MoVE: Mobile Vocational Education For Rural India

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Abstract — **The aim of this paper is to present the design of a project that involves deployment of computerized vocational training courses comprised of multimedia enhanced video lectures, virtual reality games and low cost haptic device based simulations built on mobile-learning platforms and delivered using automobile units. These mobile vocational education units are developed as a model to make vocational education and training more accessible to the rural and tribal populations of India. The paper gives an overview of the design of the mobile vocational education units and details the architecture and communication interface for the m-learning application. It further describes the software architecture of the vocational education application that is specifically designed to easily scale across various vocational trades and languages of delivery, provide flexibility and increase accessibility for vocational training.**

***Keywords*— Mobile-Learning, ICT, Vocational education and training, mobile units, e-learning, Haptics for Vocational training, skill development, human computer interaction**

I. INTRODUCTION

How does one measure the success or growth of a nation and what contributes to this success of becoming a developed nation? Growth of a nation is not just the advancement of its urban population. It greatly depends on every individual living a quality life that constitutes to have the basic necessities of food, shelter, clothing and sanitation [1]. In a vast country like India with a population of over 1.2 billion and where a third of them live below the poverty line this is a challenge. To maintain a quality life, an individual, or a family has to be equipped with appropriate means, resources, skill sets and opportunities.

Skill development is linked to economic productivity and social well-being [2]. The urban population has the means and skill set to have sustained quality life. For the rural and tribal economically challenged community this is an uphill task [3]. Countries with higher levels of knowledge and skills respond more effectively and promptly to challenges and opportunities of globalization. India is in transition to a knowledge-based economy and its competitive edge will be determined by the abilities of its people to be more flexible, analytical, adaptable and multi skilled [4].

Vocational Education and Training (VET) plays a vital role in human resource development of the country by creating skilled manpower, enhancing industrial productivity and improving the quality of life [3]. In India, over 12 million people enter the workforce every year, while the number of vocational institutes in India, are only around 12,000 which include ITI's and secondary vocational schools and can handle a capacity of only 3 million [5]. Consequently, VET remains inaccessible to a majority of unskilled population. As the demand in labour is increasing, traditional VET schools face the challenge of lack of trainers, materials, equipment, current technology, quality training and of overcoming the social stigma towards vocational courses. As the quality of instruction degenerates, prospects of receiving a job are also diminished. In order to increase the production and thereby the economic growth in India, there exists a need to find ways to train vocational courses to the majority of Indian society that has been denied access to the available schooling system.

According to Census India, 833 million people reside in rural and tribal areas that constitute about 70 percentage of the total population of the country [6]. These areas are not as easily accessible as most of this population is economically backward and lacks the resources required to set up VET schools to provide them the opportunities. The Sakshat Amrita Vocational Education (SAVE) project of AMMACHI Labs has been developing desktop and mobile - learning based vocational training courses that bring education to rural India utilizing multi-modal interfaces that interact with the user using visual, haptic and auditory feedback [7]. This program offers a solution that addresses the limitations of limited trainers, time, and materials per pupil.

Along with the economic empowerment that comes with vocational training, the courses are supplemented with Life Enrichment Education (LEE) modules. LEE modules cover topics related to Environmental and Disaster awareness, preparedness and response, Personal empowerment and social participation, civic rights and duties, business and entrepreneurship and health and hygiene. This education allows for social empowerment, a prerequisite and motivation to change existing lifestyles. Through the Mobile Vocational Education units (MoVE), the SAVE project can find its way in to rural and tribal areas with limited infrastructure and power resources.

II. RELATED WORK

M - Learning or mobile - learning is a form of education that offers both the trainers and learners the opportunity to interact and access educational material using a wireless handheld device, not being restricted by time or space [8]. Tools that facilitate the development and delivery of innovative VET activities and services such as the SMILE project and the Ad Hoc and Mobile Classroom design, provide useful insight in to the design of m-learning resources and activities [9] [10]. With the use of multimedia interactive learning and personalized learning portfolios, Hsiu-Yi Lin et al. have provided a scaffolding m-learning model to increase learning efficiency in automotive course delivery [11].

It is accepted that effective learning involves three key aspects; Constructing an understanding through the amalgamation of new experiences and existing knowledge, Conversation with teachers and other learners though questions and experiments and Control of the process and actively pursuing knowledge instead of passively consuming it [12].

The SAVE application's multi-modal approach of using multimedia animations-rich video lectures, 3D virtual reality games and practical hands-on training using haptic devices, not only includes all the three key aspects necessary to facilitate effective learning, but also reduces the costs and time consumed in VET delivery.

III. System Design

A. Mobile vocational education unit

A standard mobile vocational education unit, as depicted in Fig. 1, consists of twenty handheld touch screen devices, a laptop server, one large display monitor, low cost haptic devices and solar equipment which include solar panels, solar lanterns, batteries, a charge controller, an inverter and a generator for electrical backup. The students are given the touch screen devices preinstalled with the SAVE m-learning vocational training application which communicate actively through Wi-Fi LAN to the laptop server.

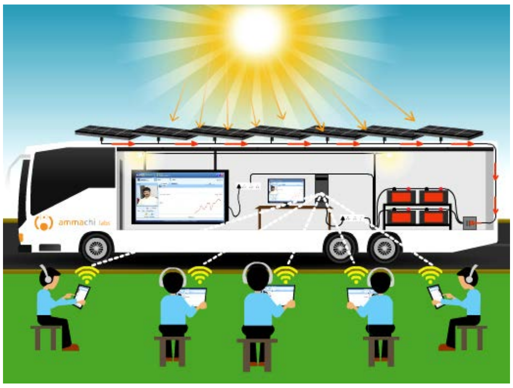

Fig. 1. Illustration of the solar powered Mobile vocational education unit providing Wi Fi connectivity to the handheld devices.

The laptop server hosts the local m-learning server application and acts as a local database for the handheld devices running the SAVE vocational training application. The MoVE unit also contains the mobile furniture that includes built in cots for the driver and a facilitator who will provide course deployment assistance. It also carries an inflatable tent that can be easily inflated using the exhaust from the vehicle and foldable chairs that transform into a temporary semi-outdoor classroom. This reduces dependence on infrastructure like schools and community halls that may be otherwise unavailable or scarce. In bad weather conditions, the mobile classrooms will be moved to the nearest available shelter. The large display monitor installed in the mobile vocational education unit acts as a virtual whiteboard for a visiting VET trainer who can operate it using a handheld device and for remote web conference calls between a resource expert and multiple mobile vocational education units, where students can ask questions to clarify doubts in their coursework.

To make the MoVE unit sustainable and to reduce its carbon foot print, all the equipment including the student driven hand-held devices are run using the power generated from Solar Photo Voltaic modules. Harnessing the power of solar also helps to run vocational training courses even in high-risk areas during natural disasters and in areas where power is in short supply. The solar panels are fixed on the roof of the mobile vocational education unit. The direct current generated from the solar panels is stored in the batteries via charge controller, which are all fixed inside the mobile vocational education unit. The direct current from the battery source is converted into 220V alternating current using an inverter. In case of emergency when not enough power is captured using solar, a generator is used as a back up to power up the equipment. Solar lanterns will be used for light when conducting the course indoors.

B. SAVE Software Framework

The SAVE m-learning vocational training application [7] provides the student with theoretical knowledge as well as hands-on training using haptic devices. It consists of two modes of operation, namely the administrative and course modes. In the administrative mode, every component in the framework can be accessed and edited from a single interface. The admin user can update any content visible on the application screen: add, edit or remove courses, course contents, modify general components such as background imaging, tutorial videos and set the language of course delivery.

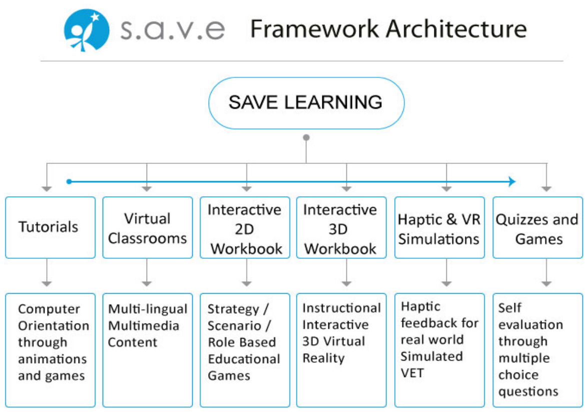

Fig. 2. Block Diagram represents the Framework of the SAVE m-learning vocational training courses.

The course mode is for the student user and provides access to the m-learning courses as shown in the Fig. 2. The framework of the SAVE learning application consists of tutorials that help a student with little or no digital literacy, to gain the minimal orientation required to use the visual interface and navigate through the course.

Fig. 3. A screenshot of the SAVE 2D installation game, present in the plumbing course module.

Each chapter in the vocational training course typically consists of Virtual classrooms, Interactive 2D and 3D workbooks, Haptic simulations and self-evaluation Quizzes.

The Virtual classrooms provide theory through recorded video lectures of experts and multimedia rich animations, which are followed by the 2D interactive workbooks, a sample screenshot is shown in Fig. 3. The Virtual classrooms, through the medium of engaging games, teach the student knowledge of tools and fixtures, their use and procedures that can be performed using them. The 3D interactive Virtual reality workbooks are used to teach installations, layout and assembly tasks. These workbooks can train a student on a strategy to follow in the performance of a particular task, or to learn to troubleshoot a problem scenario where the students can assume different roles to play.

The hands-on component of the training is provided using low cost portable custom-built haptic and touch based vocational training simulators. The haptic vocational training simulators tackle the need to train a student in over 200 tools and variants that span over 60 vocational trades. They have been designed to provide large working space, higher force feedback and realistic virtual reality interfaces run on the handheld devices, which is a requirement for hands-on training of vocational tools. Each of them allow for simulation of a wide range of tools, compensate for the lack of trainers, and eliminate the necessity for expensive materials.

C. SAVE m-learning Architecture

The SAVE m-learning application architecture is divided in to two main parts; the server side and the client side. The communication flow is shown in Fig. 4, between the client side consisting of the handheld devices and the laptop server in the MoVE unit, which communicate using the Wi-Fi LAN connectivity established between them. The laptop server is linked using CDMA or 3G wireless Internet to the remote main server, which accesses and processes requests made to it from the client-side.

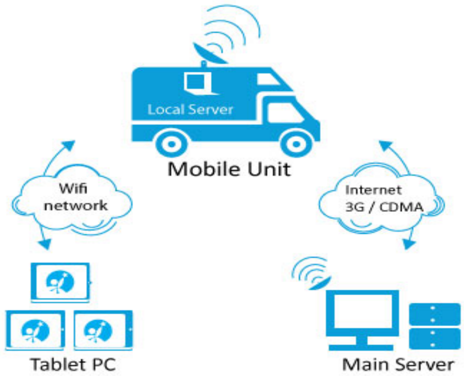

Fig. 4. Schematic of the Communication interface of the SAVE m-learning application.

In the m-learning architecture diagram shown in Fig. 5, The client side user interface and framework components are built using Adobe Flex and require Adobe Flash Player to be installed on the handheld devices

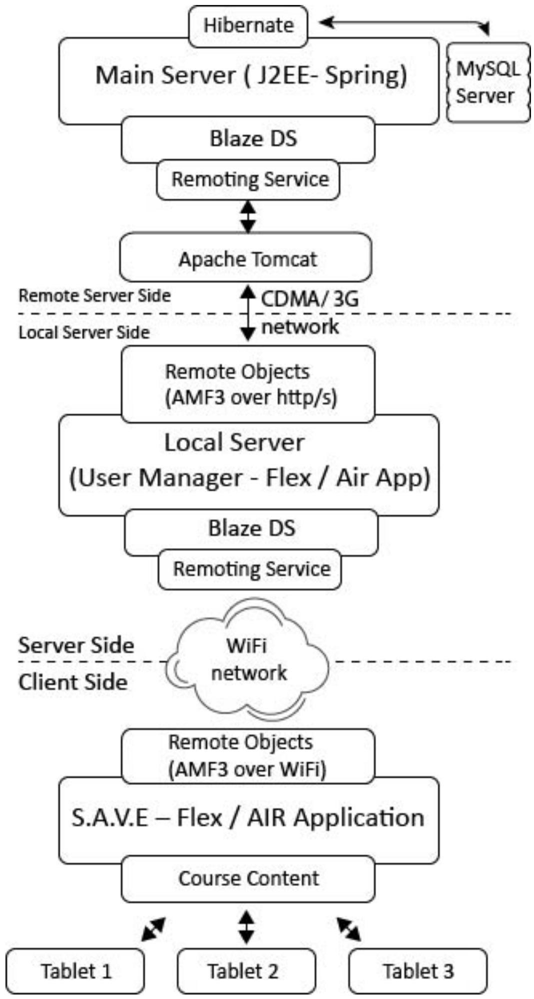

Fig. 5. Block Diagram represents the SAVE m-learning Architecture

. The application is packaged as an Adobe Air installer and requires Adobe Air runtime installed on the handheld devices. Communication between the clients and the server applications is through the server based open source, BlazeDS that provides ease to connect and push data in real-time to Adobe Flex and Adobe AIR [13][14][15]. It uses a AMF binary data transfer format that largely increases performance, allowing the application to load data up to much faster than with text-based formats. The read, write and modify data operations implemented in the database storage through services by the server-side application. Object relational mapping for data conversion is provided using the Hibernate framework at the server-side [16]. Security is a prerogative of the Spring Security framework installed at the server-side [17].

D. Learning Management System

The Learning Management System (LMS) manages activities from student registration to course wise monitoring, progress tracking, and session based statistical data collection and database updates. Student Registration process involves automated creation of student photo based identity, login details and registered course authentication. Content is provided based on the course the student has registered for and their progress is monitored to identify areas of interest or possible difficulty, hinted by topics they revisit or spend more time on. Progress tracking takes different attributes of the current user session from a dynamically generated configuration file. Attributes include time spent on the virtual classroom chapters, frequency of chapter repetitions, concurrent scores achieved in the workbooks and quizzes and more.

This data is saved to the local server on logging out of the session and subsequently transmitted from the local server back to central database in the main server. This transmission performed by a manual update by the course facilitators. All these processes enable the LMS to handle the user data intelligently for the successful completion of the course.

IV. DEPLOYMENT METHODOLOGY

The mobile vocational education units act as satellites, each attached to a nodal vocational training center (VTC) situated at the nearest semi-urbanized location. After gathering accurate data of the environment and infrastructure of the remote communities from various sources such as government baseline data, local NGOs and field trips to confirm the data, the remote locations to be serviced are determined. After completing the necessary demand analysis and aptitude assessment for the region using carefully designed surveys, the apt VET courses are decided, loaded and the optimal deployment path and schedule for the MoVE unit is mapped. The deployment strategy and topology is influenced by factors such as geography, available timings of student beneficiaries and number of courses offered per location. The deployment methodology and outreach will vary from a rural area to a tribal region. Each MoVE unit will optimally service a minimum of two remote locations.

The deployment methodology typically employs a hub and spokes model where a MoVE unit starts from the base nodal VTC to the mapped locations in order on a weekly basis. Training courses will be delivered in multiple batches to the remote population, each batch studying two to three hours per session so as not to interrupt their daily routine significantly. The first batch may be women at home, the second batch, the children back from school and the third batch would be the men back from work. The sessions would run for five days and will include a combination of theory and preliminary practicals. At the end of the five days, the batch requiring extended practise in a training center travel back in the MoVE unit to the nodal VTC for the weekend. Else they are assigned practise sessions for the weekend in situ. At the set of the fresh week they are brought back to their localities.

The desktop version of the SAVE application has been submitted to three deployments. An exploratory survey of various rural communities in the tribal district of Idukki in India was conducted to help ensure the testing population met requirements of the target population of being semi-literate, individuals who have experienced poor employment outcomes. A series of informal interviews with the local village head members and settlement leaders were conducted to assess target population compatibility, and potential interest for an computerised vocational training. Two tribal settlements, Nedugandam and Kumbitankuzhy were accordingly identified as the testing sites. The SAVE plumbing course was deployed in these sites using desktop computers with 60 participants, shown in Fig. 6. The participants were observed to assess how they interacted with the basic functionalities of the application, graphic user interface and training modality.

Fig. 6. Picture shows the participants of Nedugandam tribal settlement taking the plumbing course on the computerized SAVE VET application.

While 65 percentage of the participants were unemployed at the time of the test deployment, 90 percentage were optimistic that completion of the course would help increase their job prospects.

Based on suggestions and usability issues identified during the pilot training, the plumbing course was further revised tested along with the haptic simulator at a rural industrial training school.

Thirty-two students at the industrial training school were provided plumbing theory through the SAVE application and hands-on practise using the low cost haptic devices as shown in Fig. 7. The results suggested the use of haptic simulators improved the consistency of skilled performance of tool-based tasks of the students by over 78 percentage.

Fig. 7. An industrial training school student cutting a virtual PVC pipe using the SAVE haptic simulator.

Pre-course surveys revealed only 12.5 percentage of the participants had ever used a computer, despite which the student displayed appreciable progress in gaining skill.

V. Conclusion

The SAVE m-learning application has the advantages of portability and mobility. It provides the benefits of flexible class timings, self paced learning and an interactive learning experience. It reduces the cost of material and tools required to deliver a course and the dependence on the physical presence of a trainer.

It also potentially has the ability to:

- Standardize VET course content across India
- Establish computer-based evaluation methods
- Provide a scalable solution for VET delivery

These initial results confirm the strength of the SAVE m-learning application as an effective user-focused, vocational education technology for the rural and tribal people of India. Test populations with little or no formal education were able to learn specific vocational skills sets using user-centered ICT-based technology. Having demonstrated the effectiveness in building skill development, raised trust, confidence and social acceptance, the SAVE application not only attracted new users to technology, but more importantly, increased the reach and access of vocational education.

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