Usability Study of Personalized Learning in Mobile Learning Environment

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***Abstract*—In an effort to find out the best suitable application of mobile learning (m-learning), several research works are undertaken till date. A review of related papers unveiled that mobile devices act better as a supporting media in teaching and learning scenario. This paper presents context specific learning modules i.e. personalized learning contents using ontology based web service architecture and an experimental exploration has been done with the target audience to justify the usability of such content in a real time environment. To ensure that the developed contents are acceptable and usable, usability aspects are carefully embedded during the analysis, design and development of the contents. In this paper, the steps to fulfil the usability aspects of the prepared contents are described, architecture of the dissemination system has been designed and results of the study are presented.**

***Index Terms*—Mobile Learning, context specific, learner centric, ontology, web service, usability study.**

I. INTRODUCTION

Research on mobile learning clearly specifies that mobile learning acts better as a supporting learning media instead a means of primary method of teaching. There are people of certain profession such as nursing students, newly trained computer teachers, hardware trainees who often needs some assistance on their teaching-learning areas but they cannot disclose it. They want a personal learning assistance where mobile phone can act as supporting teaching aid. The rapid development and technological advancements of wireless technologies define 'mobile learning' as a complement of e-learning [1]. It is the e-learning on mobile computing devices. The objective of the present worker is to increase the benefits of such learners by providing certain types of learning material in handheld devices by using mobile technology [2]. In this work usability of mobile learning has been tested as a supporting learning media where target learners can access certain learning contents personally depending on their requirement anytime, anywhere, easily and repetitively provided they are authentic learners to the system. By personalized learning content worker tried to explain those content which are useful for the job of the mobile device user. In other words it may be referred as context-specific learning module. For example teaching, nursing, engineering related learning materials. The ontology based web service architecture allows the users to get just appropriate learning material easily and quickly. During the designing phase of the content the usability design principles are followed as the usability guidelines outlined by Su [3].

II. BACKGROUND

By mobile learning it means learning that takes place in the course of activity, in appropriate and meaningful contexts [4]. It can also be extended to learning in a closed environment with limited mobility like in the hospital ward (in the case of trainee nurses), in the classroom (in the case of trainee teachers) and in a bus (in case of job seekers on the way to a job interview).

The most important part of this work highlights the content creation for different types of people of different profession. There are several projects already successfully implemented in the field of mobile learning. At Stanford Learning Lab [5] an exploration of mobile learning has been done by developing prototypes that integrate practicing new words, taking a quiz, accessing word and phrase translations, working with a live coach, and saving vocabulary to a notebook. They envisioned that a good approach would be to fill the gaps of time by short (from 30 seconds to 10 minutes) learning modules in order to use the highly fragmented attention of the user while on the move. This does not fulfil any purpose of the user in an emergency rather it acts as a complete learning media to enrich English vocabulary.

Tourist and museum guides are often considered as applications in mobile learning domain. They usually refer to newest technologies as location-discovery via GPRS, radio frequency or etc. Ultra lab project is a project called *LAND* (*Location Activated Nomadic Discovery*). It explores the possibility to deliver media-rich context –aware information through mobile devices [6]. But for this type of learning users need high specification mobile phones which supports GPS technology with GPRS.

Handler is the project undertaken at the Tampere University of Technology (Finland) [7], where PDAs are used for lifelong learning (mathematical education) of children. The study-content is presented in the form of a game (again the idea of human-centered education is explored) where the pupils can communicate and help each other's and the electronic device is used to measure the average students' knowledge level and to adopt the speed of presenting new material to the learners'. So, this actually refers learning in a collaborative mode.

All these three projects analysed here draw a conclusion that the learning contents and the context are not suitable in urgency as experimented with the context and contents of this paper. Present work is related to developing modules on context-aware concept but here context-awareness means an area related to user's profession whereas in traditional concept context-awareness means user location, time of day, nearby people and devices, and user activity. So, present authors develop contents based on specific

jobs following same architecture and usability design principles.

Many approaches have been proposed to develop mobile learning systems taking into account the adaptively of learning and the learning environment context [8, 9, 10]. Taking idea from those, the present worker has designed an architecture where user's request goes to the ontology environment to access the user specific content. This architecture extends earlier architectures with the incorporation of web service to make the architecture flexible so that other user specified services can be added anytime. The description of such uses is kept out of the scope of this paper. Regarding the usability of a product it has been described by ISO 9241-11 that it is 'the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use' [11].

III. THE PROPOSED M-LEARNING ARCHITECTURE (FIG. 3)

Mobile simulator in J2ME Environment requests for certain learner-centric content. This is an HTTP request, which accesses the databases for related information via web service. The concept of using a web service is it automatically converts mobile data to (XML) via HTTP and vice versa. Also with the help of web service based architecture developers can add other specific services for the benefit of users anytime. For device recognition as a first stage it accesses the device profile database. It utilizes the CC/PP promoted by the W3C [12]. Once the device is identified, the system matches the user query with concepts in the ontology. Every information related to user query are sent back to web service and then to J2ME mobile simulator. User then accesses his/her required specific content. For implementing an effective search of the just-in –time material a method described in ontology-based authoring tool capable of mapping concepts to learning resources in different granularity levels [13] is utilised. Once user accesses context depended content he/she can store it on his/her mobile and later access it as standalone content.

IV. THE USABILITY DESIGN PRINCIPLES

This section describes the usability design principles that are applied in the m-Learning applications to carefully develop content for target audience. The principles are mainly adapted from the usability guidelines outlined by Su [3].

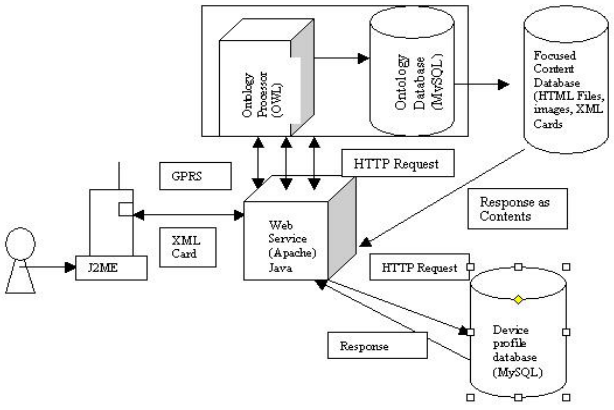

Figure 3. The Proposed M-Learning Architecture

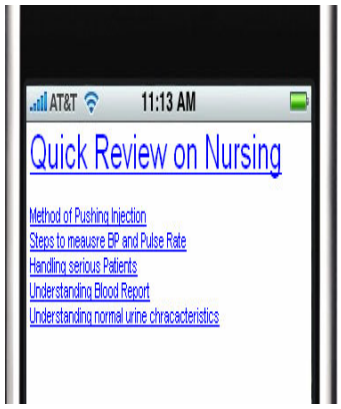

Figure 1

For human to mobile interaction usability, in this study, the design considers the contextual use and the ability to adaptation on the specific learning contents for each case. To ensure the usability of a mobile application, it is found that it is better to minimize the learner's cognitive load. This is because; there is a limit on user's capacity to process information, especially when on move and engaged in multijobs. In such environment it is assumed that information is loaded into the short-term memory. [14, 15]. Therefore, the structure of the learning contents has been designed in small information chunks that can fit well within one screen at a time [16,17].

The authors apply a usable mobile learning interface design in all types of contents authoring. Such considerations include:

1. The number of lines of text on each screen that may affect the speed of reading [18] (Fig [1]).
2. The segmentation of long pages into smaller chunks that should come together with an effective mechanism to view and go to the desired page [19], (Fig [1]).
3. The avoidance of extensive scrolling.
4. Lastly, visual **consistency** is one of the most important usable mobile learning interface design principle. So, similar page designs have been adopted in each screen.

V. MODUS OPERANDI

For the time being the present worker prepared the following contents for learners as focused and as just-in-time learning resources.

- Quick review on nursing for trainee nurse.
- Review on Computer Fundamentals for trainee teachers
- Preparation for job interview on General Knowledge for job seekers.

The aim to provide these contents via mobile phone is so that these contents can be used by the target learners anytime, anywhere.

Three mobile learning context sensitive applications based on above contexts are developed. Designing the contents follow, structured text based approach with a small portion of images, if required i.e. information displayed in smaller chunks with images wherever required n Fig [2]. It is assumed that learning materials will be re-

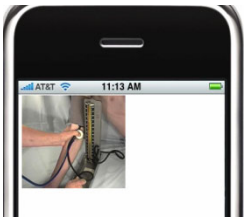

Figure 2

trieved most of the time when people are in a hurry or engaged with other jobs. For, example a nursing student may want to brush through the steps of measuring Blood Pressure just before attending a patient for the first time.

The type of sample teaching resources in the mobile application named "Quick review on nursing for trainee nurse" is

- Method of pushing injection
- Steps to measure BP and Pulse rate
- Handling serious patients
- Understanding Blood report
- Understanding normal urine characteristics

Trainee teachers of High school who are taking training on "Fundamentals of Computer" to teach the subject in their schools may need the help of learning material whenever they start teaching in the class initially. During entire teaching period they may need to review certain topics. So, looking on their mobile screen they can memorize the lessons as required within few seconds with the help of their mobile phone. Sample topics are

- Block Level diagram of Computer
- Microprocessor and its functionalities
- Input/output devices
- How to take print on hardcopy
- What is software?
- Identify Input/Process/Output jobs.
- Generation of computer
- What is DOS and it's Commands?

3rd mobile application named "Preparation for job interview for unemployed youth" provides course on General Knowledge based questions and answers; those are frequently set in the TPSC competitive examinations. Sample questions are like

- How many subdivisions are there in Tripura?
- Name the king who made Nirmahal?
- Who was the first Prime Minister of India?
- Whose was the last king of Tripura?

All these materials are available in related books elaborately. But digitizing the contents into mobile can make it available to the candidate when the candidate is travelling by bus or by any other means and going to the examination hall or they are confined in a place where searching a book and finding the topic is a tedious job. So, as far as the mobility of users and devices both are concerned accessing the contents is easier with handheld devices than from any other means.

The usability survey for the three mobile learning applications were conducted at a booth during 3 days Workshop on "Mobile Learning Awareness" organized at dep't of CSE in Tripura University. 10 Nursing students, 10 trainee teachers and 25 unemployed youth are invited to attend the Workshop (Fig 4, Fig 5). The same materials have been provided to the participants via mobile devices as well as desktops. It has been instructed that the users can access the material sitting in front of a desktop and they can also avail it via mobile phone and access the contents while in roaming around the workshop. The numbers of candidates of adopting both the facilities have been recorded. All of them are asked to fill-in a one-page questionnaire form, consisting of 8 queries, after they have tried using applications especially developed for that particular group of people. The queries are as follows

Assists them in accessing information as well as in learning in urgency.

Contains just appropriate content to learn according to requirement.

Required knowledge base is concise altogether.

They want to have the contents in their mobile phone.

They want to have the contents in their Desktop.

Is an interesting learning tool and information browser to use?

Solutions are learner-centric and context aware.

Using the contents and navigating between related information are easy within a short period.

Result shows that 80% to 100% participants answered positively against all queries. But less than 15% participants want to have the content in their desktop. It is because they think the type of learning resources are only useful on move or outside traditional learning environment.

It has been observed that altogether among 25 participants 88% availed the facility in mobile phone while in roaming around the workshop.

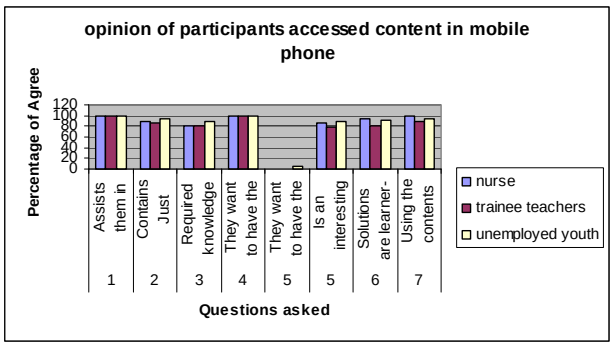

Fig 4

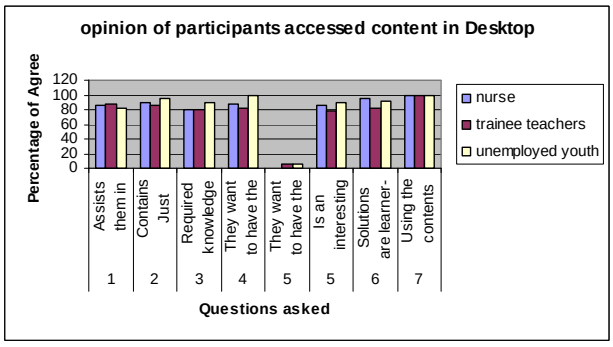

Fig 5

VI. RESULTS AND ANALYSIS

As performance evaluation, in this paper, qualitative questionnaire based technique is used. Interviews and surveys are widely used techniques for collecting information in research works. Often surveys are less time and money consuming and easier to arrange. So, in this work, interviewing against a questionnaire was the dominantly used technique.

There are several categories of context-aware applications according to Schilit [20]

1. *Proximate selection*, a user-interface technique where the objects located nearby are emphasized or otherwise made easier to choose.
2. *Automatic contextual reconfiguration*, a process of adding new components, removing existing components, or altering the connections between components due to context changes.
3. *Contextual information and commands*, which can produce different results according to the context in which they are issued.
4. *Context-triggered actions*, simple IF-THEN rules used to specify how context-aware systems should adapt.

Current context-specific application does not satisfy any of the above but Dey [21] defined context-aware feature as *presentation* of information and services to a user. According to Chen and Kotz [22] *context awareness is an application presents the new or updated context to an interested user or makes the context persistent for the user to retrieve later.*

Present work supplies learning materials related to user's job respect, irrespective of time and location. Here the context means any information which characterizes the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application.

The main findings of present work are

Context-aware (User's profession related) learning module can increase the usability of mobile handheld devices.

It carefully implements the design guidelines to facilitate successful interaction of usable context-aware mobile applications.

The gap of this work is that contents are been developed on very specific types of modules for each profession. More related learning modules can be developed with a long interaction with target learners. It is very significant to understand user related problem so that solutions can be uploaded in mobile environment.

VII. LIMITATIONS

Current state of the technology does not yet offer many experiences on personalized mobile applications in everyday life, as fully functional systems that enable long-term usage with large user groups. Designing usable context related applications set challenges but high adaptation rate of mobile devices makes the area interesting for target learners.

For the time being security issues are not considered which an important part is. A context-aware application cannot be fully evaluated without the use of context, which in reality has not been tested. Only the whole application with devices has been tested in an environment of workshop.

VIII. FUTURE SCOPE

For future work, the usability design guidelines can be iterated and developed further, and using them in application design would certainly provide valuable insight for their utility. Privacy-related issues with information sharing, location-sensitive applications would benefit from extensive studies. With technological evolution running long term usability studies and trying out context-aware application with larger user-groups in real-life offer new information to the research community.

IX. CONCLUSIONS

Context-aware computing is a mobile computing paradigm in which applications can discover and take advantage of contextual information (such as user location, time of day, nearby people and devices, and user activity). Since it was proposed about a decade ago, many researchers have studied this topic and built several context-aware applications to demonstrate the usefulness of this new technology. Context-aware applications (or the system infrastructure to support them), however, have never been widely available to users based on their profession. In this work an experiment with usability test of context-aware systems and applications in mobile learning environment has been carried out. The experiment's results shows that context-aware (User's profession related) learning module can increase the usability of mobile handheld devices. Also it proofs if usability guidelines are followed in the design stage then it can facilitate successful interaction of user and device. Though current state of the technology does not yet offer many experiences on personalized mobile applications in everyday life, as fully functional systems that enable long-term usage with large user groups but opens a rich area to the researcher. Through this study, it is clear that context-aware research is an old but rich area for research. The gaps and possible solutions outlined may serve as guidance for researchers hoping to make context-aware computing a reality and attractive.

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