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A model for Mobile-based Assessment adoption based on Self-Determination Theory of Motivation

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***Abstract*—In order to successfully deliver Mobile-Based Assessments in any educational setting, it is of great importance to investigate the factors that influence its adoption from the students. The present study aims to explain and predict the Technology Acceptance Model constructs "Attitudes towards Using" (ATU) and "Intention to Use" (ITU) mobile-based assessment from the perspective of the Self-Determination Theory of Motivation. 72 medical students answered a survey questionnaire about the use of a mobile-based assessment conducted after the lecture and patient examination procedure. Partial Least Squares (PLS) was used for data analysis. Results show that the main motivational factors of self-determination theory, namely Autonomy, Relatedness and Competency, explain students' attitudes about mobile-based assessment and also predict students' adoption. Our research findings suggest that in order to enhance students' learning motivation, the design and implementation of mobile-based assessments should satisfy the three basic psychological needs for competency, autonomy and relatedness.**

Keywords—mobile-based assessment, mobile learning, motivation, self-determination theory, technology acceptance model, medical education

I. INTRODUCTION

Mobile devices have the ability to deliver learning content and examinations "anywhere" and "anytime", crossing the boundaries of a traditional classroom. A variety of assessment types e.g. self-assessment, peer-assessment, adaptive, context-aware, game-based assessment can be implemented using mobile devices [1]. Mobile-based assessment (MBAs) can either be part of a pure mobilized curriculum or part of a blended approach where mobile learning complements traditional learning or web-based learning strategies. Furthermore, mobile-based assessment can be used both in formal settings (where learning takes place in schools or universities) and informal or semiformal settings (where learning may take place in museums, science centers, field trips, etc). In the context of formal learning, studies show that usage of smartphones as polling devices increases student attention and engagement [2]. Also, when used inside wi-fi enabled classrooms, they can support self- and peer-assessment practices [3]. In the context of informal and semi-formal learning, where learners have more control over their learning goals or the process of learning, mobile-based assessments can be particularly beneficial [4]. Examples of such rewarding implementations include mobile-assisted language learning [5], context-aware ubiquitous environmental learning [6], learning in a museum [7] or remote and virtual labs with mobile support [8].

Considering the wide spectrum of the possible educational settings and application areas where mobile-based assessment can be applied and in order to implement it successfully, it is important to investigate its user adoption. While there are numerous studies examining the acceptance of computer-based assessment [9, 10, 11] and the acceptance of mobile learning [12, 13], the issue regarding how to understand and promote learners' acceptance of mobile-based assessment needs further investigation.

This paper is organized as follows. In the next section, we briefly introduce the issue of technology adoption from the motivational perspective of Technology Acceptance Model and continue with the Self-Determination Theory of motivation approach. Then, the proposed research model is presented. A description of the conducted experiment follows along with the corresponding data analysis. Thereafter, results are discussed as well as conclusions are presented.

II. BACKGROUND

A. TAM and Mobile-Based Assessment

One valid and well-established model that addresses the issue of how users accept and use a technology is the Technology Acceptance Model (TAM) [14]. In TAM, intention to use is influenced by attitude toward use, as well as the direct and indirect effects of perceived usefulness and perceived ease of use. TAM has been successfully used as a framework to study student's acceptance of mobile learning, modified and extended with many external variables [15, 13]. These extensions are basically "technology-related enablers" while students' intention to adopt mobile learning should be examined from a motivational perspective also [16].

Also, some researchers [17] claim that the predictive power of TAM is limited to utilitarian systems (productivity oriented) because it primarily concerns with extrinsic motivations (perceived usefulness) while intrinsic motivations (conceptualized as perceived enjoyment) are usually

underestimated. Mobile-based assessments not only have a utilitarian nature (e.g. "I need to get a good grade in the test in order to pass the course") but a hedonistic as well (e.g. "I like to use mobiles to take the test whenever and wherever I prefer"). We claim that in order to understand students' intention to adopt mobile-based assessment we should examine the issue from a motivational perspective as well.

Among various motivation theories, Self-Determination Theory (SDT) of Motivation is an appropriate framework for addressing motivation in an online learning environment [18, 19, 20]. Researchers used the SDT motivational framework and found that autonomous motivation predicted perceived usefulness and perceived ease of use more strongly than external regulation [21].

B. Self-Determination Theory of motivation

Self-Determination Theory of motivation (SDT) [22, 23] introduces three basic and universal human needs: autonomy, competency and relatedness. Autonomy refers to the desire of people to regulate and self-control their own behavior, relatedness refers to the desire of people to feel connected and associated with others and competency refers to the desire of being effective and sufficient when performing an activity. The satisfaction of these three basic psychological needs produce higher levels of intrinsic motivation (the type of motivation that leads to a behavior that is inherently interesting and pleasant) in contrast to external motivation (that is built upon external rewards or punishments).

III. RESEARCH MODEL AND HYPOTHESES

The present study employs perceived autonomy, perceived relatedness and perceived competency from Self-Determination Theory of Motivation in order to explain and predict attitudes toward using and subsequently intention to adopt mobile-based assessment. According to our research model, the basic psychological needs of autonomy, relatedness and competency positively influence students' attitudes about using mobile devices during test taking procedures. Subsequently, attitudes toward using mobiles in assessment positively influence students' intention to adopt mobile-based assessment.

Attitude is the degree to which the user is interested in specific systems, and plays an important role in affecting behavioral intention to use an e-learning system especially in volitional situations such as students' voluntary adoption of technology [24].

In the context of mobile-based assessment, we propose the following hypothesis:

Hypothesis 1: Test-takers' attitude towards using (ATU) mobiles during assessment has a positive influence on their intention to use (ITU) m-assessment.

Autonomy refers to the human need of self-initiate and self-regulate own behavior. Mobile devices offer students a control over their own learning [25] and the ability to engage in learning tasks (e.g. assessments) according to their own individual contextual (anywhere) or temporal (anytime) preferences or needs [26].

Thus, we propose the following hypothesis:

Hypothesis 2: Test-takers' perceived autonomy (A) during m-assessment has a positive influence on their attitude towards using (ATU) mobile devices in assessment.

Relatedness refers to the human need to be related and affiliated to others. Mobile devices enable rich social interactions by allowing users to collaborate and share information during learning activities [27] such as formative or peer assessments.

Thus, we propose the following hypothesis:

Hypothesis 3: Test-takers' perceived relatedness (R) during m-assessment has a positive influence on their attitude towards (ATU) using mobile devices in assessment.

Competency refers to the human need to feel effective in attaining valued outcomes. It can be built upon the concept of efficacy expectations from Bandura [28]. Most high school and university students have a profound convenience in utilizing mobile devices to perform activities such as web browsing or using mobile applications. Theng [29] found that students with high mobile self-efficacy are more likely to treat mobile learning as requiring less effort and being easier to use. Learning activities such as participating in mobile-based assessment may be perceived as a stimulating and pleasant experience and students are more likely to prefer using mobile devices in assessments.

We propose the following hypothesis:

Hypothesis 4: Test-takers' perceived competency (C) during m-assessment has a positive influence on their attitude towards using (ATU) mobile devices in assessment.

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

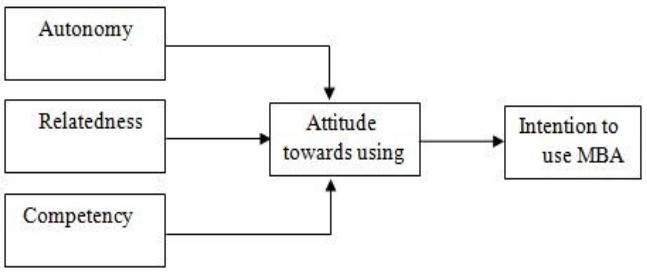

Fig. 1. The proposed model.

IV. METHODOLOGY

A. Participants

The participants in this study were 72 fourth-year medical students, enrolled in a Pathology course in the fall semester of academic year 2013-2014, in a Greek University, School of

Medicine. There were 34 males (47%) and 38 females (53%). The average age of students was 22.6 (SD = 0.98). The median mobile self-efficacy score was 81 on a scale of 100 (the questionnaire adopted from [30]), indicating that students were confident enough to use their mobile devices in the assessment.

B. Procedure

The participation in the assessment was voluntary. The mobile devices used were wi-fi enabled smartphones (65% Android, 25% iOS, 8% Windows Phone and 2% other). The "low-stake" mobile-based assessment conducted after the lecture and the patient examination procedure in order to check students' knowledge and understanding for the subject taught. There were 15 multiple choice questions with four possible answers each. For each question, students had to click on the right answer and to move on to the next screen. Students received feedback about the correctness of their responses. The duration of the assessment was 15 min. The interface of the mobile application was kept as simple as possible to avoid possible destructions. After the assessment, students were asked to participate in a survey questionnaire, self-reporting their attitudes about the assessment procedure.

C. Instrument

In order to evaluate the perceived autonomy, relatedness and competency during the mobile-based assessment procedure, as well as the attitudes towards use and intention to adopt m-assessment, we have constructed a research instrument based on previous established questionnaires that were used and validated by other researchers. To assess students' perceived Autonomy (A) support we have used 5 items from [19]. For perceived Relatedness (R) we used 3 items from [18] and for perceived competency (C) we used 5 items from the Intrinsic Motivation Inventory (IMI) [31]. To assess Attitudes Towards Use (ATU) and Intention to Use (ITU) we employed 6 items from [14]. 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 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 [32] 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 0.758 to 0.896 (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. 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 I. CONVERGENT VALIDITY OF THE MODEL

Construct Items	Mean (SD)	Factor Loading	Cronbach a	Composite Reliability	AVE
A	5.98 (0.97)		0.897	0.915	0.896
A1		0.957			
A2		0.920			
A3		0.932			
A4		0.876			
A5		0.799			
C	5.76 (1.21)		0.946	0.956	0.798
C1		0.855			
C2		0.780			
C3		0.992			
C4		0.799			
C5		0.802			
R	5.10 (1.30)		0.821	0.943	0.758
R1		0.795			
R2		0.760			
R3		0.711			
ATU	6.24 (0.95)		0.923	0.951	0.887
ATU1		0.957			
ATU2		0.920			
ATU3		0.932			
ITU	6.11 (1.12)		0.940	0.923	0.823
ITU1		0.920			
ITU2		0.895			
ITU3		0.810			

A: Autonomy, R: Relatedness, C: Competency, ATU: Attitude towards Use, ITU: Intention to Use MBA

TABLE II. DISCRIMINANT VALIDITY OF THE MODEL

Construct	A	R	C	ATU	ITU
A	**0.812**				
R	0.531	**0.944**			
C	0.553	0.423	**0.912**		
ATU	0.560	0.497	0.546	**0.961**	
ITU	0.521	0.652	0.477	0.522	**0.901**

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

Figure 2 summarizes the structural model results along with the path coefficients shown above each path and the R^2 values.

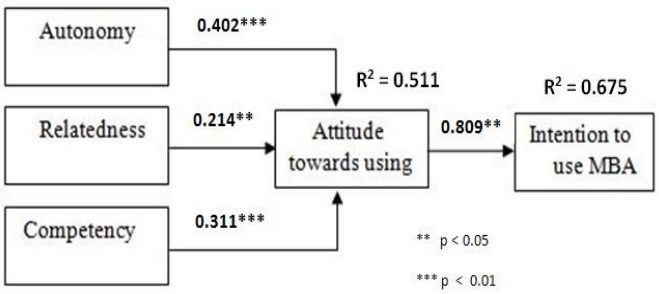

Fig. 2. Result of the structural model.

VI. RESULTS AND DISCUSSIONS

Investigating mobile-based assessment acceptance from a motivational perspective is important since users are more willing to use Information Technology when motivational enablers are supported [18]. Also, mobile based assessment has the potential to find a wide range of applications, not only in pure mobile learning curriculum but in blended learning approaches as well. Therefore, predicting and explaining its adoption from a motivational perspective can be useful for educators and stakeholders in order to design and implement motivational mobile-based assessments.

While there are numerous studies investigating the acceptance and intention to use of mobile learning [33] and computer-based assessment [9, 10, 11], adoption of Mobile-Based Assessment (MBA) has not been extensively studied. The current study is one of the first in this line of research [34] that examines the influence of Self-Determination Theory (SDT) of Motivation on MBA adoption. Its basic contribution is that it uses the constructs of perceived autonomy, perceived relatedness and perceived competency from Self-Determination Theory of Motivation in order to explain and predict attitudes toward using and intention to adopt mobile-based assessment. Secondarily, it provides further evidence for the validity of SDT in medical education [35].

Students use a lot their mobile devices but they do not use them for educational activities even though they would like to [36]. Educators and administrators may support and motivate students to use mobiles in education. Young people use their mobiles to play and communicate. Why not to use them in order to learn? Our findings indicate that autonomy, relatedness and competency, positively influence students' attitudes about using mobile devices and intention to adopt mobile-based assessment.

The perceived autonomy reported when a student takes a mobile-based test in the place and time of his/her preference, can be utilized as a motivational factor to enhance learning. Mobile "assessment pills" in the form of small-size quizzes can be delivered through mobiles to students in order to keep them engaged and motivated through their study. These "assessment pills", appropriately designed, can also be adapted to the user context [37, 38]. SDT studies have shown that when the context is autonomy supportive, people maintain their engagement in a behavior [18].

The perceived competency students report while taking a mobile-based test is in-line with their mobile self-efficacy. When perceived competency is supported, users believe that less effort is needed to perform an activity [18]. Students are more likely to adopt something that they believe they can easily accomplish. Since students feel competent enough to use mobile devices, we can use mobiles as an alternative medium to deliver assessments.

Finally, the perceived relatedness students report during mobile assessments is another motivational enabler. Students are more willing to participate in mobile polls and quizzes when they feel they are related and connected. It is the prevalent social networking features of mobile devices that have a positive influence on students' perceived relatedness. Considering the construct of relatedness we can build mobile collaborative learning and peer-assessment environments where knowledge can be shared among learners.

Mobile technologies offer innovative ways that enhance assessment. Appropriate theoretical frameworks need to be used as foundations to build mobile applications [39] and mobile learning strategies [40]. The present study is a step in this research. It complements our understanding of technology adoption of MBA, considering the satisfaction of the three basic psychological needs of autonomy, competency and relatedness.

Further investigations with more variables and in other educational settings as well, need to be done in order to understand what motivates learners to adopt mobile-based assessments.

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