Reliability and Validity Study of the Mobile Learning Adoption Scale Developed Based on the Diffusion of Innovations Theory

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Abstract

In this study, a mobile learning adoption scale (MLAS) was developed on the basis of Rogers' (2003) Diffusion of Innovations Theory. The scale that was developed consists of four sections. These sections are as follows: Stages in the innovation-decision process, Types of m-learning decision, Innovativeness level and attributes of m-learning. There is one question at the level of classification regarding the investigated characteristics of the participants in the first three sections of the scale. The last section of the scale is composed of 18 items and 5 sub-dimensions in the 7-item Likert type. MLAS was developed in three stages. In the first stage, a detailed review of literature was performed and an item pool was formed. In the second stage, explanatory factor analysis was performed to determine the factor structure of the scale while confirmatory factor analysis was performed to test whether the factors formed confirmed the theory or not. In the final stage of the study, the reliability of the scale was determined through item, test-retest reliability and internal consistency (Cronbach Alpha) analyses. In conclusion, the scale developed within the scope of this study was shown to yield valid and reliable scores.

Key words: Adoption of m-Learning, Diffusion of Innovations Theory, Scale development.

Introduction

In today's globalized world, the role of technology in the dissemination of information in the fields of formal and informal learning is in an ever increasing state (Male & Pattinson, 2011). With this role, widespread use of technology and constant dissemination of information have paved the way for distance learning, electronic learning (e- learning), and mobile learning (m-learning) (Kuşkonmaz, 2011).

Researchers and educators have a significant role in revealing the use of mobile technologies as a learning tool (Ng & Nicholas, 2012), which is one of the fastest developing areas of technology (Clough, Jones, McAndrew, & Scanlon, 2008). Mobile devices offer learners convenient access to information regardless of time and place. The use of mobile technologies in education helps learners acquire the right content, at the right time and at the right place (Wagner, 2005; Waycott, Jones, & Scanlon, 2005). In addition, the use of mobile devices encourages and supports learning opportunities (Hsu et al., 2006) through relevant forms of access to information (Smordal & Gregory, 2003) and assessment tools for students (Kneebone et al., 2003).

In the literature, m-learning can be defined as learning anywhere and anytime with a mobile device (Attewell, 2005; Geddes, 2004). Traxler (2005) regards m learning as any educational process where dominant technology involves mobile devices, whereas Colazzo et al. (2003) defines m-learning as any teaching and learning activity that can be accomplished via mobile devices.

Owing to their advanced features, mobile technologies make people's life easier (Yılmaz, 2011). With the use of mobile technologies in education, students and teachers can engage in different motivating and interesting activities (Cheon, Lee, & Crooks, 2012). When the relevant literature is examined, the advantages of mobile learning can be listed as follows: It attracts learners' attention, is efficient and effective, saves time and money, increases cooperation among learners, can be implemented through a simple design composed of small and different pieces of information, can be dynamically updated, is personal and allows access to information via different sources (Chen, Kinshuk, Wei, & Yang, 2008; Nassoura, 2012; Özdamar Keskin, 2011; Pinkwert et

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al.,2003; Woodill, 2011). Despite the opportunities mobile technologies offer, it has been argued that the use of mobile devices in the educational process is not at the desired level (Hwang & Tsai, 2011).

A scrutinization of the relevant m-learning literature reveals that many studies have focused on how and why university students adopt m-learning. Technology Acceptance Model, Theory of Reasoned Action and The Theory of Planned Behavior are some of the theories taken as bases in the adoption of m-learning. A large majority of the researchers have investigated the adoption of m-learning within the framework of Technology Acceptance Model (Akour, 2009; Chen & Huang, 2010; Huang et al., 2012; Liu et al., 2010; Mahat et al., 2012; Park et al., 2012; Tan et al., 2012). In these studies, especially perceived usefulness and personal innovation are emphasized as two important factors in the process of adoption of m-learning (Liu et al., 2010; Cheon, 2012). In studies based on Unified Theory of Acceptance and Use of Technology (Venkatesh & Davis, 2000), performance expectancy, effort expectancy, social influence, perceived playfulness and self-management of learning were all significant determinants of behavioural intention to use m-learning (Wang et al., 2009; Nassoura, 2012; Donaldson, 2011). In a study based on Theory of Planned Behavior, on the other hand, (Cheon, 2012), attitude, subjective norm and behavioral control were found to be three major factors in the process of adoption of m-learning.

Technology Acceptance Model, Theory of Reasoned Action, and The Theory of Planned Behavior are all based on social psychology and investigate adoption of innovation usually at the individual level by bringing to the fore internal decision making processes (Fishben & Ajzen, 1975; Ajzen, 1991; Davis, 1989). Diffusion of Innovations Theory, on the other hand, is focused on the features of what is new and investigates diffusion of the innovation within the system (Moore & Benbasat, 1991; Rogers, 2003). Some studies conducted on the basis of technology acceptance models are limited to investigation of user attitudes concerning functionality and nature of m-learning (Benbasat & Barki, 2007). However, m-learning is a totally new learning process (Cheon, 2012) and should be investigated from different perspectives. It is important to regard m-learning as an innovation and reveal factors determining its diffusion across educational settings. When relevant literature is examined, there is currently no study investigating the adoption of m-learning based on Rogers' Diffusion of Innovations Theory.

Theoretical Framework: Diffusion of Innovations

The process of adoption of innovations has been a subject of investigation for more than 30 years and the model Rogers proposed to in his book, entitled Diffusion of Innovations, is one of the most widely adopted models (Li & Sui, 2011; Sherry & Gibson, 2002). Many researchers have argued that the diffusion of innovations theory is the best theory for studies conducted in higher education and educational environments (Medlin, 2001; Parisot, 1995; Sahin, 2006). Rogers (2003) stated that since many diffusion studies include technological diffusion, the words *technology* and *innovation* can be used interchangeably. In the Diffusion of Innovations Theory, the factors affecting diffusion were investigated in terms of individuals' perceptions and how those innovations would diffuse within the social system through communicative processes (Rogers, 2003).

Attributes of innovations

Within the theory, attributes of innovations contain 5 characteristics of innovation. (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability and (5) observability. Relative advantage means the degree to which an innovation is perceived to be better than the idea it supersedes. According to Rogers (2003), the relative advantage can be measured in economic terms, social prestige, convenience and satisfaction. Compatibility indicates the degree of compatibility among the values, past experiences and potential needs of adopters of an innovation. Ease of use (as opposed to complexity), in Rogers's definition, refers to the extent to which an innovation is perceived as easy to understand and use. Agarwal and Prasad (1997) also defined ease of use as the perception by a potential adopter of the use of an innovation as easy. As for triability, it refers to "the degree to which an innovation may be experimented with on a limited basis" (Rogers, 2003, p. 16), meaning that the more an innovation is tried, the faster it is adopted. Finally, observability is the degree to which the results of the use of an innovation can be observed by the adopters.

Types of innovation decision

There are three types of innovation decisions affecting diffusion of innovations in a social structure, which are namely innovation decision made by the individual himself/herself (optional), innovation decision made under the influence of others (collective) and innovation decision made under the influence of an authority (authority)

(Rogers, 2003). In the innovation decision made by the individual himself/herself, decision of adoption or rejection is made independently of the social system. In the innovation decision made under the influence of social system, or environment, (collective), decision of adoption or rejection is made by consensus of members of the system. In the decision of adoption or reject of the innovation made under the pressure of an authority, on the other hand, the decision is made by a group that possesses power, status or technical expertise (Rogers, 2003).

Innovativeness levels

According to Rogers (2003), innovativeness is "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system" (p. 242). Rogers (2003) categorized adopters into five on the basis of innovativeness: innovators, early adopters, early majority, late majority, and laggards.
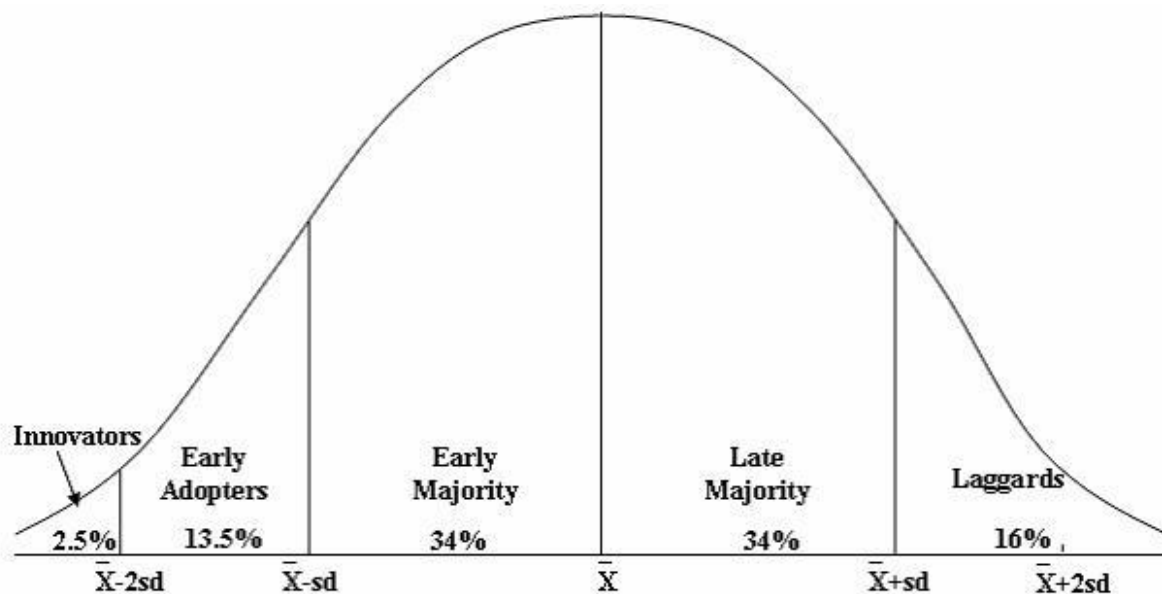
Figure 1. Adopter Categorization on the Basis of Innovativeness

As can be seen in Figure 1, the distribution of adopters is a normal distribution. In his studies, Rogers found that members of a social system were in compliance with the normal distribution. Moreover, Rogers (2003) noted that incomplete adoption and non-adoption do not form this adopter classification. Only adopters of successful innovations generate this curve over time. In this normal distribution, each category is defined using a standardized percentage of respondents.

Innovators take an interest in new ideas and lead cosmopolitan lives far from the norms of the society where they live. Early adopters are better integrated into the social system in comparison with innovators. They adopt new ideas in their initial stages, thereby helping reduce uncertainties in this regard, and convey their subjective judgments about the innovation to their immediate environment through interpersonal communication. The Early Majority's innovation decision process takes longer when compared with innovators and early adopters. They would not like to be either the first one or the last one to try an innovation and they attach importance to the ideas of their inner circle (Rogers, 2003). Late majority, whose most important characteristic is to approach innovations with suspicion, begin the adoption process after a large majority of the society has adopted the innovation. Individuals in this group do not like taking risks and are conservative. Laggards are the last ones in a social system to adopt innovations. As traditionalists, laggards consult with those who have traditional values like themselves.

Stages of innovation-decision process

According to the Diffusion of Innovations Theory (Rogers, 2003), innovation decision process consists of five stages: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation.It is a process that begins with an individual's getting information about the innovation (knowledge), and continues with developing an attitude towards the innovation (persuasion), deciding to adopt or reject the innovation (decision), implementing the innovation (implementation) and confirming the decision to implement the innovation.
Given that mobile technologies are considered innovations that have an impact on the society in general and on educational settings in particular, the Diffusion of Innovations Theory can be used as a framework to further investigate the adoption of mobile devices for learning purposes. Thus, the purpose of this study is to develop a mobile learning adoption scale based on Rogers' Diffusion of Innovations Theory.

Methodology

The m-Learning Adoption Scale (MLAS) is composed of four sections. The first section is intended to reveal the participants' decision stage concerning the adoption of m-learning. The second section of the scale is aimed at revealing the participants' type of decision regarding the adoption of m-learning, whereas the third section aims to determine the features of innovativeness in the adoption of m-learning. The last section of the scale consists of items including the Attributes of m-learning as an innovation as described in the Diffusion of Innovations Theory (Rogers, 2003).

Study Group

The study group is composed of preservice teachers majoring in different departments in the college of education at a university. Four different study groups were formed in order to determine the validity and reliability of the relevant scale. The number of individuals in the group formed for the Explanatory Factor Analysis (EFA) was 205. 95 of the participants in this group were male (46.3 %), whereas 110 were female (53.7 %). On the other hand, the number of participants in the group formed for the Confirmatory Factor Analysis (CFA) was 266. 121 of the participants in this group were male (45.5 %), whereas 145 were female 145 (55.5 %). The group that was formed to determine the test-retest reliability was composed of 59 people. 34 of the participants in this group were male (57.6 %), while 25 were female 25 (42.4 %). Finally, the group that was formed for the linguistic validity of the relevant scale consisted of 32 people. 19 of the group in question were male (59.3 %) whereas 13 were female (41.7 %).

Validity Analyses

Content Validity

In the first three sections of the scale (decision stage, decision type and of innovation), there are questions at the level of classification. There are six choices in the question intended to determine the participants' decision stage regarding adoption of m-learning. 1=knowledge, 2=persuasion, 3=decision (accept or reject), 4=implementation and 5=confirmation. High scores obtained from this section indicate that the person in question is at a higher level at the decision stage. A question with three choices was asked to determine the decision type regarding adoption of m-learning. The choices are, 1=decision based on an authority, 2=decision based on one's environment and 3=individual's own decision. An increase in the scores obtained from this section means an individual's decision to adopt m-learning is independent of authority or environment. There are five choices in the question prepared to determine the participants' characteristics of innovativeness. The relevant choices are: 1=laggards, 2=late majority, 3=early majority, 4= early adopters and 5=innovators. High scores obtained from this section indicate that the individual's innovative characteristic is also high.

In order to develop the last part of the m-learning adoption scale (attributes regarding the adoption of m-learning), a detailed review of literature was conducted within the scope of Rogers' (2003) Diffusion of Innovations Theory. Then, a 32-item draft scale was prepared under 5 factors, namely "Relative Advantages", "Compatibility", "Trialability", "Complexity", and "Observability". The draft form was reviewed by three expert academicians in the field of instructional technology and two expert academicians in the field of curriculum development. In accordance with the feedback and suggestions received concerning the comprehensibility of the items, complexity of the statements and their compliance with the Diffusion of Innovations Theory, the items in the scale were revised and rewritten. 18 items that were approved by at least

four experts were included in the scale. The items in this section are of the 7-point Likert type. The choices in the relevant items range from 1=I totally Disagree to 7=I Totally Agree.

Construct Validity

Factor Analysis can be defined as a multivariate statistic intended to find or discover a limited number of unrelated and conceptually significant new factors or dimensions by bringing together p-numbered interrelated variables (Büyüköztürk, 2012). Factor analysis is divided into two, namely explanatory factor analysis and confirmatory factor analysis. In this study, EFA was conducted in order to determine the factor structure of the first section of the scale. EFA is a factor analysis technique performed to determine the number of latent variables in a scale and the factor structure underlying these variables instead of testing hypotheses (Shur, 2006). Kaiser-Meyer-Olkin (KMO) and Barlett tests were conducted to determine whether factor analysis could be performed on the dataset. Statistical Package for Social Sciences (SPSS) 17.0 was used for EFA, KMO and Barlett tests. Confirmatory Factor Analysis (CFA) was performed in order to determine whether or not the factor structure of the relevant section in the original form could be confirmed. Sümer (2008) defined CFA as an analysis intended to determine to what extent factors formed from various variables deriving from a theoretical basis complied with actual data. Since a model whose factors were derived from a theory was being tested, a confirmatory maximum likelihood factor analysis was perfomed using AMOS 19.0.

Linguistic Validity

The translation-retranslation method, which is recommended in the relevant literature, was performed for the linguistic validation of the scale developed (Kevrekidis et al., 2008; Sahin, 2010). First of all, the scale was translated into English by three academics in the English Language and Literature Department independently of the authors of the study. Then, the English version of the scale was translated back into Turkish by an academic who has a good command of both languages. To give the scale its final form, the two translations were compared and contrasted and necessary changes were made. The English and Turkish versions of the scale were administered to the student teachers attending their senior class in the English Language and Literature Department twice with a three-week interval.

Reliability Analyses

The reliability analysis of the scale developed within the scope of the study was determined through item, test-retest reliability and internal consistency (Cronbach Alpha) analyses.

Item Analysis

Item-total correlation explains the relationship between the scores obtained from the test items and the total score of the test. A positive and high item total correlation indicates that the items exemplify similar behaviors and the internal consistency of the scale is high (Büyüköztürk, 2012). Another way of conducting item analysis is determining the differences between the top 27% and bottom 27% item score averages that emerged as a result of the test total scores using unrelated t test. If the differences between the groups are, as anticipated, significant, then this is an indication of internal consistency of the test (Büyüköztürk, 2012).

Test-Re-Test Reliability Analysis

This is explained through the correlation between the data obtained by administering a test twice to the same group at certain intervals. The degree of the correlation between the two data sets is calculated by using the correlation coefficient. The correlation coefficient is used to interpret to what extent the scores generated by a scale in different times are consistent (Büyüköztürk, 2012; Büyüköztürk et al., 2012).

Internal Consistency (Cronbach Alpha) Analysis

The internal consistency of the six sub-dimensions included in the first section of the scale was investigated using the Cronbach Alpha value. SPSS 17.0 program was used for these calculations.

Findings and Discussion

Findings about participants' m-learning decision types, decision stages and characteristics of innovativeness

The participants' decision stages concerning m-learning is given in Table 1.

Table 1. m-Learning Decision Stage

Sub Dimension		Choice	n	%
Knowledge		I do not have much knowledge about M-learning. I usually see learning applications on mobile devices in people around me.	78	16.5
Persuasion		I think the use of mobile devices in the educational process is beneficial. I am conducting research regarding learning via mobile devices.	97	20.6
Decision	*Adoption*	In the time ahead, I will receive the knowledge I need using the opportunities provided by mobile devices.	74	15.7
	Rejection	I do not think that I will obtain the news I need using mobile devices.	32	6.8
Implementation		I learn the knowledge I need using mobile devices. I use mobile devices in educational activities.	91	19.3
Confirmation		I have realized that learning through mobile devices is beneficial for me. I think mobile devices can be used effectively in educational activities.	99	21

According to Table 1, of the 471 student teachers, 16.5 % (n=78) were at the knowledge stage, 20.6 % (n=97) were at the persuasion stage, 15.7 % (n=74) at the decision/adoption stage, 6.8 % (n=32) were at the decision/rejection stage, 19.3 % (n=91) were at the implementation stage whereas 21 % (n=99) were at the confirmation stage.

The participants' decision types regarding the adoption of m-learning are given in Table 2.

Table 2. m-Learning Decision Type

Sub Dimension	Choice	f	%
Authority	I used m-learning applications under the influence of people in authority. Social pressure was effective in my decision to use m-learning applications. I obtained information about the educational uses of mobile devices due to a demand by an authority (directors or people in authority).	64	13.6
Environment	Since important people around me used mobile devices, I used these devices for the purpose of learning. My friends' using mobile devices encouraged me to use these devices in education. My family supported in my using mobile devices for educational purposes.	188	39.9
Self	Learning the knowledge I need using mobile devices was entirely of my own accord.	214	46.4

When Table 2 is examined, it is seen that of the 471 student teachers, 64 (13.6 %) decided to learn under the influence of an authority, 188 (39.9 %) decided under the influence of social pressure while 214 (44.6 %) decided on their own.

Distribution of 471 student teachers according to their innovativeness is given in Figure 2.
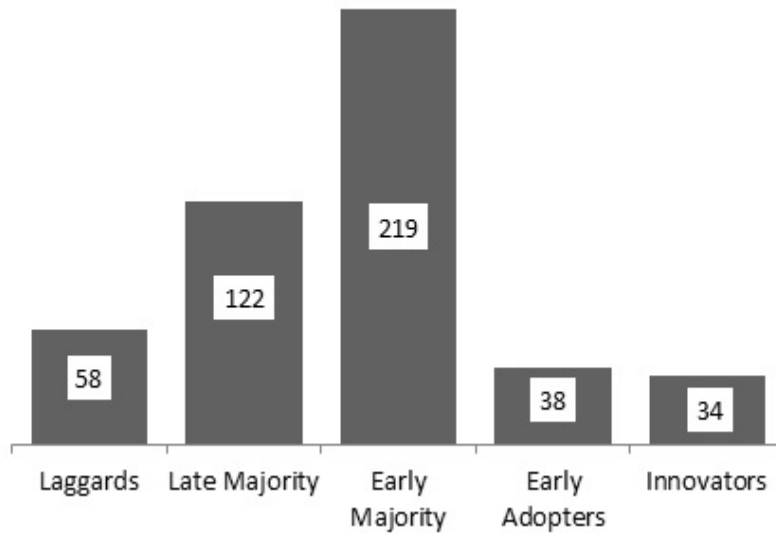

Figure.2. Participants' Innovativeness

When Figure 2 is examined, it is observed that 12.3 % of the participants are Laggards (n=58), 25.9 % are late majority (n=122), 46.5 % are early majority (n=219), 8.1 % are early adopters (n=38) and 7.2 % are innovators (n=34) (Skewness:0.295; Std.Dev:1.02; Kurtusosis:0.06). In the relevant literature, it has been stated that distributions where skewness coefficient is between -1 and +1 are normal distributions (Büyüköztürk, 2012). Participants' innovativeness exhibits a normal distribution as proposed by the Diffusion of Innovations Theory (Rogers, 2003). The groups with the highest percentages according to Rogers' classification are Early Majority and Late Majority (68 %). In the classification of innovativeness regarding m-learning, Early Majority and Late Majority have percentages similar to those in the theory (72.1 %). Moreover, according to Rogers, the group with the lowest percentages in the innovativeness classification involves innovators. In the m-learning innovativeness classification, the group with the lowest percentage is innovators with a share of 7.2 %.

Table 3. m-Learning Innovativeness

Sub Dimension	Choice	f	%
Laggards	I am one of the last to use m-learning applications in my environment / I have not yet used a mobile device to learn new information.	58	12.3
Late Majority	In the learning process, I started to use mobile devices much later than many other people around me.	122	25.6
Early Majority	I was not one of the first to use mobile devices in the learning process but I used them earlier than many others around me.	219	46.5
Early Adopters	When mobile devices were becoming widespread around me, I was one of the first to learn the knowledge I needed using mobile devices.	38	8.1
Innovators	I began to use m-learning applications when those around me did not have any information about these applications and there were not enough mobile devices around.	34	7.2

Findings about Construct Validity

KMO and Barlett tests were conducted to determine whether the data obtained were suitable for making factor analysis. For the data to be suitable for factor analysis, KMO should be above.60, and the Bartlett test should be significant (Büyüköztürk, 2012). According to the data in the study, KMO value was .93 and Bartlett test result

was significant ($\chi2$=6083.7; p<.001). On the basis of these findings, it was concluded that the data were eligible for factor analysis. Principal components analysis technique and varimax rotation method were used in the exploratory factor analysis. As a result of the factor analysis, it was found that 18 items constituted a five-factor structure whose Eigenvalue was greater than 1. Eigenvalues, variance percentages and total variance percentages belonging to the 5 factors that emerged are given in Table 4.

Table 4. Factor Structure of m-Learning Characteristics

Factor	Eigenvalue	Percentage of Variance	Percentage of Total Variance
1	3.99	19.01	19.01
2	3.34	15.92	34.93
3	2.69	12.84	47.77
4	2.56	12.21	59.99
5	1.57	7.50	67.49

When Table 4 is examined, it is seen that the rate of variance each factor explains varies between 7.50 and 19.01, and the total variance explained is around 67.49 %. As a result of the principal components analysis, the emerging factor loadings of the items in the scale are given in Table 5.

Table 5. Item Factor Loads Regarding Adoption of m-Learning

Sub Dimension	Items	Factor Loads				
		1	*2*	*3*	*4*	*5*
Relative Advantage	RA1	0.881				
	RA2	0.913				
	RA3	0.888				
	RA4	0.796				
Compatibility	CM1		0.667			
	CM2		0.769			
	CM3		0.839			
	CM4		0.873			
Trialability	TR1			0.901		
	TR2			0.911		
	TR3			0.512		
Complexity	EU1				0.626	
	EU2				0.890	
	EU3				0.880	
Observability	OB1					0.727
	OB2					0.879
	OB3					0.866
	OB4					0.809

When Table 5 is examined, it is seen that factor loadings of the items in the scale vary between 0.512 and 0.913. In order to test the five-item structure of the scale, which emerged as a result of the exploratory factor analysis and find out to what extent the exploratory model was appropriate (Tabachnick & Fidell, 2007), confirmatory factor analysis was performed on the dataset obtained from 236 participants. As a result of the analysis conducted, goodness of fit indices of the 5-factor model were examined and it was found that chi-square value ($\chi2$=337,534 *sd*= 117, $\chi2$/*sd*=2,89 *p*=0.00) was significant. In confirmatory factor analysis, if the $\chi2$/sd rate obtained is smaller than 3, then this shows that the model has favorable goodness of fit values (Kline, 2005; Tabachnick & Fidell, 2007). In this sense, it was observed that the proposed 5-factor model was highly compatible with the data. When the other indices included in the model were examined, it was seen that GFI value was .92, CFI value was .95, IFI value was .96, RMR value was .05 and RMSEA value was .066. The values obtained for the specified indices are regarded as indicators of good fit values in model studies (Kline, 2005; Tabachnick and Fidell, 2007). The findings indicate that the five factor structure of the scale has been confirmed as a result of the confirmatory factor analysis.

As can be seen from Figure 2, the path coefficients in the model vary between .37 and .90. All of these values are above .30, which is regarded as a breakpoint (Kline, 2005). The path coefficients of the scale vary between

.70 and .81 in the relative advantage dimension, between .50 and .72 in the compatibility dimension, between .70 and .85 in the observability dimension, .37 and .88 in the complexity (simplicity) dimension and between .67 and .85 in the trialibility dimension.
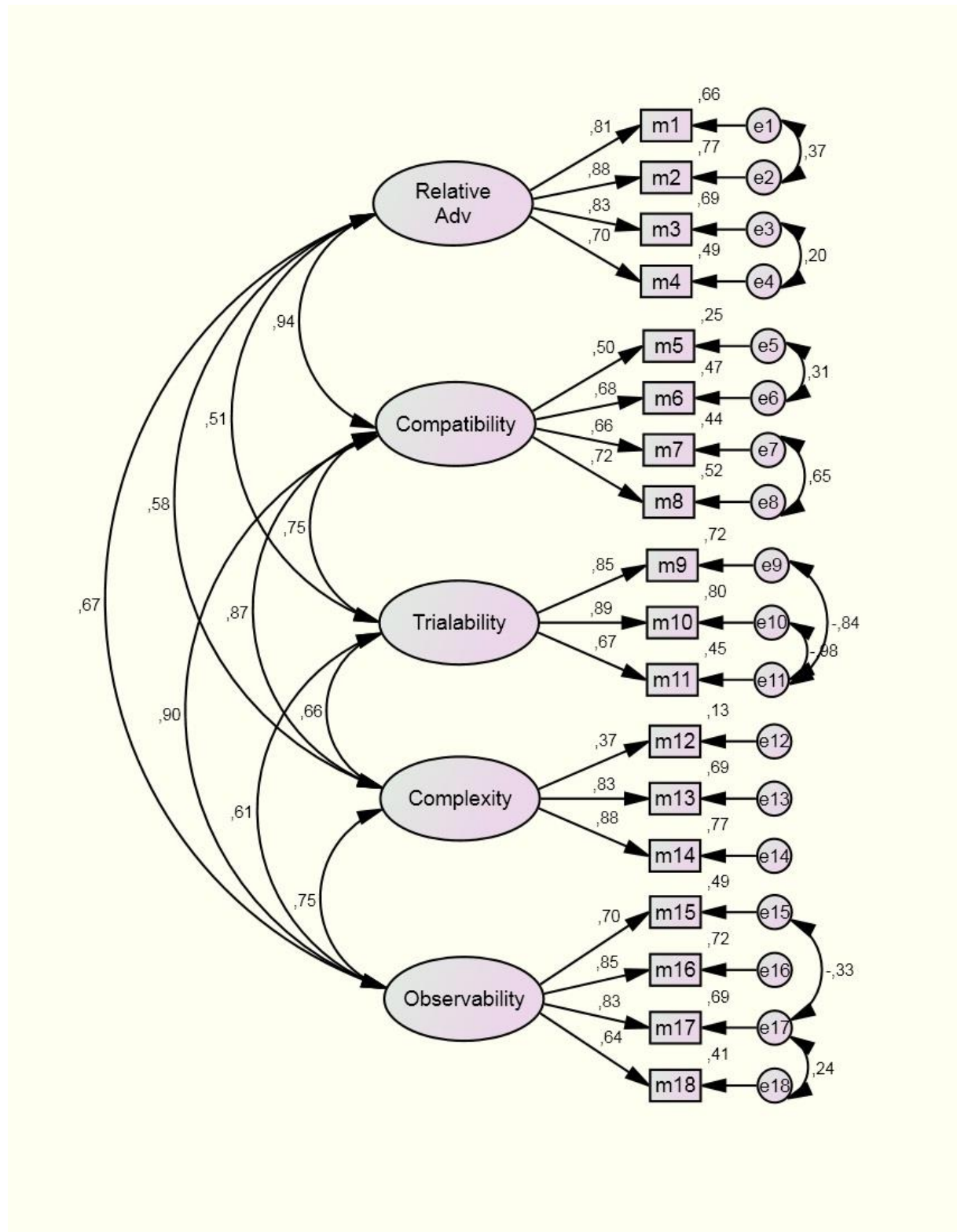

Figure. 3. CFA results of the five-factor model ($\chi2$=451,603 sd= 167, $\chi2$/sd=2,70, p<0.001)

Findings Regarding the Reliability Analysis

Item-total correlation and 27 % top-bottom group comparisons were performed in order to determine the item discrimination of the scale developed. The findings obtained are shown in Table 6.

Table 6. 27 % Top-Bottom Groups Comparison and Item-Total Correlation for Items of m-Learning Characteristics

Items	Item-total correlation	Bottom Group 27 %		Top Group 27 %		Comparison of Top and Bottom Groups
	r	$\bar{X}$	S	$\bar{X}$	S	t
m-LA1	,721	3,33	1,35	6,22	0,98	-18,85**
m-LA2	,774	3,43	1,21	6,35	0,93	-20,78**
m-LA3	,715	3,44	1,23	6,23	1,00	-19,11**
m-LA4	,673	3,81	1,52	6,32	1,06	-14,71**
m-LA5	,543	2,97	1,33	5,22	1,68	-11,42**
m-LA6	,726	3,23	1,30	6,03	1,06	-18,13**
m-LA7	,720	2,93	1,36	6,09	1,12	-19,48**
m-LA8	,777	2,91	1,30	6,32	0,88	-23,66**
m-LA9	,602	3,26	1,53	6,04	1,22	-15,47**
m-LA10	,642	3,32	1,47	6,08	1,23	-15,61**
m-LA11	,541	4,19	1,74	6,16	1,12	-10,36**
m-LA12*	,359	4,54	1,47	5,93	1,68	-6,77**
m-LA13	,715	3,48	1,29	6,33	0,99	-19,02**
m-LA14	,733	3,58	1,30	6,52	0,77	-21,10**
m-LA15	,681	3,18	1,42	5,99	1,30	-15,90**
m-LA16	,747	2,76	1,25	6,08	1,08	-21,87**
m-LA17	,722	2,86	1,16	5,93	1,20	-19,96**
m-LA18	,602	2,82	1,24	5,26	1,53	-13,43**

** p<0.01, *reverse item

When Table 6 is examined, it is seen that t values that were obtained vary between -23.66 and -6.77. It is also observed that the scores derived from each item are significantly correlated with item-total correlation. The Cronbach Alpha internal consistency coefficient of the mobile learning adoption scale calculated on the basis of item analysis was 0.94 for the whole scale. The Cronbach Alpha coefficients calculated for the subdimensions of the scale are as follows: Relative Advantages 0.892; Compatibility, 0.797; Trialability, 0.795; Complexity, 0.725; and Observability 0.839. When the relevant literature is examined, for scales used in research, the level of an acceptable Cronbach's alpha coefficient is suggested as 0.70 (Anastasi, 1982; Tavsancil, 2002; Sahin, 2010). Thus, it can be concluded that all five subdimensions of the scale are reliable.

Findings about the Test-retest Reliability Analysis

In order to further investigate the reliability of the scale through test-retest method, the scale was administered twice to a sample of 59 students at an interval of two weeks. Pearson correlation coefficient between the scores of the two administrations was found to be 0.87 (p<.01). Hence, it is concluded that consistent (decisive) measurements can be made using the adapted scale at different administrations.

Findings about Linguistic Validity

For linguistic validity, the Turkish and English Versions of the scale were administered to a group of 34 people at an interval of three weeks. Pearson correlation coefficient between the scores obtained from these two versions was found to be 0.91 (p<.01). According to this finding, it can be said that the linguistic validity of the English version of the scale was ensured.

Conclusion

In this study, an m-learning adoption scale was developed on the basis of Rogers' (2003) Diffusion of Innovations Theory. The scale consists of four sections. These sections are as follows: Stages in the innovation-decision process, Types of m-learning decision, Innovativeness level and Attributes of m-learning. The last section of the scale is composed of 18 items and 5 sub-dimensions and uses a 7-point Likert type rating scale.

MLAS was developed in three stages. In the first stage, a detailed review of literature was performed and an item pool was formed. An expert in instructional technology was consulted in order to ensure content validity for the items created. The items of the scale were reviewed in accordance with the feedback and suggestions received from the expert. In the second stage, EFA was performed to determine the factor structure of the scale while CFA was performed to test whether the factors confirmed the theory or not. KMO and Barlett's tests were calculated in order to determine whether the data for EFA were eligible for factor analysis or not. KMO value was high and Barlett's test was significant, which indicated that the data were suitable for conducting the factor analysis. At this stage, CFA was performed for the scale using the Maximum Likelihood method. The model formed for CFA seemed to have acceptable goodness of fit indices. As a result of the CFA, it was concluded that the dimensions included in the scale confirmed the structure in Rogers' Diffusion of Innovations Theory.

In the final stage of the study, the reliability of the scale was determined through item, test-retest reliability and internal consistency (Cronbach Alpha) analyses. The fact that the item total correlation for the m-learning adoption scale was positive and high indicated that the items represented similar behaviors and that the internal consistency of the scale was high. Also, 27 % top-bottom groups comparisons were made in order to determine the item discrimination of the scale. The fact that the expected scores between the groups were significant is an indication of the internal consistency of the scale. Thus, it was seen that the scale discriminated the individuals in terms of the attribute measured. Moreover, the high correlation coefficient calculated for the test-retest reliability indicates that consistent measurements can be obtained from the scale in different administrations. In conclusion, the scale developed within the scope of this study was shown to yield valid and reliable scores.

Acknowledgements

References

Agarwal, R., & Prasad, J. (1997). The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. *Decision sciences*, *28*(3), 557-582.

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50*(2), 179-211.

Akour, H. (2009). *Determinants of mobile learning acceptance: an empirical investigation in higher education* (Doctoral dissertation, Oklahoma State University).

Attewell, J. (2005, October). From research and development to mobile learning: Tools for education and training providers and their learners. In *4th World Conference on mLearning* (pp. 1-6).

Benbasat, I., & Barki, H. (2007). Quo vadis, TAM?. *Journal of the Association for Information Systems*, *8*(4).

Büyüköztürk, Ş. (2012). *Veri Analizi El Kitabı* (Onaltıncı baskı). Ankara: PegemA Yayıncılık.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö.E., Karadeniz, Ş., & Demirel, F. (2011). Bilimsel araştırma yöntemleri (12.baskı). Ankara: PegemA Yayıncılık.

Chen, N. S., Wei, C. W., & Yang, S. J. (2008). Designing a Self-contained Group Area Network for Ubiquitous Learning. *Journal of Educational Technology & Society*, *11*(2).

Cheon, J., Lee, S., Crooks, S. M., & Song, J. (2012). An investigation of mobile learning readiness in higher education based on the theory of planned behavior. *Computers & Education*, *59*(3), 1054-1064.

Clough, G., Jones, A. C., McAndrew, P., & Scanlon, E. (2008). Informal learning with PDAs and smartphones. *Journal of Computer Assisted Learning*, *24*(5), 359-371.

Colazzo, L., Ronchetti, M., Trifonova, A., & Molinari, A. (2003). Towards a multi-vendor mobile learning management system. In *World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education* (Vol. 2003, No. 1, pp. 2097-2100).

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

Donaldson, R. L (2011). *Student acceptance of mobile learning. The Florida State University College of Communication & Information* (Doctoral dissertation, The Florida State University).

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*.

Geddes, S. J. (2004). Mobile learning in the 21st century: benefit for learners. *Knowledge Tree e-journal*, *30*(3), 214-228.

Hsu, T. Y., Ke, H. R., & Yang, W. P. (2006). Knowledge-based mobile learning framework for museums. *Electronic Library, The*, *24*(5), 635-648.

Huang, J. H., Lin, Y. R., & Chuang, S. T. (2007). Elucidating user behavior of mobile learning: A perspective of the extended technology acceptance model. *Electronic Library, The*, *25*(5), 585-598.

Hwang, G. J., & Tsai, C. C. (2011). Research trends in mobile and ubiquitous learning: A review of publications in selected journals from 2001 to 2010. *British Journal of Educational Technology*, *42*(4), E65-E70.

Kevrekidis, P., Skapinakis, P., Damigos, D., & Mavreas, V. (2008). Adaptation of the Emotional Contagion Scale (ECS) and gender differences within the Greek cultural context. *Annals of general psychiatry*, *7*(1), 14.

Kline, R. B. (2011). *Principles and practice of structural equation modeling*. Guilford press.

Kneebone, R., Nestel, D., Ratnasothy, J., Kidd, J., & Darzi, A. (2003). The use of handheld computers in scenario-based procedural assessments. *Medical teacher*, *25*(6), 632-642.

Kuşkonmaz H., (2011). *İlköğretim Okullarındaki Öğretmenlerin Mobil Öğrenmeye Yönelik Algı Düzeylerinin Belirlenmesi*. Bahçeşehir Üniversitesi Fen Bilimleri Enstitüsü Bilgi Teknolojileri Bölümü. Yüksek Lisans Tezi

Li, Y., & Sui, M. (2011). Literature Analysis of Innovation Diffusion. *Technology & Investment*, *2*(3).

Liaw, S. S., Hatala, M., & Huang, H. M. (2010). Investigating acceptance toward mobile learning to assist individual knowledge management: Based on activity theory approach. *Computers & Education*, *54*(2), 446-454.

Liaw, S. S., Hatala, M., & Huang, H. M. (2010). Investigating acceptance toward mobile learning to assist individual knowledge management: Based on activity theory approach. *Computers & Education*, *54*(2), 446-454.

Liu, Y., Li, H., & Carlsson, C. (2010). Factors driving the adoption of m-learning: An empirical study. *Computers & Education*, *55*(3), 1211-1219.

Mahat, J., Ayub, A. F. M., & Luan, S. (2012). An Assessment of Students' Mobile Self-Efficacy, Readiness and Personal Innovativeness towards Mobile Learning in Higher Education in Malaysia. *Procedia-Social and Behavioral Sciences*, *64*, 284-290.

Male, G. & Pattinson, C. (2011). Enhancing the quality of e-learning through mobile technology. *Campus-Wide Information Systems 28*(5), 331-344.

Medlin, B. D. (2001). *The factors that may influence a faculty member's decision to adopt electronic technologies in instruction* (Doctoral dissertation, Virginia Polytechnic Institute and State University).

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information systems research*, *2*(3), 192-222.

Nassuora, A. B. (2012). Students acceptance of mobile learning for higher education in Saudi Arabia. *American Academic & Scholarly Research Journal*, *4*(2), 24-30.

Ng, W., & Nicholas, H. (2013). A framework for sustainable mobile learning in schools. *British Journal of Educational Technology*, *44*(5), 695-715.

Özdamar, K. N. (2011). *Akademisyenler için bir mobil öğrenme sisteminin geliştirilmesi ve sınanması, Yayımlanmamış Doktora Tezi*, Eskişehir Anadolu Üniversitesi Eğitim Bilimleri Enstitüsü.

Parisot, A. H. (1995). *Technology and teaching: The adoption and diffusion of technological innovations by a community college faculty* (Doctoral dissertation, Montana State University).

Park, S. Y., Nam, M. W., & Cha, S. B. (2012). University students' behavioral intention to use mobile learning: Evaluating the technology acceptance model. *British Journal of Educational Technology*, *43*(4), 592-605.

Pinkwart, N., Hoppe, H. U., Milrad, M., & Perez, J. (2003). Educational scenarios for cooperative use of Personal Digital Assistants. *Journal of Computer Assisted Learning*, *19*(3), 383-391.

Rogers, E. M. (1983). *Diffusion of innovations*. New York: Free Press.

Rogers, E. M. (2003). *Diffusion of innovations (5th ed.)*. New York: Free Press.

Sahin, I. (2011). Development of Survey of Technological Pedagogical and Content Knowledge (TPACK). *Turkish Online Journal of Educational Technology*, *10*(1).

Sahin, I., & Thompson, A. (2006). Using Rogers' Theory to Interpret Instructional Computer Use by COE Faculty. *Journal of Research on Technology in Education*, *39*(1).

Sherry, L., & Gibson, D. (2002). The path to teacher leadership in educational technology. *Contemporary issues in technology and teacher education*, *2*(2), 178-203.

Smørdal, O., & Gregory, J. (2003). Personal Digital Assistants in medical education and practice. *Journal of Computer Assisted Learning*, *19*(3), 320-329.

Suhr, D. D. (2006). *Exploratory or confirmatory factor analysis?* (pp. 200-31). Cary: SAS Institute.

Tabachnick, B. G., & Fidell, L. S. (2007). *Experimental designs using ANOVA*. Thomson/Brooks/Cole.

Traxler, J. (2007). Defining, Discussing, and Evaluating Mobile Learning: The moving finger writes and having writ…. *International Review of Research in Open & Distance Learning*, *8*(2).

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management science*, *46*(2), 186-204.

Wagner, E. D. (2005). Enabling mobile learning. *EDUCAUSE review*, *40*(3), 41-42.

Wang, Y. S., Wu, M. C., & Wang, H. Y. (2009). Investigating the determinants and age and gender differences in the acceptance of mobile learning. *British Journal of Educational Technology*, *40*(1), 92-118.

Waycott, J., Jones, A., & Scanlon, E. (2005). PDAs as lifelong learning tools: an activity theory based analysis. *Learning, Media and Technology*, *30*(2), 107-130.

Wei-Han Tan, G., Ooi, K. B., Sim, J. J., & Phusavat, K. (2012). Determinants of mobile learning adoption: an empirical analysis. *Journal of Computer Information Systems*, *52*(3).

Woodill, G. (2010). *The mobile learning edge: Tools and technologies for developing your teams*. McGraw Hill Professional.

Yılmaz Y., (2011).Mobil Öğrenmeye Yönelik Lisansüstü Öğrencilerinin Ve Öğretim Elemanlarının Farkındalık Düzeylerinin Araştırılması. *Dokuz Eylül Üniversitesi Eğitim Bilimleri Enstitüsü. Yayınlanmış Yüksek Lisans Tezi*

APPENDIX.1

MOBILE LEARNING (M-LEARNING) ADOPTION SCALE

m-learning Decision Stage	
Please mark the best choice with an X.	**Choice**
I do not have much knowledge about m-learning. I usually see learning applications on mobile devices in people around me.	
I think the use of mobile devices in the educational process is beneficial. I am conducting research regarding learning via mobile devices.	
I will learn the knowledge I need in the future using the opportunities provided by mobile devices.	
I do not think that I will obtain the news I need using mobile devices.	
I learn the knowledge I need using mobile devices. I use mobile devices in educational activities.	
I have realized that learning through mobile devices is beneficial for me. I think mobile devices can be used effectively in educational activities.	

m-Learning Decision Type	
Please mark the best choice with an X.	**Choice**
I used m-learning applications under the influence of people in authority. Social pressure was effective in my decision to use m-learning applications. I obtained information about the educational uses of mobile devices due to a demand by an authority (directors or people in authority).	
Since important people around me used mobile devices, I used these devices for the purpose of learning. My friends' using mobile devices encouraged me to use these devices in education. My family supported in my using mobile devices for educational purposes.	
Learning the knowledge I need using mobile devices was entirely of my own accord.	

m-Learning Attribute of Innovativeness	
Please mark the best choice with an X.	**Choice**
I am one of the last to use m-learning applications in my environment / I have not yet used a mobile device to learn new information.	
In the learning process, I started to use mobile devices much later than many other people around me.	
I was not one of the first to use mobile devices in the learning process but I used them earlier than many others around me.	
When mobile devices were becoming widespread around me, I was one of the first to learn the knowledge I needed using mobile devices.	
I began to use m-learning applications when those around me did not have any information about these applications and there were not enough mobile devices around.	

Mobile Learning (m-Learning) Adoption Attributes							
Specify whether you agree with the following statements or not. 1- means: I totally disagree and 7-means: I totally disagree.	I totally disagree						I totally agree
	1	2	3	4	5	6	7
1. Learning through mobile technologies increases my efficiency.							
2. I find m-learning beneficial							
3. M-learning increases the quality of what I do.							
4. Use of mobile devices contributes to my career.							
5. Use of mobile devices is compatible with my traditional teaching methods.							
6. Use of mobile devices is compatible with my learning preferences.							
7. I possess the knowledge required to use the m-learning method.							
8. I use m-learning effectively with my existing knowledge.							
9. I possess adequate means to try mobile technologies in the educational process.							
10. I can access m-learning applications any time I like.							
11. I first try an m-learning application and then I use it.							
12. It is difficult for me to use m-learning applications.							
13. It is easy for me to use m-learning applications.							
14. It is easy for me to access information I need via mobile devices.							
15. I can observe that use of mobile devices for educational purposes benefits those around me.							
16. I can tell others about the benefits of m-learning.							
17. I share with those around me the applications about the educational uses of mobile devices.							
18. Those around me help each other in regard to m-learning applications.							

APPENDIX.2

MOBİL ÖĞRENME (M-ÖĞRENME) BENİMSEME ÖLÇEĞİ

m-Öğrenme Karar Aşaması	
Lütfen en uygun seçeneği X ile işaretleyiniz.	**Seçenek**
m-öğrenme hakkında fazla bilgim yoktur. Mobil cihazlardaki öğrenme uygulamalarını daha çok çevremdekilerde görürüm.	
Mobil cihazların eğitim-öğretim sürecinde kullanılmasının faydalı olduğunu düşünüyorum. Mobil cihazlarla öğrenme konusunda araştırma yapıyorum.	
İleriki zamanlarda ihtiyacım olan bilgiyi, mobil cihazların sunduğu imkânları kullanarak öğreneceğim.	
Benim için gerekli olan bilgiyi mobil cihazları kullanarak elde edeceğimi düşünmüyorum.	
İhtiyacım olan bilgiyi mobil cihazları kullanarak öğreniyorum. Mobil cihazları eğitim-öğretim faaliyetlerinde kullanıyorum.	
Mobil cihazları kullanarak öğrenmenin bana faydalı olduğunu anladım. Mobil cihazların eğitim-öğretim faaliyetlerinde etkili bir şekilde kullanılabileceğini düşünüyorum.	

m-Öğrenme Karar Türü	
Lütfen en uygun seçeneği X ile işaretleyiniz.	**Seçenek**
m-öğrenme uygulamalarını yetkili kişilerin etkisiyle kullandım. m- öğrenme uygulamalarını kullanımına karar vermemde çevre baskısının etkisi oldu. Mobil cihazların eğitsel kullanımı hakkında otorite (idare veya yetkililer) istediği için bilgi sahibi oldum.	
Çevremdeki önemli insanlar, mobil cihazları kullandıkları için ben de bu cihazları öğrenme amaçlı kullandım. Arkadaşlarımın mobil cihazları kullanması, beni de bu araçları eğitimde kullanmama teşvik etti. Ailem mobil cihazları eğitsel amaçlı kullanmam hususunda beni destekledi.	
Mobil cihazları kullanarak gerekli bilgiyi öğrenmek, tamamen kendi isteğimle olmuştur.	

m-Öğrenme Yenilikçilik Özelliği	
Lütfen en uygun seçeneği X ile işaretleyiniz.	**Seçenek**
Çevremde m-öğrenme uygulamalarını en geç kullanan kişilerdendim/ Henüz yeni bir bilgi öğrenmek için mobil cihaz kullanmadım.	
Öğrenme sürecinde mobil cihazları kullanmaya çevremdeki birçok kişiden sonra başladım.	
Öğrenme sürecinde mobil cihazları ilk kullanan kişilerden değilim; ancak çevremdeki birçok kişiden önce kullandım.	
Çevremde mobil cihazlar yaygın hale gelirken, kendim için gerekli bilgiyi mobil cihazları kullanarak öğrenen ilk kişilerden biriydim.	
m-öğrenme uygulamalarını kullanmaya, çevremdekilerin çoğu bu uygulamalar hakkında bilgi sahibi değilken ve çevremde yeterince mobil cihaz yokken başladım.	

Mobil Öğrenme (M-Öğrenme) Benimseme Özellikleri							
Aşağıda ifadelere katılıp katılmadığınızı belirtiniz. 1-Hiç Katılmıyorum 7-Tamamen Katılıyorum anlamına gelmektedir.	Hiç Katılmıyorum						Tamamen Katılıyorum
	1	2	3	4	5	6	7
1. Mobil teknolojilerle öğrenme, verimliliğimi artırmaktadır.							
2. m-öğrenmeyi faydalı bulurum.							
3. m-öğrenme yaptığım işin kalitesini artırır.							
4. Mobil cihazların kullanılması kariyerime katkı sağlar.							
5. Mobil cihazların kullanılması, alışageldiğim öğrenme yöntemleriyle uyumludur.							
6. Mobil cihazların kullanılması, öğrenme tercihlerimle uyumludur.							
7. m-öğrenme yöntemini kullanmak için gerekli bilgiye sahibim.							
8. Varolan bilgilerimle, m-öğrenmeyi etkin bir şekilde kullanırım.							
9. Eğitim-öğretim sürecinde mobil teknolojileri denemek için yeterli imkânlara sahibim.							
10. m-öğrenme uygulamalarına istediğim zaman erişebilirim.							
11. Bir m-öğrenme uygulamasını öncelikle dener, daha sonra kullanırım.							
12. m-öğrenme uygulamalarını kullanmak benim için zahmetlidir.							
13. m-öğrenme uygulamalarını kullanmak bence kolaydır.							
14. İhtiyacım olan bilgiye mobil cihazlarla ulaşmak benim için kolaydır.							
15. Eğitsel amaçlı mobil teknoloji kullanımının çevremdekilere sağladığı faydaları gözlemleyebiliyorum.							
16. Başkalarına m-öğrenmenin yararlarını anlatabilirim.							
17. Çevremdekilerle mobil teknolojilerin eğitsel kullanımına ilişkin uygulamaları paylaşırım.							
18. Çevremdekiler m-öğrenme uygulamalarıyla ilgili birbirlerine destek olurlar.							