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A Preliminary Evaluation Study for M-learning Services and Implications for Future Design

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Abstract— This paper presents a preliminary investigation into the contextual factors surrounding Mobile Learning (M-learning) systems. A set of experimental trials demonstrating different learning settings were conducted within Jerash University environment; results achieved were used to draw some implications for the design of future context adaptive M-learning system. The newly designed system meets users learning requirements and is more suitable to the learning conditions and environment.

Keywords- Mobile learning; Contextual factors; Mobile users; learning environment; Context Adaptation.

I. INTRODUCTION

The huge advancement in ICT more especially in mobile technologies has opened a new era of education, and provided opportunities to establish new applications for the benefit of learning. Typical applications include time management and communication tools, reading course content, revising for exams and meeting course deadlines.

As laptops, handheld computers and smart phones become more widely used by all members of educational institutions (students, lecturers, and administrators), new trends of learning resources and service provision have emerged allowing learners to utilize the learning resources from their educational institutions anywhere and anytime without being physically on campus, this can be described as Mobile Learning (m-learning O'Malley (2003).

M-learning is considered as a shift from mass and traditional teaching to support of self and advanced teaching and learning services. Therefore, it is the responsibility of M-learning system administrators and developers to ensure that educators and students have the relevant skills and required technology to utilize the system and be adaptive in such learning environment (Jung et al., 2006). In general, m-learning is a learning activity that takes place without considering a fixed location to the learner user, this can be achieved by communicating over wireless networks and using mobile devices such as mobile phones, personal digital assistants (PDAs), or laptop computers (Sharples et al., 2002). . Although, mobile technology is encountering huge developments, Mobile phones industry is continuously facing limited computing resources and limitations on user/device interaction level, as well as narrow network capability and coverage (Rudman et al., 2002).

This paper investigates the contextual factors surrounding m-learning systems. This includes learning environments, learning tools usefulness, mobile devices capability and performance, and users' requirements and patterns of services usage. The experimental trials conducted were focused towered university students. The results were used to draw conclusion for future M-learning system's design and implementation.

II. BACKGROUND

A number of researchers have investigated the applicability of mobile technology in the learning context. Naismiths et al. (2004) has addressed the importance and need of moving the learning process, from being in a fixed location at the classroom to take place anywhere at the learner environment.

Pawar et al. (2007) and Hesselman et al. (2006) describe the concept behind Context-Aware systems in the support of M-learning services and applications. In addition, Bull et al. (2004) describes a set of M-learning models in terms of associated users attributes and behaviors as well as a group of environment related contextual factors. In Malliou et al. (2002), context adaptation was achieved using a profiling approach in order to create personalized learning resources combining modules content into a personalized virtual document.

Taylor et al. (2006) have identified a number of examples for how mobile technology can be adopted in the learning environment, taking into consideration the user behavior, technology infrastructure, and environment structure. In the same concern, Kukulska-Hulme and Traxler (2005) have also shown how the capabilities of PDAs and a set of different

mobile devices can be used to provide academic support for learners.

With reference to M-learning systems design and implementation, Mohamed (2004) and Brown (2005) have developed new schemes for designing M-learning tools and adaptive models fulfilling learning users' needs and requirements. Milrad (2007) has proposed a new system design based on a set of learning scenarios including environment settings, and users' objectives, actions and events. Some adaptive mobile learning models take into account the user's location or specific details of the context, in order to present learning information relevant to the learner's current situation (Zancanaro et al., 2003). This approach unties learners using desktop computers and allows the learning opportunity at the user's location. In the same concern, Hunaiti et al. (2008) presented a new M-learning system design, in which the concept of Location Based Services (LBS) were utilized allowing learning resources to be delivered to mobile users based on their changing geographical location.

Vavoula and Sharples (2008) and Taylor (2007) have presented a new scheme of evaluating the outcome of M-learning systems taking into consideration the learning context as well as the educational outcome and its applicability to enhance the learning experience. In this work, an evaluation study was conducted; in which the conclusions were used to draw some implication for designing an adaptive M-learning system. The evaluation study includes a set of preliminary experimental trials that took place measuring a set of learning contextual factors; such as user requirements, usability issues, environment settings and the used technology performance.

III. Methodology and Experimental Settings

In this work an integrated set of learning services utilizing the Pocket Outlook Personal Information Manager (PIM), were adopted in the evaluation process. The most common services used were:

- Calendar and Tasks
- Diary and Notes
- Email and Data Sharing
- Supplement audio/visual materials.

These services were made available to students with a customized design to present the structure of student learning process. A number of study trials were conducted in order to evaluate the above services in realistic learning settings. This includes using a set of mobile devices with different capabilities and utilizing available mobile networks coverage. The study trials took place during one academic semester at Jerash University, in which a group of twenty students from the computer science department have participated in the study. The following methods were used in the study trials:

1. Questionnaires administered at 4, 16 weeks, and 4 months of the academic year.

2. Focused groups to follow on each of the questionnaires.

The main factors being investigated during the study trials are summarized as follows:

- *Impact of learning tools on the learning process.* This measures the effect of learning tools on the learning process in terms of simplicity and understanding.
- *Reported patterns of mobile technology usage*: This decides on the attitudes of mobile users while utilizing the learning service and determines user's preferences and requirements. This factor also measures the most common locations and time periods of utilizing the learning resources by mobile users.
- *The perceived usefulness of the mobile devices while utilizing the learning tools:* This includes the simplicity and usefulness of mobile devices while utilizing learning resources. This factor also measures mobile devices capability, performance and adaptation level.

IV. Equipments and Software Tools

Participant in the study were asked to utilise the following equipments representing mobile devices with different capabilities:

- HP 614c business navigator
- HTC p3300
- Dell studio XPS
- Nokia N95

V. Results and discussion

A. The perceived usefulness of the mobile devices while utilizing the learning tools

Using a 5 point scale scheme (1 strongly disagree to 5 strongly agree); Table 1 summarizes the results of measuring the perceived usefulness and portability of the mobile device being used to utilize the learning services.

TABLE I. Mobile devices usefulness and portability scales

Type of Device	Usefulness scale	Portability Scale
Nokia N95	2.8	4.1
HP 614c business navigator	3.5	3.9
HTC p3300	3.1	4.2
Dell studio XPS	4.2	3

Results variation in the above table was due different devices capabilities; this includes limited memory, screen size

and resolution, weight, and battery life and processor power. Table 2 below explains details of the devices capabilities. Mobile devices with enhanced capability have received a higher rate in terms of usability factor; despite devices with big weight and size (for example Dell Studio XPS device has received a low rate in portability). More student's preferred using the PDA devices, more than using laptops. While other students find it difficult to use PDAs if they where to continue using the learning tool as well as utilizing other services on the same device.

TABLE II. HANDHELD DEVICES CAPABILITY

Device number	Type of Device	Memory	Screen Resolution	Battery life (while usage)	Weight	Processor
1	Nokia N95	128MB	240 x 320 pixels	240 min	120 g	332 MHz
2	HP 614c business navigator	256 MB SDRAM	240 x 320 pixel	390 min	150g	520 MHz
3	HTC p3300	64 MB SDRAM	240 X 320 pixel	Up to 3.5 - 5 hrs	130g	201 MHz
4	Dell studio XPS	4GB - 2DIMM DDR3	1280x800 pixel	Up to 5 hrs	3kg	2.4 GHz

Looking at table 2, it can be observed that the best memory size, battery and processor power can be found in device number 4 (Dell studio XPS); however this device had the largest size and weight. Hence, the portability scale of this device was the worst comparing to other devices. Device number 2 (HP 614c business navigator) had the best capability values in terms of processing power and battery life, comparing to other mobile devices; therefore it was rated by students with highest in the scale of usefulness.

B. Impact of learning tools on the learning process

Participants were asked in the survey to name the tools that made the greatest impact on their learning in terms of simplicity and understanding. Table 3, summarizes the results of measuring the effect of each learning tool in terms of simplicity and understanding. For example diary and note taker and supplement audio/visual materials have received the most impact in terms of understanding and simplicity. Whereas the calendar and task organizer as well as the email and data sharing tools have received a low overall rank in both simplicity and understanding. Such results were due to most students believing that time management and tasks organizing are one of the most important issues to be considered for a successful and efficient learning.

TABLE III. IMPACT OF LEARNING TOOLS ON THE LEARNING PROCESS

Learning Service	Simplicity	Understanding
Calendar and tasks organizer	27%	25%
Diary and note taker	35%	27%
Email and Data Sharing	13%	13%
Supplement audio visual materials	25%	35%

C. Reported patterns of mobile technology usage

This part of study was aimed to measure how often students have used their mobile devices to utilise the learning services, taking into consideration the locations of service usage.

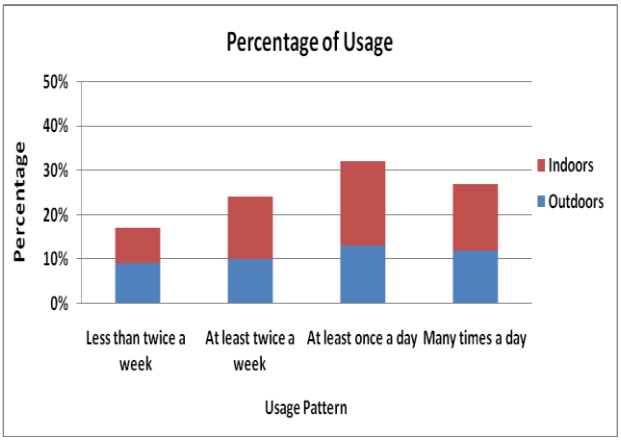

Figure 1. Patterns of learning service usage

Figure 1, illustrates the percentage of using the devices either per day or per week during the study trial period. The percentage of participants using the devices at least once per day was around 30%. The next highest pattern of usage is many times per day with nearly 25 %. Usage became very infrequent between students in the week scale. At home, school and inside the university campus area were the most common locations of use. Therefore, looking back to figure 1, the indoor service usage was (58%) comparing to (42%) for the outdoor.

In terms of users preferences, participating students were asked to decide on their learning style and type. The learning style decides on how users are interacted with the learning tools (online or offline) and the learning type describes the way learning materials are presented to the user. In this study, only two types were considered verbal and visual learning. Results in table 4 show that verbal learning was rated as the lowest comparing to visual learning, where as the majority of students prefer using both learning types. In terms of the learning style almost half of students prefer to be online while interacting with learning tool.

TABLE IV. FREQUENCY OF LEARNING STYLE AND TYPE BETWEEN PARTICIPATING STUDENTS

Learning Style	Percentage	Learning Type	Percentage
Offline	**30%**	**Verbal**	**20%**
Online	**45%**	**Visual**	**35%**
Mix	**25%**	**Mix**	**45%**

VI. RECOMMENDATIONS FOR FUTURE M-LEARNING SYSTEM DESIGN

- Mobile devices capability limitations such as battery life, screen resolution, processing power, and memory size play an important role in the expected performance while utilising the learning services.
- The delivery of mobile learning services is very much affected by wireless networks performance factors including delay, coverage, bandwidth, and packet loss. Therefore, optimised service delivery methods must be developed considering the available network performance levels.
- Using positioning information allows providing information and interactions relevant to the learner's situation. Also, the location information assists in identifying learning styles and characteristics of the learning environment.
- Wireless connectivity should be installed and widely deployed in most educational institutions infrastructure. This allows students to easily access the learning resources across the campus.
- New educational polices should be adopted to support the integration of mobile and handheld devices into formal learning environment.
- Different learning tools have different impact on the learning process. Hence, this must be considered when designing and developing such tools.

The study has shown a clear need to develop a customised design of a new mobile learning system which considers the following:

- Provide learning services based on available learner's device capability and current mobile network performance.
- Provide learning services adapted to learner's context and needs. Learner's location information, along with continues information feeds concerning the learning environment and patterns of service usages can be utilised to understand the surrounding context.
- Provide learning services with reference to its perceived impact on the learning process.

VII. CONCLUSION

This paper draws the attention for a clear need to develop a customised and an adaptive M-learning system. A set of recommendations for future M-learning system design were presented based on preliminary investigation that was conducted focusing on contextual factors surrounding the learning environment. The investigation started with the analysis of previous M-learning systems, and included a group of experimental trials measuring the usability of mobile technology, while utilising a set of learning tools in different user patterns and within different location.

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