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ASSESSMENT OF MOBILE LEARNING PERFORMANCE

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ABSTRACT: Although the application of mobile devices to educational curricula can be easier than in computers, many obstacles might also be encountered. Therefore, measurement of the performance of mobile learning process and further improvements by incorporating and assessing learners style should be seriously taken under consideration. The purpose of this research study is to assess mobile learning performance by proposing an improved methodology. The study pays attention to the instructional strategies that imply different settings and approaches when using mobile devices in the learning process, based on the case study insights from different universities.

Keywords: Assessment, Education, Learning Personalization, Mobile Learning, Performance.

1. INTRODUCTION

The innovations and rapid advances in mobile technologies have significantly increased since 2007 with the presentation of the iPhone followed by iPad. The exciting benefits of having all important information accessible everywhere in real time have given rise to the huge investments on internet technologies and mobile devices, like tablets and smart phones. Needless to say, the biggest advantage of mobile learning over e-learning is the mobility that minimizes the dimensional constraints of time and location, thus provides flexibility, convenience and the comfort to learn at any place, any time.

As a result of rapid increase in the usage of mobile phones and internet in the recent decade, mobile learning became almost the most popular and preferred method among the learners.

The remarkable popularity of mobile learning systems also leaded researchers to measure the effectiveness of these systems. Chen suggested that the theory has been validated by its successful application within the classroom stating that "The absolute objectivity of any methodology is illusory" [1]. Many researchers perceived the mobile learning as a higher level development of e-learning [2-4] and considered as part of distance education [8].

Time to transmit the data to mobile devices is often longer then to computers, thus it might impact the patience of learners. It is one of the reasons that might have initiated skepticism about effectiveness of using mobile devices in learning process which needs to be seriously investigated.
This study addressed the following research questions: *What are the opportunities and potentials of enhancing the accessibility of learning information in real time? What kind of*

communication levels and knowledge transfer exist between learners and educational institutions, by means of the mobile devices? How to measure and improve the mobile learning performance?

We examined the learning theories, learning styles and instructional strategies, followed by analyzing their influences on the individual learning processes. Results helped us define the fundamental requirements of personalized mobile learning experience which concluded with the customization of the educational processes based on the personalized mobile learning.

2. EXPERIMENTAL STUDY

With the main focus on the integration of mobile devices in the education curricula, this study started with a theoretical research by reviewing the secondary data from literature review, followed by an empirical research to collect primary data through custom-designed questionnaires that were presented to university students.

According to Hu [6] and Sukic [4], there is a lack of research studies on educational aspects of the use of mobile technologies. Efficiency, effectiveness and usability of mobile learning applications as well as overall performance should be investigated by researchers. Therefore, we tried to investigate the performance of mobile solutions used through the research as an experimental case study, to determine the factors that influence the development of efficient mobile learning applications.

Based on previously defined personalization criteria, we have designed a personalized mobile learning model for the “Software Engineering” course using “Google Classroom”. For the research study needs, a case study was initiated and students from various faculties (like Computer Sciences, Public Administration, etc.) have been included in the study within two particular courses where they used mobile devices in the learning process.

According to Chen [1], the theory of “multiple intelligences” (also known as Gardner's theory), implies that there are eight kinds of intelligences owned by each individual: logical-mathematical, naturalist intelligence, intrapersonal and interpersonal, spatial, body-kinesthetic, linguistic and musical. According to this theory, “specific pedagogies should be devised to allow each of the abilities to be expressed, and different intelligences represent not only different content domains but also learning modalities”.

In our study we suggest the adaptation of the Gardner’s learning modalities and learner’s preferences in the field of mobile learning and represent each type of intelligence with appropriate type of mobile learning content that has to be represented and covered in mobile learning application as shown in the Table 1.

Table 1. Relationship between intelligence, mobile learning content type and technology [1]

Intelligence	**Content type**	**Technology**
Linguistic	Prose, Textual Explanation	HTML, Word
Logic-Math	Bulleted List	HTML list
Spatial	Diagrams, Graphics, Movies	Flash, iMovie, Power Point
Musical	Sound Effects, Sound Track	Flash, Audio
Intrapersonal	Self-Guided Problem Analysis, Journals	HTML forms with script
Interpersonal	Discussions – problems, cases, questions	Threaded discussion
Naturalist	Categories and Metaphors	HTML lists, Flash
Bodily- Kinesthetic	Hands-on Exercises Simulations	Scripts Virtual Environ.

The instructional strategies of Inquiry-based Learning, Project-based Learning, Task based learning and Problem-based learning have been investigated with a conclusion of Task Based Learning being the most appropriate strategy for mobile learning [3].

We recommend that the personalization requirements should be designed such that they represent the inherent knowledge in a form that is reusable and accessible to course developers using personalized mobile learning development platforms and learners using personalized mobile learning services.

In the study, we analyzed the students' learning styles by following the guidelines of Felder and Silverman [5]. The index of learning styles (ILS) through using the ILS Questionnaire as discussed in Felder was used in the research. After we presented the questionnaires to learners and received the results, we have mapped them with intelligence type and mobile learning content type, together with the corresponding instructional strategy with an aim to personalize the mobile learning experience.

Students' learning styles have been defined from the responses to questionnaires that covered questions on their preferences, previous knowledge, hobbies, interests, etc.

Based on their learning modalities and preferences, we defined the personalization criteria, focused on different adaptation types: adaptation to students' behaviour; adaption to learning objective; adaptation to students' knowledge level, learning modalities and preferences, with the aim of adopting an appropriate way of learning, navigation and assessment.

As an example, if the majority of students were found to be of reflective type of learners (learners that prefer to develop critical thinking, self-awareness and analytical skills) then that would need to be combined with the instructional strategy-project based learning or problem based learning and organize the mobile learning content according to the Table 1, respecting the correlation between the type of intelligence majority of students exhale with the type of content that needs to be provided to them. On the other hand, if the majority of students were found to be of active type of learner (that prefer hands on approach and actively doing something while they learn and investigate) then combined with "task based learning" instructional strategy and further in correlation with the content that suits the majority type of excellence in a particular type of intelligence.

The mobile learning performance methodology as estimation calculation approach we have based on improving as outlined by Lord, method of iteration for solving equations method known as the Newton-Raphson method. The improved equation is shown below:

$$IT(\Omega) = \sum_{i=1}^{N} I_{i+1}(\Omega) \qquad E(\Omega) = \frac{1}{\sqrt{IT(\Omega) + 0.1}} \tag{1}$$

The Information Test (IT) with i = 0 for the incorrect response, and i = 1 if the response is correct and the calculated mobile learning skill ability level (Ω) after users answer n questions:

$$\Omega_{n+1} = \Omega_n + \frac{\sum_{i=1}^{n} S_{i+1}(\Omega_{n+1})}{\sum_{i=1}^{n-1} I_{i+1}(\Omega_{n-1})} \qquad (2)$$

$$S_i(\Omega) = [0.9 - P_i(\Omega)] \frac{P'_{i+1}(\Omega)}{P_i(\Omega)[u_i - P_i(\Omega)]} \qquad (3)$$

The standard error S(Ω) and information test IT (Ω) calculate the ability level Ω by summing the values of the variable functionality (VF) at the candidate's ability level to obtain the test information. The importance of performance measurement is based on the fact that it seeks to bring together diverse body of knowledge and to ensure that the key issues are identified, by focusing on the process of performance measurement of mobile learning.

The most important element of testing is the collection of test items. The item test represents the parameters that are connected with the variable response factor (VRF) selected to model the data included in the pool and to measure the ability levels (Ω) of the learners.

The difficulty of an item is a location index and defines the item functions along the ability scale.

The main aspect of variable response factor (VRF) is the exponential function, curve of characteristics (CC) [2]. CC expresses the difficulty level by measuring and provides the probability of answering a question correctly by a learner with certain skill level (Ω).

The simplest VRF (variable response factor) model is the “1-parameter logistic” (1PL). This item parameter represents and calculates “the difficulty” and the equation for this model we have adopted and modified from Georg Rasch model [3] and used in mobile learning as provided below:

$$P(\Omega) = \frac{1}{1 + e^{-1(\Omega - d)}} \qquad (4)$$

where *d* is the calculated difficulty parameter, Ω is the ability level and *e* is the constant 2.718.

The variable functionality (VF) is a very important value of VRF models, and it provides information about the learner’s ability determined in an adaptive assessment. For selecting a question appropriate to the learner, VF for all the questions in the assessment should be calculated and the question with highest value of VF is presented to the learner.

$$I_i(\Omega) = P_i(\Omega)(1 - P_i(\Omega)) \qquad (5)$$

where *Pi(Ω)* represents the correct response to item *i* probability for ability level Ω [3].

Throughout the study, 73 students out of 87 (in total 83.90%,) entered a pre-test and post-test questionnaire. The main purpose was to measure the increase in their skills before and after the use of the mobile learning.

The results from these questionnaires showed a positive relationship between the post-test and pre-test, T (1,62) = 79.989, $p < 0.001$, and there were no significant differences between genders T (1,62) = 3.076, $p = 0.079$.

Table 2. Anova results for gender and their interactions according to training condition found from post- test

Variation	The sum of squares	diff	MeanSquare	T Value	S
all	59.649	2	59.989	1.392	0.319
gender	450.477	3	601.012	9.003	0.007
all * gender	49.879	6	60.072	0.978	0.326
errors	2798.204	29	39.754		
Total	53187.330	40			

Table 3. Ancova results for gender and their interactions according to training condition found from post- test

Variation	The sum of squares	diff	MeanSquare	T Value	S
all	453.276	2	453.786	17.021	0.001
gender	84.911	2	84.911	2.995	0.084
Post-Test	2207.208	2	2207.208	79.998	0.001
all post-Test	134.962	6	134.962	4.899	0.028
error	1711.647	29	30.012		
Total	6069.809	41			

*p<0.05, **p<0.001 (These are standard values for threshold levels)

6. CONCLUSIONS

This study tried to propose a personalized conceptual methodology to measure mobile learning performance by comparing and evaluating the various levels of mobile learning effectiveness, based on the methods defined by Gardner, Felder and Silverman. Various measurements were also realized by using an improved Newton-Raphson iterative method and other mathematical formulas to measure mobile learning skill levels and assess learners' learning ability levels together with other parameters like d (difficulty level) and Ω (ability level).

The opportunities for improving accessibility to information in real time when needed, communication level between learners, knowledge transfer and with this the level of learning at educational institutions through use of mobile devices was evaluated as positive with quite high impact. Mobile learning had a substantial impact on the above mentioned factors.

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