The effects of Perceived Mobility and Satisfaction on the adoption of Mobile-based Assessment

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***Abstract*— Mobile-based Assessment is increasingly used in different educational settings. Its successful implementation though depends on user acceptance. While previous research provides evidence on acceptance of mobile learning and computer-based assessment, there are not many studies focusing explicitly on the acceptance of Mobile-based Assessment. This study examines the impact of Perceived Mobility, Satisfaction, Perceived Usefulness and Perceived Ease of Use on students' Behavioral Intention to Use Mobile-based Assessment. 47 secondary school students, using their mobile devices and Quick Response (QR) - coding technology, participated in an outdoor Mobile-based Assessment procedure during their visit in a Botanic Garden. Partial Least Squares (PLS) was used for the data analysis of the recorded students' perceptions about the Mobile-based Assessment. Results show that Perceived Mobility, Satisfaction, Perceived Usefulness and Perceived Ease of Use are all significant determinants of Behavioral Intention to Use mobile-based assessment. Several important implications for designing and implementing mobile-based assessment procedures are discussed.**

Keywords—mobile-based assessment, mobile learning, motivation, perceived mobility, outdoor education, technology acceptance model, QR codes

I. INTRODUCTION

Mobile-based Assessment is increasingly used in different educational settings. Mobile devices have the potential to facilitate the process of delivering learning and assessment material "anywhere" and "in any anytime", maximizing the benefits for students, teachers and administrators [1].

Mobile devices can support different assessment strategies, i.e. formative or summative assessments, self- or peer-assessment, adaptive, context-aware, game-based assessment. Mobile-based assessment can either be part of a pure mobile-learning curriculum or part of a blended educational approach complementing other traditional or web-based educational practices. Mobile devices can be used for assessment purposes inside the classroom boundaries, e.g. polling devices [2] or beyond, in context-aware ubiquitous learning activities [3]. They have been already used in a wide variety of educational settings, e.g. language teaching and learning [4], learning in museums [5], remote and virtual labs [6] and environmental education [7, 8, 9].

In order for a mobile-based assessment strategy to be implemented successfully, it is necessary to investigate the factors that influence its adoption from the learning community. The current study fills a gap in the literature about the student's acceptance of mobile-based assessment.

The study is organized as follows. In the next section, we briefly introduce the issue of technology adoption from the perspective of Technology Acceptance Model. Then, the proposed research model with our hypotheses is presented. Methodology section follows with participants, description of the conducted experiment and the instruments used. Data analysis comes afterwards. Thereafter, results are discussed as well as conclusions are presented.

II. BACKGROUND

Technology Acceptance Model (TAM) is one valid and well-established information system theory that models how users accept and use technology [10]. TAM has been successfully used to explain the adoption of different educational technologies. While many studies use TAM as a framework to explain and predict student's acceptance of mobile learning [11,12] and computer-based assessment adoption [13,14,15] there is a gap in the literature about the adoption of Mobile-based Assessment. The current study is focusing on mobile-based assessment acceptance using a motivational perspective as well.

In TAM, behavioral intention to use is influenced by attitudes toward use, as well as the direct and indirect effects of perceived usefulness and perceived ease of use. Since its first introduction, TAM has been modified and extended to include additional variables in order to improve its predictive power. Researchers argue that m-learning users may have different roles (technology users, consumer and learners) [16]. Therefore different factors driving mobile learning adoption should be incorporated in an extended TAM model. Mobility is perceived to be the most significant feature of mobile devices [17]. Our model introduces perceived mobility, as an external TAM variable, from the point of view of technology user.

Many researchers [18,19] claim that the predictive power of TAM is limited to utilitarian systems (productivity oriented) because it is primarily concerned with extrinsic motivations (perceived usefulness) while intrinsic motivations (conceptualized as perceived enjoyment or satisfaction) are usually underestimated. Intrinsic motivation is the type of motivation that leads to a behavior that is inherently interesting and pleasant [20]. Nikou & Economides [21, 22] have introduced intrinsic motivational factors into the mobile-based assessment adoption research. The current study further examines the effect of satisfaction (as a form of intrinsic motivation) on the students' intention to use mobile-based assessment.

III. RESEARCH MODEL AND HYPOTHESES

The theoretical framework of the current study is the Technology Acceptance Model (TAM) [10]. TAM, based on the constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), explains and predicts Behavioral Intention to Use (BIU) an information system. Perceived Usefulness (PU) is defined as "the degree to which a person believes that using a particular system will enhance his/her job performance" [10]. Perceived Ease of Use (PEOU) is defined as "the degree to which a person believes that using the system would be free of effort" [10].

Our model about mobile-based assessment adoption proposes the following hypotheses according to the basic TAM structure:

H1a: Perceived Ease of Use (PEOU) has a positive effect on Perceived Usefulness (PU).
H1b: Perceived Ease of Use (PEOU) has a positive effect on Behavioral Intention to Use (BIU).
H2: Perceived Usefulness (PU) has a positive effect on Behavioral Intention to Use (BIU).

Beyond the original TAM constructs, a number of external variables have been added to it in order to improve its predictive power. In the context of mobile-based assessment in a field trip, the current study introduces the constructs of Perceived Mobility (PM) and Satisfaction (S). The study investigates how these factors contribute to the user's perception of how easy mobile-based assessment is, how useful it is and the degree of the students' intention to use the system.

Perceived mobility (portability) is defined as ''the extent of user awareness of the mobility value of mobile services and systems'' [23]. Users, who perceive the value of mobility, appreciate the ubiquity of mobile learning and have a strong perception of its usefulness. Previous research shows that perceived mobility significantly impacts perceived usability and perspectives of users toward mobile services [23, 24]. Also, the mobility value compensates the technical limitations of mobile devices (e.g. screen size, low battery life) by enabling users to access information anytime and anywhere and enhancing this way users' acceptance of mobile services during mobile-based learning and assessment.

Therefore, we hypothesize that:

H3a: Perceived Mobility (PM) has a positive effect on Perceived Usefulness (PU).
H3b: Perceived Mobility (PM) has a positive effect on Perceived Ease of Use (PEOU).

Satisfaction is defined as a sense of contentment that arises from an actual experience in relation to an expected experience [25]. It is the overall affective evaluation of a user regarding his or her experience related to an activity [26]. Many previous studies have shown that perceived satisfaction with a particular service positively affects the intention of users to use the service on an ongoing basis [27]. Also, new technologies that are considered enjoyable are less likely to be difficult to use and satisfaction seems to correlates with the users' positive attitudes. Thus we hypothesize:

H4a: Satisfaction (S) has a positive effect on Perceived Ease of Use (PEOU).
H4b: Satisfaction (S) has a positive effect on Behavioral Intention to Use (BIU).

The research model and all the hypotheses proposed in our model are depicted in Figure 1.

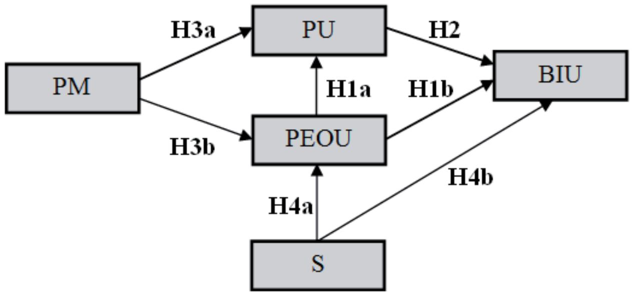

Fig. 1. The proposed model.

IV. METHODOLOGY

A. Participants

The participants in this study were 47 secondary school students enrolled in a project-based course about environmental education. There were 21 males (45%) and 26 females (55%). The average age of students was 16.2 (SD = 1.01). Even though students have never used their mobile devices into a mobile learning activity so far, they were confident enough to use their devices for answering the questions during the assessment activity since the median mobile self-efficacy score (the questionnaire adopted from [28]) was 85 out of 100.

B. Procedure

The learning environment was the city's Botanic garden. The main educational activity was a mobile-based assessment procedure in the context of a project-based course about

Environmental Education. The objective of the learning activity was to introduce students to plants' morphology, taxonomy, usage and their role in biodiversity. Students used their mobile devices (equipped with camera and the appropriate Quick Response - QR application) to scan QR codes placed on the target plants under investigation, as figure 2 shows. By scanning the QR codes, students were redirected each time to web addresses with relevant learning content and questions about the plants under observation. The questions were all of multiple choice type to facilitate data entry. Students prompted to answer the questions. Once students provided the questions the system provided the correct answers. After the learning activity, students were asked to respond to a survey questionnaire, self-reporting their attitudes about the assessment procedure.

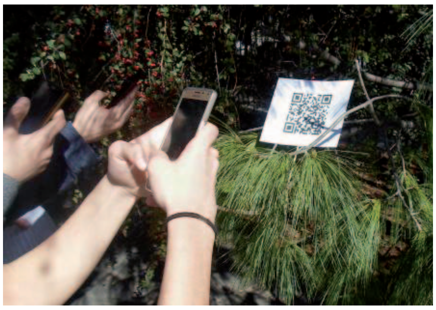

Fig. 2. Mobile-based assessment.

C. *Instrument*

In order to evaluate the Perceived Mobility, Satisfaction, Perceived Usefulness and Perceived Ease of Use and Behavioral Intention to Use Mobile-based Assessment we have constructed a research instrument based on previous established questionnaires that were used and validated by other researchers. The questionnaire items used are described in Table IV (Appendix). Items for Perceived Usefulness (PU), Perceived Ease of Use (PEOU) and Behavioral Intention to Use (BIU) were adopted from [10]. To assess Perceived Mobility (PM) we adopted items from [23] and to access Satisfaction (S) we adopted items form [27]. Minor wording modifications of the items were made in order for them to describe the current research context (mobile-based assessment), i.e. the item "I intend to use e-learning in the future" was substituted by the item "I intend to use mobile devices for assessment purposes in the future". The initial development of the questionnaire was made in English and then a native bilingual speaker translated it into the Greek language. All items were measured using 7-point Likert scales ranging from 1 (strongly disagree) to 7 (strongly agree).

V. DATA ANALYSIS

Partial Least-Squares (PLS) with Smart PLS 2.0 [29] was used as the analysis technique to predict factors influencing mobile-based assessment adoption. Our sample size exceeds the recommended value of 30 (10 times the largest number of independent variables impacting a depended variable).

Convergent and discriminant validity of the proposed research model need to be verified in order to ensure the quality of the model. Convergent validity is evaluated based on the following three criteria: (1) all the indicators factor loadings should exceed 0.7, (2) composite reliability of each construct should exceed 0.7 and (3) the average variance extracted (AVE) by each construct should exceed the variance due to measurement error for that construct (AVE > 0.5). As table I shows, all criteria for convergent validity are satisfied: all factor loadings on their relative construct exceed 0.7 and all AVE values range from 0.598 to 0.785 (AVE > 0.5) Discriminant validity is supported when the square root of the average variance extracted (AVE) of a construct is higher than any correlation with another construct.

TABLE I. DESCRIPTIVE STATISTICS AND THE RESULTS FOR CONVERGENT VALIDITY FOR THE MEASUREMENT MODEL (ACCEPTED THRESHOLD VALUES IN BRACKETS)

Construct Items	Mean (SD)	Factor Loading (>0.70)	Cron-bach's a (>0.70)	Composite Reliability (>0.70)	Average Variance Extracted (>0.50)
Perceived Ease of Use	5.79 (0.88)		0.867	0.795	0.690
PEOU1		0.786			
PEOU2		0.832			
Perceived Usefulness	4.77 (1.29)		0.769	0.801	0.710
PU1		0.795			
PU2		0.801			
PU3		0.860			
Perceived Mobility	5.98 (0.92)		0.812	0.842	0.785
PM1		0.891			
PM2		0.811			
PM3		0.740			
Satisfaction	5.11 (1.65)		0.822	0.824	0.598
S2		0.820			
S2		0.714			
S3		0.707			
Behavioral Intention to Use	5.02 (0.79)		0.890	0.982	0.742
BIU1		0.857			
BIU2		0.721			
BIU3		0.733			

As table II shows, all AVE square root values are greater than the intercorrelation values between constructs. Thus both convergent and discriminant validity for the proposed research model are verified.

TABLE II. DISCRIMINANT VALIDITY OF THE MODEL (VALUES IN BOLD: THE SQUARE ROOT OF THE AVERAGE VARIANCE EXTRACTED)

Construct	PEOU	PU	PM	S	BIU
PEU	**0.83**				
PU	0.57	**0.84**			
PM	0.34	0.46	**0.88**		
S	0.41	0.57	0.45	**0.77**	
BIU	0.22	0.17	0.69	0.51	**0.86**

Bold values: the square root of the average variance extracted (AVE) of each construct.

Table III and Figure 3 summarize the structural model results. The figure shows the path coefficient for each path with its significance (as asterisks) and the R2 for each endogenous variable.

TABLE III: SUMMARY OF FINDINGS

Hypothesis	Effect	Coefficient	support
H1a	PEOU → PU	0.31^{**}	yes
H1b	PEOU → BIU	0.38^{***}	yes
H2	PU → BIU	0.29^{**}	yes
H3a	PM → PU	0.25^{**}	yes
H3b	PM → PEOU	0.47^{***}	yes
H4a	S → PEOU	0.19^{**}	yes
H4b	S → BIU	0.41^{***}	yes

*p < .05,**p < .01, ***p < .001.

The model explains 24% of variance in Perceived Ease of Use (R^2=0.24), 34% in Perceived Usefulness (R^2=0.34) and 47% in Behavioral Intention to Use (R^2=0.47).

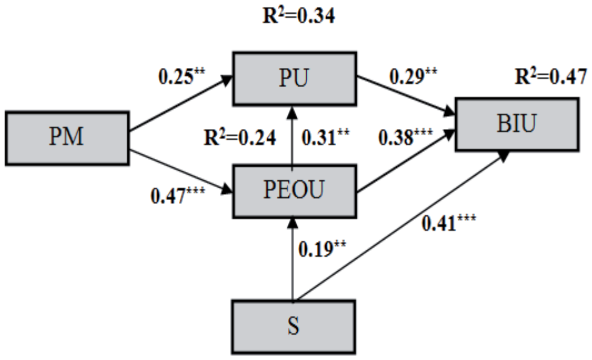

Fig. 3. Result of the structural model.

VI. RESULTS AND DISCUSSIONS

To the best of our knowledge, the current study is the first that investigates secondary students' attitudes and perceptions about the use of mobile devices in learning and assessment procedures during outdoor education in Greece. This study contributes to the research in the adoption of mobile learning by focusing in the field of mobile-based assessment adoption. It provides further evidence that when mobile-based assessment is considered useful and easy to use, students are more likely to adopt it.

It extends Technology Acceptance Model with the variables of Perceived Mobility and Satisfaction. Perceived Mobility is the distinguished advantage of mobile learning over traditional forms of education. Mobile learners can access learning resources "anytime" and "anyplace" without any temporal and spatial limitations. This technological feature has a significant influence on user's attitudes and perceptions about mobile-based learning and assessment, which is in agreement with previous research [16]. Students appreciate the mobility feature that mobile devices offer during the educational activity outdoors. Therefore, Perceived Mobility significantly impacts user adoption of mobile-based assessment.

Satisfaction is the psychological enabler that provides a link between technology acceptance and motivation. Previous research has shown that satisfaction has a significant effect on behavioral intention to use mobile communication services [30] and social network games [26]. Our findings provide evidence that satisfaction has a significant effect on behavioral intention to use mobile-based assessment as well. Satisfaction, as a hedonic variable, plays a critical role in the adoption of mobile-based assessment. It is the intrinsic motivational factor that opens to the primary utilitarian nature of TAM a new window to theories of intrinsic motivation. The current study supports previous findings of previous research that have extended TAM to include variables from Self-Determination Theory [21, 22]. Students are more willing to use a mobile-based assessment system that is enjoyable, satisfactory and intrinsically motivating.

The results of the study can be valuable for researchers in the field of technology adoption, educational policy administrators, instructional designers and teachers.

Mobile technologies offer innovative ways that have the potential to enhance assessment if they build upon proper theoretical frameworks [31, 32]. Mobile devices can be used both in in-class and outdoor "on-the-spot" assessments. They can be used not only in a pure mobile learning curriculum but in blended learning approaches as well. Students would like to use mobile devices for educational purposes [33] and therefore educational policy makers and instructional designers should facilitate the use of mobile devices for learning and assessment. However, for a successful implementation of mobile-based assessment in different educational settings, research on mobile-based assessment adoption needs to investigate all possible involved variables that affect student's adoption. Among our research goals is to further investigate more variables and other educational settings as well, in order to understand what motivates learners to adopt mobile-based assessments.

APPENDIX

TABLE IV: QUESTIONNAIRE ITEMS USED

Constructs	Items	Descriptions	Sources
Behavioural Intention to Use	BIU1	I indent to use mobile devices for assessment purposes in the future.	Davis (1989)
	BIU2	I plan to use mobile devices for assessment purposes in the future.	
	BIU3	I predict I would use mobile devices for assessment purposes in the future.	
Perceived Mobility	PM1	It is convenient to access mobile-based assessment anywhere and anytime.	Huang et al. (2007)
	PM2	Mobility is an outstanding advantage of mobile-based assessment.	
	PM3	Mobility makes it possible to get the real-time assessment data.	
Satisfaction	S1	The mobile-based assessment that I am using now meet my expectations.	Park et al (2014)
	S2	Overall I am satisfied with the mobile-based assessment.	
	S3	I recommend mobile-based assessment to others who indent to use mobile devices in learning.	

Constructs	Items	Descriptions	Sources
Perceived Ease of Use	PEOU1	I find the mobile-based assessment easy to use.	Davis (1989)
	PEOU2	Learning how to use the mobile-based system is easy for me.	
Perceived Usefulness	PU1	I think mobile-based assessment is useful for my learning.	Davis (1989)
	PU2	Using mobile-based assessment increases my productivity.	
	PU3	Using mobile-based assessment improves my performance and effectiveness in my learning	

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