Mobile-based Assessment: Towards a Motivational Framework

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***Abstract*—Mobile-based Assessment (MBA) is a relatively new delivery mode of assessment. MBA not only offers an alternative to web-based tests and quizzes that can be answered anytime and anywhere but it also introduces a new assessment paradigm offering adaptive, personalized, context-aware and ubiquitous assessment activities embedded in learning flow. However, for an effective use of MBA, instructional designers and educators need to be aware of its underpinning motivational dimensions and concepts. The current study proposes MBAMF, a Mobile-Based Assessment Motivational Framework based on the Self-Determination Theory (SDT) of Motivation. The framework aims to connect the basic SDT constructs with features offered by mobile-based assessment. For a preliminary evaluation of the model, a pilot study with 47 medical students in a near-patients clinical training environment was conducted. The study provides empirical evidence that fits into the proposed framework. Mobile-assisted assessment can effectively support the three basic psychological needs of SDT, namely perceived autonomy, competence and relatedness. The current work provides a foundation for further elaboration towards a more comprehensive motivational framework for mobile-based assessment. Implications are discussed.**

Keywords— mobile-based assessment; motivation; self-determnation theory

I. INTRODUCTION

The utilization of mobile devices in learning and assessment provides many benefits to education: multimedia presentation capabilities, adaptivity and personalization, seamlessness, ubiquity, context-awareness and social media connectivity [1]. Many institutions promote nowadays the Bring Your Own Devices (BYOD) policies [2]. However, in order for instructional designers and educators to effectively design and use mobile learning and assessment, they need to be aware of its underpinning motivational dimensions and concepts.

There are many frameworks exploring mobile learning from different perspectives e.g. technology acceptance, system design, learning environment, pedagogy and evaluation [3]. However, research on mobile learning and assessment frameworks focusing primarily on psychological constructs is rather limited. The current study is aiming at filling this gap in the literature by investigating the motivational constructs that relate to features of mobile-based assessment. Motivation is a fundamental issue in learning. Moreover, considering the lack of students' interest towards STEM subjects and careers [4], motivating students in science subjects is a very important issue nowadays.

The study is organized as follows. The next section provides a background about Mobile-Based Assessment and Self-Determination Theory. MBAMF, the proposed Motivational Framework for Mobile-Based Assessment based on SDT is presented next. Methodology section follows with the instruments, participants, procedure, data analysis and results sub-sections. The study closes with the conclusions and discussions section.

II. BACKGROUND

A. Mobile-based Assessment

Mobile-Based Assessment (MBA) is a relatively new mode of assessment that is delivered through mobile devices (PDAs, mobile phones, smartphones, tablets). MBA can be used both in the context of a pure mobile learning approach and also in a blended learning approach, as complementary or alternative to computer- or paper-based assessment [5]. Mobile devices can be used in different assessment types, either inside or outside the classroom boundaries for formative assessment [6], self- and peer-assessment [7], work-based assessment [8], classroom polling [9], etc. Mobile devices and wireless technologies offer many affordances that can not only enhance existing but also introduce new opportunities to assess learning. Some of these affordances are: adaptivity and personalization [10], context-awareness, seamlessness and ubiquity [11], [12], social media connectivity [13]. Research provides evidence that mobile technologies have a considerable potential for enhancing learning motivation [14], [15]; however no comprehensive framework exists that associates motivational constructs with features of mobile-based assessment.

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B. *Self-Determination Theory of Motivation*

The current study is based on the Self-Determination Theory (SDT) of Motivation [16], [17]. SDT 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 promote 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).

Previous research has highlighted the importance of SDT in education [18] and e-learning environments [19], [20], [21]. Autonomous motivation, in comparison with controlled motivation, has been associated with better learning [22]. With students' perceptions of autonomy, competence and relatedness to be high enough, students feel self-determined and autonomously motivated [23]. Furthermore, research suggested numerous factors (e.g. limited choice, insufficient guidance and feedback, lack of communication) that can undermine learners' perceptions of autonomy, competence and relatedness in an online context [24]. The current study uses SDT as the basis for the proposed motivational framework for mobile-based assessment, arguing that it provides an appropriate background in order to develop motivational mobile-assisted assessment activities.

III. A FRAMEWORK FOR STUDENT MOTIVATION IN MOBILE-BASED ASSESSMENT

The current study proposes MBAMF, a motivational framework for Mobile-Based Assessments based on the self-determination theory of motivation. The framework has three dimensions that correspond to the basic psychological needs of the SDT, namely autonomy, competence and relatedness. Each dimension, in turn, is further analyzed into sub-dimensions that correspond to certain instructional principles. Autonomy support can be implemented by providing meaningful choices to students [25], offering contextualized support [26] and reducing test anxiety [27]. Competence support can be implemented by providing immediate and appropriate feedback to students [24], appropriate guidance [28] and delivering authentic learning and assessment tasks [11]. Relatedness support can be implemented by facilitating the communication [24] and collaboration [20] among learners. Figure 1 depicts the proposed framework

It is possible for mobile-based assessments to facilitate the implementation of the aforementioned instructional principles, when designed and implemented according to the following guidelines:

For autonomy support:

- Group questions according to certain learning objectives and grading policies, and allow students to follow their own personalized learning-assessment paths by selecting to answer the questions set of their choice (A1).
- Deliver adaptive and personalized formative or self-assessments with optimally challenging tasks based on the students' perceived capabilities in order to reduce the levels of students' testing anxiety (A2).
- Provide context-aware assessment tasks where questions are presented to and needed to be answered from students in real world locations after interaction with real or virtual objects through geolocation, RFID, QR-coding or other sensing technologies (A3).

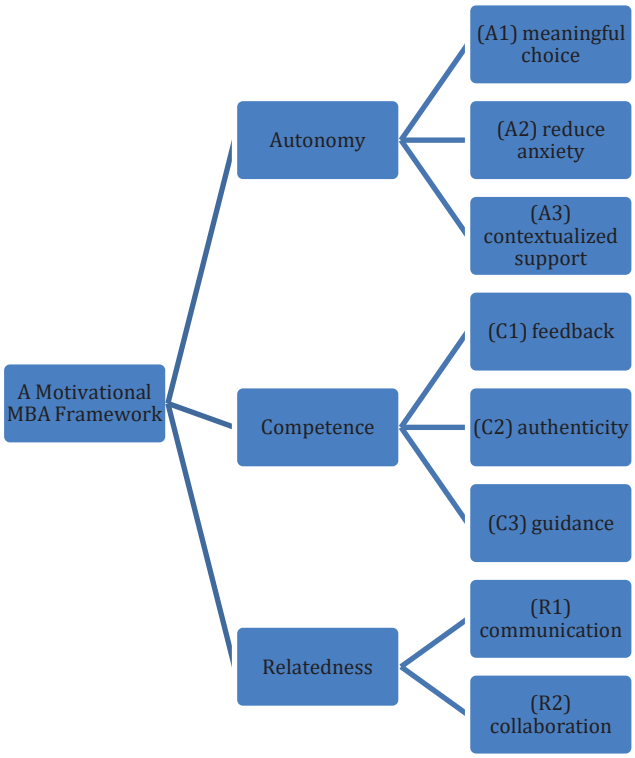


Fig. 1. The proposed framework MBAMF

For competence support:

- Provide emotional or cognitive feedback that is immediate and supportive in nature so as to increase students' feelings of being capable and competent (C1).
- Drive students to engage in authentic learning activities in 'real world' settings and offer them the possibility to participate in competence-based authentic assessments (C2).
- Provide the appropriate guidance and supportive mechanisms in order to enhance the feelings of competence (C3).

For relatedness support:

- Facilitate synchronous and asynchronous communications among peers through messaging applications (R1).
- Facilitate knowledge sharing among students through mobile-based cloud services (R2).

The next section describes a pilot study that has been implemented for the preliminary evaluation of the framework.

IV. METHODOLOGY

The study, implemented in the context of the preliminary evaluation of the proposed framework, follows a quasi-experiment design. The independent variables were the two different assessment strategies (mobile-based and conventional paper-based). The dependent variables were the perceived levels of autonomy, competence and relatedness.

A. Instruments

In order to evaluate the perceived levels of Autonomy, Competence and Relatedness, we adopted items from the following previously validated questionnaires: (1) the Basic Psychological Need Satisfaction (BPNS) Questionnaire [29] assessing the degree to which people feel satisfaction of the basic SDT psychological needs and (2) the Intrinsic Motivation Inventory (IMI) Questionnaire [30] assessing participants' subjective experience related to intrinsic motivation and self-regulation. A total of 12 question items were used. Sample item are: for perceived autonomy "I feel a sense of choice and freedom while participating in the MBA", for perceived competence "I think I am pretty good at the MBA" and for perceived relatedness "I have the opportunity to be close to others when I participate in the MBA". All items were measured using 7-point Likert scales ranging from 1 (strongly disagree) to 7 (strongly agree). The three basic needs satisfaction factors had good internal reliabilities (alpha values were 0.79, 0.76 and 0.81 for autonomy, competence and relatedness respectively).

B. Participants

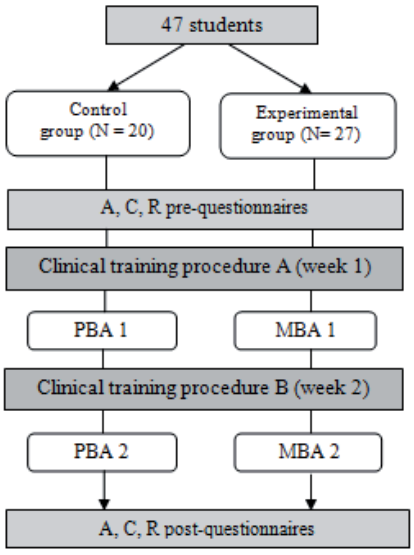
A total of 47 third-year medical students participated in the study. There were 27 females and 20 males. The average age was 22. Participated students split randomly into two groups: twenty students were assigned to be the control group and twenty-seven students were assigned to be the experimental group. Students' were informed about the research procedure; their participation was voluntarily and all the data collected anonymously.

C. Procedure

The study was implemented during a two weeks clinical training procedure of the 47 third-year medical students in a near-patient work-placed clinical environment. There were two training sessions. Each session lasted for two hours and followed by a self-assessment. The first session performed during the first week and was about emergencies in cardiology (A) and the second session performed during the second week and was about heart infections (B). In the beginning of the first training session students completed a pre-questionnaire about their pre-existing levels of motivation. Students from both groups followed the same near-patients clinical training program with the same doctors; however students in the control group answered a conventional paper-based test after each clinical training session (PBA 1 and PBA 2) while students in the experimental group answered the same tests using their mobile devices (MBA 1 and MBA 2.

The MBA used was based on a Moodle platform. There were 20 questions compliant with the Question and Test Interoperability (QTI) v.2.1 specifications, i.e. multiple choice, multiple response and yes/no questions. During our system development, the following design issues (from the proposed framework) have been taken into consideration: (i) questions were grouped in three difficulty levels (tagged as easy, medium and difficult) with the students to decide which track to follow, (ii) questions were optimally challenging by taking into consideration previous students knowledge and experience, (iii) appropriate tutor guidance and immediate informative (cognitive domain) and positive (affective domain) feedback was provided, (iv) real-time record of student progress was shown (v) questions were associated with real authentic experiences giving the opportunity to the students to record evidence and reflection on their experiences in real work-placed authentic tasks, (vi) students were able to upload and share questions, answers, self-reflections and peer comments on real clinical work experience through cloud-based services.

In the end of the second training session students completed a post-questionnaire about their perceived levels of autonomy, competency and relatedness they had experienced during the assessment. Fig 2 shows the experimental procedure.



A: Autonomy, C: Competence, R: Relatedness
PBA: Paper-Based Assessment
MBA: Mobile-Based Assessment

Fig. 2. Experimental procedure

D. Data Analysis

Data analysis includes computation of t-tests and one-way ANCOVA procedures in order to analyze the data collected from the pre- and post-questionnaires about the perceived levels of motivation. SPSS 22.0 used for the data analysis.

E. Results

The means and standard deviations of the pre-questionnaires for perceived autonomy were 3.71 and 1.15 for the control group and 4.04 and 1.11 for the experimental group with the t-test results to show no significant difference between the two groups for the pre-questionnaires ($t = 0.86$, $p > 0.05$). The means and standard deviations of the pre-questionnaires for perceived competence were 4.60 and 0.86 for the control group and 4.67 and 0.93 for the experimental group with the t-test results to show no significant difference between the two groups for the pre-questionnaires ($t = 2.50$, $p > 0.05$). The means and standard deviations of the pre-questionnaires for perceived relatedness were 4.35 and 1.02 for the control group and 4.01 and 1.00 for the experimental group with the t-test result to show no significant difference between the two groups for the pre-questionnaires ($t = 1.15$, $p > 0.05$). Therefore, the two groups had the same level of motivation before the clinical training procedure.

In order to test the differences between the two groups after the clinical training procedure, analysis of covariance (ANCOVA) used with the pre-test scores as the covariate and the post-test scores as the dependent variables.

The results for the perceived levels of autonomy, when adjusted for the covariate, revealed a significant difference after the intervention between the two groups ($F = 17.38$ $p < 0.001$), as Table I shows. The adjusted mean for the experimental group (4.91) was significantly higher than that of the control group (3.86).

TABLE I ANCOVA RESULTS FOR THE POST-TEST SCORES ON PERCEIVED AUTONOMY

Group	*N*	*Mean*	*S.D.*	*Adj. Mean*	*Std. error*	*F*
Control	20	3.75	1.10	3.86	0.19	17.38***
Experimental	27	5.00	1.14	4.91	0.16	

*** $p < 0.001$

The results for the perceived levels of competence, when adjusted for the covariate, revealed a significant difference after the intervention between the two groups ($F = 8.40$ $p < 0.01$), as Table II shows. The adjusted mean for the experimental group (5.10) was significantly higher than that of the control group (4.65).

TABLE II ANCOVA RESULTS FOR THE POST-TEST SCORES ON PERCEIVED COMPETENCE

Group	*N*	*Mean*	*S.D.*	*Adj. Mean*	*Std. error*	*F*
Control	20	4.62	0.88	4.65	0.12	8.40**
Experimental	27	5.13	1.14	5.10	0.10	

** $p < 0.01$

The results for the perceived levels of relatedness, when adjusted for the covariate, revealed a significant difference after the intervention between the two groups ($F = 7.59$ $p < 0.01$), as Table III shows. The adjusted mean for the experimental group (5.54) was significantly higher than that of the control group (4.73).

TABLE III ANCOVA RESULTS FOR THE POST-TEST SCORES ON PERCEIVED RELATEDNESS

Group	*N*	*Mean*	*S.D.*	*Adj. Mean*	*Std. error*	*F*
Control	20	4.76	1.00	4.73	0.22	7.59**
Experimental	27	5.51	0.95	5.54	0.19	

** $p < 0.01$

Therefore, the proposed approach had a significant positive impact on student perceived levels of autonomy, competence and relatedness, enhancing their motivation.

V. CONCLUSIONS AND DISCUSSIONS

Motivation is a fundamental issue in learning. Research provides evidence that mobile devices offer new opportunities in learning and assessment and also have the potential to enhance student motivation [14].

The current study proposes a motivational framework for developing mobile-based assessments. The framework explores the links among the SDT motivational dimensions of autonomy, relatedness and competence with the features of mobile technologies used in assessment. While many studies exist highlighting the importance of SDT in e-learning contexts, few studies exist in the context of mobile learning, e.g. a study that integrates SDT motivational factors into the technology acceptance model for MBA [31]. Our current work is aiming at filling this gap in the literature.

The study also provides a preliminary evaluation of the proposed framework. It delivers competency based assessment via mobile devices in work-based settings with a positive impact on students' motivation. From the experimental results, it was found that the proposed approach promotes student autonomy, competence and relatedness, and hence supports intrinsic motivation. Results are in-line with related literature [14, 15, 8]. Furthermore, the proposed framework is one of the first approaches to model the motivational dimensions (based on SDT) of mobile-assisted assessment strategies.

The proposed framework is in its early stage. Not all features of mobile learning have been investigated in terms of their motivational impact. One of them is context-awareness. Contextualized support was not implemented in the current phase. In order for wireless sensor technologies in real medical work-based environments to be implemented, specialized technical and administration issues need to be resolved first.

Our research plans are to further elaborate on the framework and provide a more comprehensive version. This future version will consider the motivational impact of all features that wireless and mobile technologies can offer. The proposed framework, when fully developed, aims to help in designing and implementing more engaging mobile-based assessment that can trigger and sustain student learning motivation enhancing teaching and learning.

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