say "1" for lesson1 Word processing test
IVR:      Say "2" for lesson2 Spreadsheet test
```

Figure 2: Partial call flow of the application

The model was implemented using the following tools: VoiceXML for the Voice User Interface (VUI), PHP for Web User Interface (WUI), Apache as middle-ware, and MySQL database as back-end. The phone gateway used was provided by [22] for application development and testing. The choice of these tools is due to their advantage as Free and Open Source Software (FOSS) [23]. VoiceXML's wide acceptance as a standard, huge industry uptake, suitability for multimodal interaction, and increased developer productivity clearly demonstrate its superiority over other tools for developing voice applications [24].

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The VoiceXML prototype application was deployed on a Voxeo voice server [25] on the web and accessed from a mobile phone using the format:<source country int. dial out #> <destination country code><destination area code><generated voice network 7 digit #>. Evaluation of the Phone learning system was carried out using [26,27] usability criteria. Statistical Package for Social Sciences (SPSS) was used to generate the usability analysis and reports.

5. SYSTEMS EVALUATION

The application was evaluated for usability to determine the level of effectiveness, efficiency, users' satisfaction, learnability and memorability. In conducting the usability evaluation, questionnaire were designed and administered. Each section of effectiveness, efficiency, user satisfaction, learnability and memorability contains five questions represented by Q1, Q2, Q3, Q4 and Q5. The questionnaire aims at eliciting information from learners to measure the usability of the Phone-based learning application provided. A total of 70 questionnaires were administered but only 63 responses were received, analyzed and reported. The questions were designed using five-point likert-scale where 1= strongly disagree, 2 = disagree, 3= undecided, 4 = agree and 5= strongly agree. The usability attributes analysis of the evaluation has effectiveness 3.96, efficiency 4.12, user satisfaction 4.03, learnability 4.00 and memorability 4.02 (see Figure 3). The average total rating of the usability evaluation is 4.03.

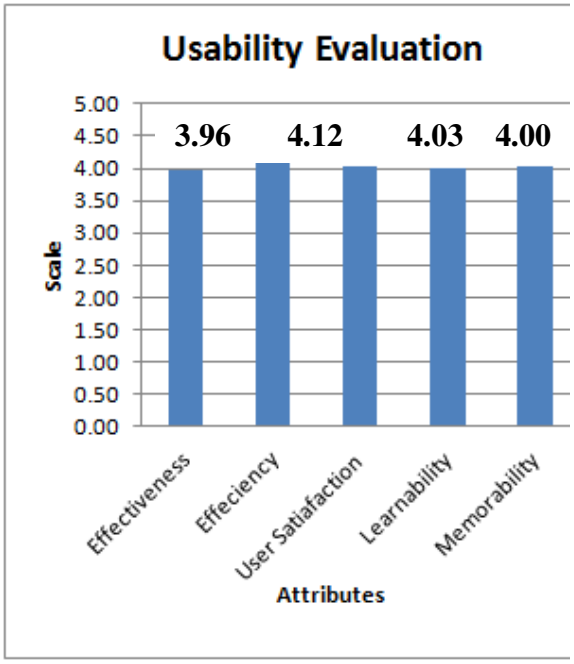

Figure 3: Usability attributes analysis

Several usability studies suggest the system with "Very Bad Usability" should have 1 as mean rating, "2 as Bad Usability", 3 as Average Usability, "4 as Good Usability" and "5 as Excellent Usability". It was proposed in [28] that "Good Usability" should have a mean rating of 4 on a 1-5 scale and 5.6 on a 1-7 scale. Therefore, it can be concluded that the prototype application developed to validate our model has "Good Usability" based on the average (AVG) total rating of 4.03.

6. RESEARCH IMPLICATIONS

The research contain herein has several implications. Lecture materials are stored in a central server and delivered to learners through voice interface. To participate in the training, employees are required to dial a telephone number from a remote location using a mobile phone that will connect the caller to the lecture materials. Expectations for continuous performance of government employees is high, hence the need for an appropriate training to enhance workers productivity. The aforementioned highlights the need to design training programs that addresses not only the needs of the able-bodied learner but also that of the visually impaired.

The phone learning system have the following benefits to the able-bodied and the visually impaired: (i) Learners can learn at Anytime, Anywhere and Anypace (A3), (ii) productivity is enhanced, (iii) the time, cost and logistics of bringing people together is eliminated, iv) the new system can reduce training related expenses such as travel, accommodation and facilities, and (v) Government due process policy is avoided.

The issues to consider when using phone learning system are as follows [3]: (i) A new level of competence and awareness with ICT is required for the employee, (ii) diverse opinion on high cost of deployment, (iii) There may also be resistance from government employees as they are used to attending classroom/hall session training outside of their office station, preferably in oversea country.

The opinion of some school of thought about high cost of investing in Phone learning application is arguably incorrect. Research shows that a simple one percent increase in productivity typically produces more than ten times the impact of a one percent decrease in training costs [29]. The requirement is for participating institution to subscribe to a service provider by paying a periodic token of fee.

7. CONCLUSION AND FURTHER WORKS

In this paper, a model and prototype application has been provided to brigbe the gap that exist between the visually impaired worker and their able-bodied conterpart in terms of productivity enhancement. The prototype application was tested by some learners, and the result of evaluation shows that the prototype application developed has "Good Usability" rating of 4.03 out of 5 scale.

The findings shows that the users are enthusiastic about using a mobile phone training tool as another form of assistive technology to compliment the conventional travelling-based training method. When employees of government are made to embrace the new Phone learning system, it follows that the efficiency and productivity of staff are enhanced which will have a multiplier effect on the economy in general.

The future research direction for this study is to engage voice biometric techniques based on speech data. Voice authentication will be added as additional means of security mechanism to enhance the authentication of candidates for examination and quizzes. An improved system will combine the conventional pin/telephone number authentication and biometric to increase security of the application.

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Authors' Brief

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