INTENTION TO USE M-LEARNING IN HIGHER EDUCATION SETTINGS

INTENCAO DE USAR O M-LEARNING EM AMBIENTES DE EDUCAÇÃO SUPERIOR

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RESUMO

Este estudo tem por objetivo identificar fatores que influenciam a intenção de uso do *m-learning* (ensino com mobilidade) em um ambiente de ensino superior. Por meio da modelagem de equações estruturais, e com base na literatura sobre modelos de aceitação de tecnologia (TAM) (Davis et al., 1989), um modelo foi proposto, e um estudo transversal com 402 estudantes de uma universidade brasileira foi usado para medir e avaliar um conjunto de construtos relacionados à aceitação de tecnologia (*m-learning*). Os resultados indicam que, enquanto efeitos significantes foram encontrados para a facilidade de uso, compatibilidade e auto-eficácia. Por fim, conclui-se que a percepção de utilidade no curto prazo foi o fator que exerceu o maior efeito na intenção de uso dos estudantes para usar o *m-learning*.

Palavras-chave: Aceitação de Tecnologia.
M-learning. TAM. Ensino Superior. Aparelhos móveis.

ABSTRACT

This study focuses on identifying factors influencing intention to use m-learning (learning through mobile devices) in a higher education environment. Using Structural Equation Modeling, supported by the literature on Technology Acceptance Model (TAM) (Davis et al., 1989), a framework has been proposed, and a cross-sectional survey comprising 402 students from a Brazilian university was used to measure several constructs related to technology acceptance (m-learning). Results indicate, through structural equations modeling analysis, that while significant effects were found for ease of use, compatibility and self-efficacy. Lastly, we conclude that perceptions of short-term usefulness exert the greatest effects on students' intention to use m-learning.

Keywords: Technology Acceptance. Mobile learning. TAM. Higher Education. Mobil devices.

INTRODUCTION

The latest mobile and wireless technologies (like mobile phones, smartphones, tablets and notebooks) offer a range of possibilities for learning. They allow you to exchange information, share ideas, experiences, resolve questions and access a wide range of resources and materials, including text, images, audio, video, e-books, articles, online news content on blogs, microblogs and games, whenever necessary. Because of the potential for widespread use of these handheld devices, it is argued that mobile learning (m-learning) is the next wave for new learning environments (GOH; KINSHUK, 2004; HSU; KE; YANG, 2006).

According to consulting firm Teleco (http://www.teleco.com.br/ncel.asp), Brazil closed September 2012 with almost 259 million mobile phone subscriptions, and of these, approximately 49 million (18.8%) subscribers are in the post-paid category. At a global level, consulting firm MobiThinking (http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats) pointed out in December 2011 that there were already almost 6 billion mobile phone subscriptions, which is, in a crude tally, a number equivalent to approximately 85% of the world population. Given that a considerable portion of the world's population has now access to mobile devices, this environment has become a very promising arena for the practice of teaching and learning. In this context, m-learning is presented as a new form for delivering education, one that can help people acquire knowledge and skill in an ubiquitous manner with the support of various mobile technologies.

However, despite the euphoric discourse surrounding m-learning, knowledge about its practices and uses is still in its infancy, and its theoretical foundations have not yet matured (MUYINDA, 2007). Regardless of the high degree of insertion of mobile devices in current society, the mere availability of technology itself does not guarantee that its potential will be used for learning or accepted by all evenly. That translates into the perception that, up to this moment, m-learning still has not caused a great impact in the educational context (LIU; HAN; LI, 2010). In Brazil, particularly, there are hardly any reports in the literature concerning experiences with m-learning use.

On the other hand, although there are already some studies that seek to understand what factors influence students' intention to use m-learning (HUANG;LIN; CHUANG, 2007; PHUANGTHONG; MALISAWAN, 2005, WANG; WU; WANG. 2009), understanding the adoption of mobile technologies in educational environments is still incipient (POZZI, 2007). In particular, questions about how to promote the acceptance of m-learning by users are still largely unresolved. In the light of this argument, the following research question is postulated: What factors can influence higher education students to adopt m-learning as a tool to support the traditional face-to-face teaching? Drawing upon the related literature, the objective of this study is twofold: (1) identify the current situation regarding studies on adoption of m-learning and (2) propose and test a model to evaluate the intended use of m-learning.

The paper is structured as follows. It begins with this introduction that contextualizes the research problem and outlines the objectives of the work. Then, m-learning is conceptualized, followed by a literature review about models used to evaluate technology acceptance and m-learning adoption. The next section describes the employed methodology. Finally, a model is proposed and empirically tested. The paper closes with a discussion and conclusions generated by the obtained results.

REVIEW OF THE LITERATURE

Mobile Learning (M-learning)

The increasing number of resources available in today's mobile devices brings up a range of opportunities for educational institutions to employ these technologies to the teaching process, either to support traditional face-to-face classroom sessions or for distance education purposes. Geddes (2004, p.1) defines m-learning (Mobile Learning) as the "acquisition of knowledge and skills through mobile technology anywhere and at any time". For Geddes, m-learning has the potential to start a new era in training and education (CLYDE, 2004; GAYet al., 200; HILL; ROLDAN, 2005).

According to Saccol, Schlemmer and Barbosa. (2010), individuals can use mobile and wireless technologies to access virtual learning environments at any place or time for several purposes, such as conducting or participating in a course, interacting with colleagues, searching for or uploading content. These devices allow people to interact with peers and teachers, sending and receiving messages about educational activities (via SMS or chat) or reminders of different natures, participating in forums and meetings, asking questions (MOTIWALLA, 2007), responding to "quizzes", accessing video or audio content (GJEDDE, 2008) and learning by the use of mobile games (ARDITO et al., 2008). Moreover, it facilitates the process of capturing and organizing information involved in learning processes that occur in specific places, such as museums or visits to working places (VAVOULA et al., 2009). Other features include listening to podcasts with comments or summaries assembled by a teacher or colleagues after a class, holding meetings to work and study synchronously (web conferencing) by means of video, chat, audio or text, wherever participants are, and even if they are in transit (EVANS, 2008). Finally, workers can participate in training processes or field training promoted by their employers (BROWN;METCALF, 2008; PETERS 2005).

For Mallat et al. (2008), the main aspect of m-learning is mobility. In this sense, Kakihara and Sørensen (2001) point that the mobility concept consists of three different dimensions of human interaction: (a) the temporal dimension, (b) the spatial dimension, and (c) the contextual mobility. Thus, for a proper understanding of the concept of m-learning, one must understand that mobility can be understood in different ways (KAKIHARA; SØRENSEN, 2002; KUKULSKA-HULME et al., 2009; LYYTINEN; YOO, 2002; SACCOL; SCHLEMMER; BARBOSA, 2010; SHARPLES, 2000; SHERRY;SALVADOR, 2002, SORENSEN; AL-TAITOON; KIETZMANN, 2008): there is the physical mobility of apprentices, i.e., during transit people may want to take advantage of opportunities to learn. There is also the technology's mobility which means that several mobile devices may be used when the apprentice is in movement. On the other hand, conceptual mobility proposes that we are always learning, and our attention has to be shared between the different concepts and contents with which we have contact daily. Regarding social/interactional mobility, it is stated that we learn by contacting with different social groups, including family, co-workers, etc. Finally, there is the chronological/temporal mobility, in which one may learn at different moments.

However, an important distinction should be made about what sets m-learning apart from other practices, such as e-learning. According to Wagner and Wilson (2005), mobile learning should not be seen as e-learning transferred to mobile devices. Instead, they claim that the value of mobile devices as a learning tool resides in their capacity to allow people to connect to previously downloaded materials anytime,

anywhere, and to facilitate the connection between everyone at any time and place. As a result, m-learning offers better control and autonomy over one's own learning processes. Besides, it makes possible learning in context. In other words, in places, schedules and conditions the student judges more appropriate. It also provides continuity and connectivity between contexts. For example, while the learner moves in a certain area or over an event he can be in constant contact with his peers and educational content. Finally, m-learning contributes to the spontaneity and opportunism of the learning process, since the learner can take any time, space and opportunities to learn spontaneously, according to their interests and needs (KUKULSKA-HULME et al., 2009; SHARPLES, 2000; TRAXLER, 2009; WINTERS, 2007). So if e-learning takes students beyond the traditional classroom, m-learning takes him beyond the classroom and beyond a fixed location (CMUK, 2007).

Despite the huge potential and benefits that can be provided by the use of mobile technologies, several limitations have been identified. From the technological point of view, many researchers argue that there are many technical constraints that may impede the adoption of m-learning. Wang, Wu and Wang (2009) point out that, technical challenges in adapting the existing e-learning services to m-learning are huge, and that users may not be ready to accept m-learning. Those restrictions, as discussed by Maniar and Bennett (2007), include aspects such as the small screen size and its low resolution; lack of data entry capacity; low data storage capacity; low bandwidth; the processor limited speed; short battery duration; software and interoperability problems and lack of standardization. However, with the improvement of the current smartphones and tablets, some of these problems already have a solution on their way. Given this scenario, Table 1 contrasts a number of benefits and limitations that must also be considered in relation to the practice of m-learning.

TABLE 1 - Benefits and limitations of m-learning

Benefits	Limitations
- Flexibility (learning at any location or time).	- The duration of learning activities and the amount of content (when these are addressed) may be limited.
- Situated learning (anywhere) encourages the exploration of different environments and resources and increases the feeling of "freedom of movement" of apprentices.	- Ergonomic barriers in the extant mobile devices limit the use of certain features (text).
- Learner centered processes, personalized. Contributing to greater individual autonomy.	- One should be careful to maintain relationships and collaboration with other learners or facilitators, instructors, teachers, etc, avoiding isolation.
- Fast access to information and interaction (in real time, anywhere).	- Risk of quick and superficial interactions can bring up the need for more elaborated learning and activities that demand intense collaboration.
- Use of "dead time" for educational activities.	- The attention of the learner may be impaired due to other activities or environmental parallel stimuli (noise, interruptions, etc..), noting that, in the current society we live in, there are increasingly less "dead time" available.
- Harness technologies widely available in our society (eg mobile) as educational tools.	- Mobile and wireless technologies are far from mature and can be unstable or unavailable, besides suffering rapid obsolescence.
- Appeal stimulant - giving the opportunity to explore new technologies and innovative practices.	- There may be an excessive focus on technology (technocentrism) in the detriment of real learning objectives. - It is necessary that learners and teachers have knowledge of and also be technological savvy regarding mobile technologies, but above all, it is essential that teachers have didactic and pedagogical skills in order to use those technologies to enhance student learning.
- Can collaborate to facilitate educational activities in different social classes and geographical areas.	- The connection costs may be higher and may become infeasible for certain individuals. - Ergonomic limitations of mobile devices can be particularly inappropriate for users with special needs.
- Can be used to enrich other forms of education (classroom, e-learning).	- There is need for careful planning in the use of a combination of learning modalities, in order to not generate redundancy or overhead, that will require that the teacher has well developed technical and pedagogical-didactic skills.
- Can fulfill training needs for mobile professionals (who have problems in leaving work or other activities in order to educate themselves).	- It is necessary that mobile professionals have the necessary contextual conditions (physical, temporal, etc…) in order to learn effectively through m-learning, this entails well developed autonomy (namely capacity to define their learning needs and to go in search of elements to supply them) and authorship (in the sense of being the author of your learning process).

Source: Saccol; Schlemmer; Barbosa (2010, p. 34-35)

It is observed that the success of m-learning may depend on whether or not the users' are willing to adopt new technologies and a learning style that is different from what they are accustomed to. It is important to note that in m-learning contexts a large degree of autonomy is demanded from the students, transferring to them responsibility for their own learning process. Unlike conventional learning contexts, such as face-to-face classes, the use of m-learning is argued to be a new option instead of a mandatory liability. Thus, the key issues for the success of m-learning are tied to each individual's cognitive and subjective desires to engage in activities of m-learning.

Technology Acceptance

The current term and conception of technology acceptance originally grew out from the work of Davis (1989), who, based on the Theory of Reasoned Action (TRA) of Fishbein and Ajzen (1975), developed the Technology Acceptance Model (TAM) in order to understand what factors led employees in a company to accept and use new Information Technologies (IT) introduced in their workplace. Davis defines technology acceptance as the voluntary intention to use a technology followed by its actual adoption and use, with two cognitive constructs (perceived usefulness and perceived ease of use) as antecedents of an individual's attitude regarding the adoption of a new technology.

For Davis, Bagozzi and Warshaw (1989), perceived usefulness was characterized as the probability of performance improvement in tasks related to work which the individual saw possible through the use of a given technology. Later, that definition was widened to encompass contexts outside the workplace, with usefulness coming to simply mean the improvements perceived by an individual in his/her productivity or efficiency in any task given the use of a certain technology. Thus, according to TAM, perceived usefulness means how much people believe that the technology will help them do a better work. On the other hand, perceived ease of use represents the perception that an individual possesses concerning the effort that will have to be spent to use the new technology. These two variables mirror two attributes of innovations described in Rogers' (2003) diffusion model: relative advantage and complexity.

Considering that information and communication technologies used in teaching and learning processes are, in fact, computer-related technologies, numerous researchers have been using this theoretical outline to investigate the acceptance and diffusion process of digital technologies in the learning environment.

Concerning e-learning, the use of TAM has been thoroughly documented in the literature (ARBAUGH, 2005; CHENG et al., 2011; HONG et al., 2011; HUANG; YANG; LIAW, 2012; KIRAZ; OZDEMIR, 2006; MARTINS; KELLERMANNS, 2004; PITUCH;LEE, 2006; SANCHEZ-FRANCO, 2010; SUGAR; CRAWLEY; FINE, 2005; TEO; NOYES, 2011; ZAYIM; YILDIRIM; SAKA, 2006). Diversely, regarding m-learning, in spite of the already existing works using the TAM (HUANG; LIN; CHUANG, 2007; LIU; HAN;LI, 2010; LIU; LI; CARLSSON, 2010; LU;VIEHLAND, 2009; PARK, NAM; CHA; 2011; SUKI;SUKI 2011), the research is still incipient and the results inconclusive, for the most part because m-learning is a relatively recent phenomenon and remains little known.

Acceptance of Mobile Learning

Some works have been carried out in order to investigate factors that influence the intention to use m-learning. This section presents some recent studies that verified which constructs influence the intention to use this tool in the teaching process.

Liu, Han and Li (2010) did a wide revision of the literature on TAM and adapted its basic structures to propose a model to evaluate the adoption of m-learning. According to their proposed framework, the adoption of m-learning would be influenced by the perception of mobility (KAIGIN;BASOGLU, 2006; MALLAT et al., 2008) that an individual possesses concerning its use. Among other variables, a construct said to possibly influence the usage decision of m-learning is perceived quality (LIAW, 2008), separated in two

dimensions: perceived content quality and perceived system quality. The model proposed by Liu, Han and Li (2010) was not empirically tested. However, the authors argue that, despite having great potential, the adoption of m-learning services is in general much slower than expected (LIU; HAN; LI, 2010). To them, the adoption of mobile technology is more individual, more personalized and focused on the services made available by the technology. Besides, a m-learning user behaves as a student instead of an employee. Afterward, Suki and Suki (2011) empirically confirmed the positive influence of perceived mobility on the intention to use m-learning.

Huang, Lin and Chuang (2007) extended the TAM and proposed a study with the objective of verifying if it would be possible to foresee the acceptance of m-learning in activities in which the users made use of learning material through mobile devices. The model introduces two external variables to explain the individual differences in use: perceived mobility value (SEPPÄLÄ; ALAMÄKI, 2003) and perceived enjoyment (DAVIS; BAGOZZI; WARSHAW, 1992; TEO;LIM, 1997).

The results corroborate the basic relations observed in TAM. Regarding the newly introduced variables, perceived mobility value and perceived enjoyment were able to predict students' intention to use mobile learning, with perceived enjoyment being the strongest predictor of the model. The authors concluded that users have positive attitudes concerning m-learning, generally seeing m-learning as an efficient tool. On the other hand, Suki and Suki (2011) didn't confirm the positive influence of perceived enjoyment in the intention to use m-learning, presenting conflicting results on which factors indeed influence the adoption of the technology.

In contrast, the model proposed by Liu, Li and Carlsson (2010), also based on the TAM, introduced two new ideas. First, according to Chau (1996), the authors postulated that perceived usefulness should be divided in short and long-term perceptions, each of which were understood to have significant impacts on the intention of using information technologies. Perceived long-term usefulness would reflect future results perceived by the immediate use of the technology, while short term usefulness would evidence immediate results by its use. Secondly, Liu, Li and Carlsson (2010) added personal innovativeness (AGARWAL; PRASAD, 1998) to their model, with the construct being defined as being the individuals' disposition in trying any new information technology. Individuals with higher levels of innovativeness are more prone to develop positive beliefs about innovations, compared to those that possess lower levels. Their results indicated that long andshort-term usefulness and personal innovativeness have significant influence on the intention to adopt m-learning. Personal innovativeness was verified to be a predictor of both perceived ease of use and long term usefulness. In their model, long-term usefulness was the most significant predictor for m-learning acceptance. However, unlike previous studies, ease of use didn't have any effect in the intention to use of m-learning.

To understand the acceptance of m-learning by Korean higher education students, Park, Nam and Cha (2011) adapted the TAM by adding four exogenous variables to its structure: self-efficacy, subject relevance, system accessibility and subjective norm. According to the proposed model, attitude is affected by perceived usefulness, which, in turn, is significantly influenced by perceived ease of use. Attitude toward m-learning was shown to be the most important variable among the endogenous ones in influencing the intention to use the technology. The model presented a good fit and provided a good explanation of the intention to use m-learning. Park,Nam and Cha (2011) credited their results to the addition of social

(subjective norm) and organizational (system accessibility) factors, besides individual (self-efficacy and subject relevance) factors.

Finally, Lu and Viehland (2008) adapted the TAM introducing four external variables: self-efficacy, subjective norms, previous experience with e-learning (NAGY 2005) and the perception of financial resources (MATHIESON, 1991). Previous experience with e-learning entails that the individual with previous experience with electronic learning would be more prone to accept m-learning, while the perception of financial resources indicates the measure in which a person believes to have the financial resources to use an information system. Among these, just previous e-learning experience didn't have influence on the intention to use of m-learning.

Proposed Model

Based on the presented literature, this study proposes an extension of the TAM in order to evaluate the intention to use m-learning as a tool to support traditional face-to-face teaching processes in Brazilian higher education environments. Two external constructs are added to the model: compatibility (MOORE;BENBASAT, 1991; VENKATESH et al., 2003) and self-efficacy (COMPEAU; HIGGINS, 1995; PITUCH; LEE; 2006). Figure 1 describes the proposed model along with the relations between constructs. According to literature review, it is believed that the proposed model is adapted to properly evaluate m-learning in a Brazilian context.

Compatibility represents the degree by which an innovation is perceived to be consistent with one's values, needs and previous experiences. It is believed that this construct is important in the adoption of m-learning, because, in order to be able to perceive advantages in using it as a learning tool, the user must notice its compatibility with the teaching processes he/she is accustomed to, taking into consideration his/her beliefs and values. In contrast, self-efficacy (COMPEAU; HIGGINS, 1995; PITUCH; LEE; 2006) represents a person's judgment about his/her capacity to organize and execute a required course of action to achieve designated types of performance. Still, as described by Bandura (1977), self-efficacy reflects beliefs about the individual's capacity to execute certain tasks with success. Since we stated that m-learning demands more individual autonomy, we propose that self-efficacy is an important construct and positively influences students' intention to use the technology, having already been tested previously and validated for e-learning contexts (PITUCH; LEE, 2006).
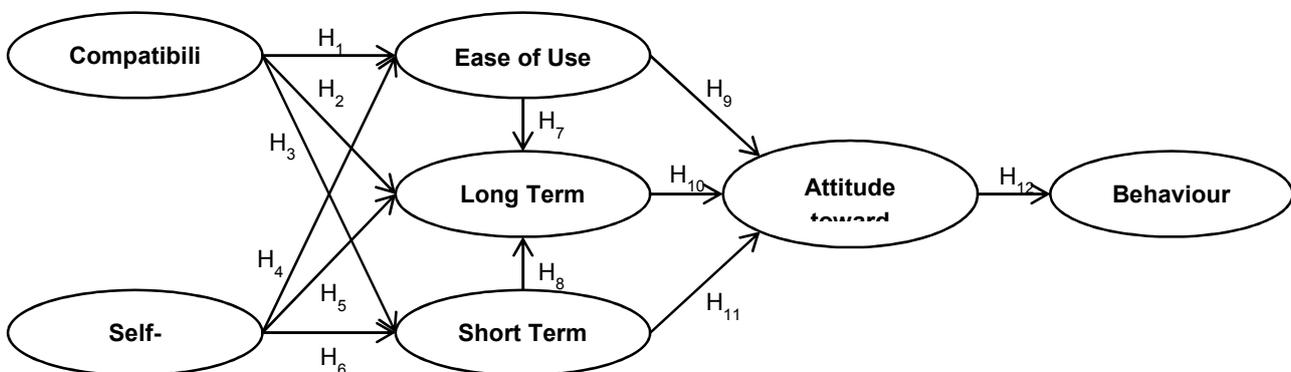
Compatibility and self-efficacy would directly affect perceived ease of use (H1 and H4). Following Chau (1996) and Liu, Li and Carlsson (2010), in the model, perceived usefulness is separated in two components: short and long term (THOMPSON;HIGGINS; HOWELL, 1991). In this sense, compatibility and self-efficacy would directly affect and perceived long/short term usefulness of use (H2, H3, H5 and H6) and, consequently, have indirect effects on students' intention to use m-learning. Finally, as proposed by Cole, Bergin and Whittaker (2008) and Eccles and Wigfield (2002), it is affirmed that if the student notices that the accomplishment of a task in a short term will be useful to assist in some future objective, that helps his/her short term engagement in learning activities, aiming for some important objectives in the long term. As such, short term perceived usefulness would influence long-term usefulness (H8), with the same effect being expected from ease of use (H7). Both long/short term usefulness would then exert positive effects upon students' attitude toward m-learning (H10 and H11), together with ease of use (H9). Attitude, mediating the effects of all other constructs, would in turn directly influence students' intention to use the technology (H12).

METHODOLOGY

To test the hypotheses of this study, a cross-sectional survey (PARASURAMAN; GREWAL; KRISHNAN, 2006) was performed with a non-probabilistic sampling of the population of interest (higher education students). The majority of studies on consumer acceptance of technology have used this same method (CHILDERS et al., 2001; YOUSAFZAI; FOXALL; PALLISTER, 2007), with structured questionnaires being administered to consumers (or students, in the present case).

Operationalization of variables

The scales used in this study to measure all evaluated constructs have been previously developed and tested in the literature, as can be seen next:

- Compatibility: composed of three items (MOORE;BENBASAT, 1991; VENKATESH, et al (2003).
- Self-efficacy: composed of six items (COMPEAU;HIGGINS, 1995). Also present at the studies of Tan and Teo (2000) and Pituch and Lee (2006).
- Perceived Ease Of Use: composed of four items (DAVIS, 1989). Also present at Huang, Lin and Chuang (2007) and Lu and Viehland (2008).
- Perceived Short-Term Utility: composed of three items (LIU; LI; CARLSSON, 2010).
- Perceived Long-Term Utility: composed of four items (LIU; LI; CARLSSON, 2010).
- Attitude Toward Adoption: composed of four items (BAGOZZI; DAVIS; WARSHAW, 1992). Also present at Hu et al. (1999), Huang, Lin and Chuang (2007) and Lu and Viehland (2008).
- Behavioral Intention to Use: composed of 3 items (BAGOZZI; DAVIS; WARSHAW, 1992). Also present Hu et al. (1999) and Huang, Lin and Chuang (2007).

The questionnaire was translated into Portuguese by two English-Portuguese professional translators, with back-translation to English being employed to ensure that the scales in Portuguese were as close as possible to the originals.

Three pretests were conducted with three different small samples of the population to assess respondents' understanding of the questionnaire. The two initial pre-tests results served to fine-tune the questionnaire. The refined version was then subject to a final pre-test, to check for any final adjustment, whether in the translation or in the presentation of the questionnaire. Using the results of this last pre-test, the final research instrument was designed with a total of 27 items measured by seven-point Likert scales and five items related to demographic variables.

Sample and Data Collection Procedures

The study population comprised young Brazilian undergraduate students in Rio de Janeiro. The sample was collected in March 2012 from classes of a private university in Brazil. First, the students were invited to watch a video in which the basic concepts of m-learning. The video was also used in order to show a quick review about current experiences in the use of this technology and how m-learning could be applied as a support to traditional face-to-face education.

After watching the video, questionnaires were passed to the students; the questionnaires were self-administered and completed by the respondents themselves, with further instructions stating that the study only considered smartphones and tablets as mobile devices.

In the end, a sample of 440 respondents was obtained; of these, 27 were eliminated due to missing data, and another 10 were eliminated because they choose not to answer the questionnaire. Thus, the final sample (with no missing data and only participants willing to answer) consisted of 402 valid questionnaires. The average age of the survey participants was 22.8 years old, with a standard deviation of 2.26. Furthermore, 52% of the respondents were male.

In order to test the scales' validity, unidimensionality and reliability, confirmatory factor analysis was performed. Structural Equation Modeling was used to test the proposed model and the research hypotheses.

RESULTS

Measurement Model

Confirmatory factor analysis (CFA) was conducted to test the validity, unidimensionality and reliability of the scales used in the measurement model (FORNELL; LARCKER, 1981; GARVER; MENTZER, 1999). Two sets of measurement models were tested (BOLLEN, 1989), one containing exogenous variables and the other built with the endogenous constructs. For both exogenous and endogenous parts of the model, $\chi 2$ / df. measures were below 3.0, while CFI, IFI and TLI measures were above 0.90 (BYRNE, 2010). RMSEA values were between 0.05 and 0.07, indicating a good fit along with RMR values below 0.08 (HU; BENTLER, 1999).

Based on the measurement model, procedures were performed to test nomological validity (analysis of the correlation matrix between constructs); convergent validity (calculation of Average Variance Extracted [AVE] for each construct); discriminant validity (comparison of the average variance extracted for each construct with shared variance [the square of correlation coefficient] between all pairs of constructs); and, internal consistency, unidimensionality and reliability of the scales used (analysis of alpha coefficients,

composite reliability, and estimated factor loadings). The results obtained for these tests were satisfactory, indicating that the scales used in the measurement model are reliable and thereby allowing the assessment of the proposed relationships by estimates of the structural model.

Structural Model

Structural equation modeling (SEM) was used to test the proposed model and the research hypotheses. In SEM, the significance of the estimated coefficients for the hypothesized relationships in the model indicates whether the relationship between constructs appears to hold true or not (BYRNE, 2010). Most indices indicated good fit of the model to the data. The incremental fit indexes were greater than 0.90, with a CFI of 0.91, a TLI of 0.90, and an IFI of 0.91. On the other hand, the ratio χ^2/df was 3.2, slightly higher than the value of 3.0 suggested by Byrne (2010). In turn, the absolute fit indexes were close to the 0.08 cutoff established in the literature (HU; BENTLER, 1999; Byrne, 2010; Hair et al., 2009), also indicating a reasonable fit of the model. RMSEA was 0.074 (C.I. 0.069 to 0.080) and SRMR was 0.11. Given these indexes, the fit of the proposed model is adequate. Furthermore, it was verified that the model was able to explain 76% of the variance in the attitude towards mobile learning and 89% of the variance in the behavioral intention to use mobile learning, lending strength to the belief that the employed constructs were suitable to characterize the studied phenomenon.

After verifying the fit of the proposed measurement and structural models, estimated path coefficients were obtained for the tested relationships. Verification of each of the research hypotheses was performed with an analysis of magnitude, sign and significance of the standardized path coefficients (BYRNE, 2010). The estimated path coefficients, together with the research hypotheses and associated significance levels, are shown in Table 2. The results and their possible meanings and impacts are discussed in the next section.

TABLE 2 - Hypotheses, Standardized Path Coefficients and Significances

Path	Standardized Path Coefficient	p-value	Hypothesis Verified?
H₁: Compatibility → Ease of Use	0.253	<0.001	yes
H₂: Compatibility → Long Term Usefulness	-0.077	<0.001	no
H₃: Compatibility → Short Term Usefulness	0.808	0.396	no
H₄: Self-Efficacy → Ease of Use	0.850	<0.001	yes
H₅: Self-Efficacy → Long Term Usefulness	0.136	0.324	no
H₆: Self-Efficacy → Short Term Usefulness	0.144	<0.001	yes
H₇: Ease of Use → Long Term Usefulness	-0.258	0.074	no
H₈: Short Term Usefulness → Long Term Usefulness	0.970	<0.001	yes
H₉: Ease of Use → Attitude	0.096	0.029	yes
H₁₀: Long Term Usefulness → Attitude	-0.238	0.020	no
H₁₁: Short Term Usefulness → Attitude	1.132	<0.001	yes
H₁₂: Attitude → Behavioural Intention	0.998	<0.001	yes

Source: Research data

DISCUSSION

The results show short-term usefulness perceived by students in regard to mobile learning as the most important antecedent to their attitude toward the use of mobile technologies for learning (standardized coefficient of 1.132), supporting H11. This result points to the fact that recognizing instant and clear benefits to learning via mobile devices plays a key role in determining whether or not students will develop positive attitudes towards m-learning. This result is in line with previous findings (HUANG; LIN; CHUANG, 2007). This positive attitude, in turn, might lead to a behavioral intention to adopt and use mobile devices as a way to engage in learning activities, as evidenced by the strong significant direct effect found between attitude and intention (0.998) proposed by H12, and also corroborated by previous findings (HUANG; LIN; CHUANG,2007).

Among the evaluated constructs, ease of use was found to have a small significant effect on the attitude toward mobile learning (0.096), indicating that, if the use of mobile learning is perceived as an easy task, students will tend to form slightly more positive attitudes towards it and possibly utilize it more often, supporting H9.

In previous findings, perceived usefulness has been found to exert stronger effects than ease of use (GENTRY; CALANTONE, 2002; O'CASS; FENECH, 2003; VAN DER HEIJDEN, 2003; HUANG; LIN; CHUANG, 2007). In this study, perceived short-term usefulness was stronger than ease of use, which is in line with previous findings, as pointed above. The results indicate that users' perceived short-term usefulness is more important than their perception of ease of use in influencing their attitude of using M-learning. However, it can be noted that perceived long-term usefulness displayed a significant negative direct effects on the attitude toward mobile learning, not supporting H10. This result might be explained by the difficulty that survey respondents usually have in evaluating long-term scenarios and answering accordingly. Similar negative effects were found between long-term usefulness and ease of use (H7; -0.258, non-significant) and between long-term usefulness and compatibility (H2; -0.077, $p < 0.001$), presenting further evidence that the long term uses of mobile learning might not have been well grasped by the sample, or the students could not visualize the long-term benefits of m-learning on their learning objectives. Since the use of mobile devices for learning purposes was still a novelty for the sample, the difficulty in perceiving its usefulness for learning purposes could have influenced this negative result.

Both exogenous constructs of the proposed model, compatibility and self-efficacy, were found to significantly influence perceived ease of use of mobile learning technologies (0.253 and 0.850, respectively). In this research, perceived self-efficacy regarding mobile devices has a positive effect on perceived ease of use for learning purposes. Learners who have higher perceived self-efficacy are likely to have a more positive perception about the ease of use of mobile devices for learning, indicating that the more students feel mobile devices are part of their lives and the more they get used to them, the easier they will find the usage of such technology in a learning context. This result supports H4 and it is in line with previous findings for e-learning (PITUCH; LEE, 2006) and m-learning (JU;SRIPRAPAIPONG; MINH, 2007). Furthermore, the direct effect of self-efficacy on short-term usefulness (H6) was also significant (0.144), pointing towards the fact that students' confidence in the use of mobile learning systems will usually generate greater perceived short-term rewards from such activities. Also, H1 was supported and corroborates previous findings on the

positive effect of compatibility on ease of use. However, compatibility was found to have no significant effect on short-term usefulness, while self-efficacy displayed no significant effect on long-term usefulness, not supporting H3 and H5 respectively.

Finally, short-term usefulness exhibited a strong effect (0.970) on perceived long-term usefulness, supporting H8, and clearly indicating that short-term learning outcomes and rewards influence the long-term view of students in regard to m-learning usefulness. However, this result is not in accordance with previous findings. Liu, Li and Carlsson (2010) found exactly the opposite: perceived long-term usefulness influences positively short-term usefulness. According to them, "students' perception of near-term usefulness is mainly derived from a positive feeling of long-term usefulness" (LIU; LI; CARLSSON, 2010, p. 1216). A possible explanation for the contradictory result found in this research could be drawn from Cole, Bergin and Whittaker (2008) and Eccles and Wigfield (2002), who argue that, if the student perceives that carrying out a task in the short term will be useful to meet some future goal, it will facilitate their engagement in some learning activity in the short term, aiming at a important goal in the long term, even if there is a lack of interest in the learning activity.

CONCLUSIONS

The results and relations encountered in the study represent significant contributions to the theory of technology acceptance and to the research about mobile learning, bringing several implications.

First, the study confirms the importance of several constructs in the understanding of the attitude and intention to adopt mobile learning by higher education students.

Second, it shows that the indirect effects of ease of use, long term usefulness and short term usefulness, mediated by the attitude toward mobile learning, contribute to a good explanation of the behavioral intention to utilize such technology in a higher education setting, corroborating previous results (HUANG; LIN; CHUANG, 2007; LIU; LI; CARLSSON, 2010). The good explanatory power of the proposed model suggests that it employs relevant relations to the assessment of attitude and intention in relation to students' adoption of mobile learning.

Third, the findings also support some indirect influence of compatibility and self-efficacy on a student's intention of utilizing mobile learning. Such effects should therefore be taken into account in future research on mobile learning acceptance.

Finally, an unexpected interesting finding from this study was that the direction of the effect of perceived short-term usefulness on perceived long-term usefulness was contrary to prior research (LIU; LI; CARLSSON, 2010). This must be due to students' difficulties to perceive the long-term utility of using something they are not familiar in the learning environment. As stated, students, in order to positively evaluate m-learning in the long run, need to perceive its usefulness in the short-term, since only then will they continue to use the system. Thus, this issue needs further investigation.

With regard to managerial/educational implications, this study presents several findings that might prove useful for both universities and companies that might want to use mobile technologies as learning tools. For implementers, the findings suggest that, to facilitate the adoption of m-learning, it is important to show students that m-learning as a learning tool is useful in their immediate study activities, emphasizing its

short-term benefits. Students should be well informed about the short-term benefits of using m-learning in an university course, in particular during the introduction phase of such a technology in their curriculum.

LIMITATIONS AND FUTURE RESEARCH

As m-learning is still in its infancy, actual usage behavior was not incorporated in the proposed model. This is not a serious limitation, as there is substantial empirical support for the causal link between intention and actual usage behavior (TAYLOR; TODD, 1995; VENKATESH; DAVIS, 2000; VENKATESH; MORRIS, 2000).

Another important limitation of the study is in regard to the collection and processing of data. Regarding the external validity of the results, because the data reflect only the vision of young Brazilian university students of mid-high class A and B, it is quite possible that relationships found in this study do not apply exactly as presented to other kinds of learners, from C, D and E class, for example.

Regarding the data collection procedure, although effort was made to make it clear what was mobile learning and what was being evaluated (with an explanatory video being shown to the respondents), some respondents might not have had a full understanding of the concept before answering the questionnaires, which might have biased the results. Special attention should be given to the measurement of long term impacts of any technology, since respondents might have a hard time imagining such long term consequences.

Given the limitations outlined above, the replication of the proposed model with students with profiles different from those evaluated in this research would be a good way to validate and expand the scope of the results obtained here. Additionally, well-designed experiments, in which respondents evaluate in more depth the possible uses and meanings of mobile learning, could be a viable alternative to explore how broadly the model's findings can be generalized.

Future research may also explore other scales for the constructs used in the proposed model or constructs that are conceptually similar, comparing results with those obtained here.

Finally, it would be interesting to investigate possible moderating effects that certain demographic variables (e.g. gender, income, age) might have on the relationships observed in the model.

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