Psychometric Properties of Smartphone Scales: Perspectives of University Students in the Kingdom of Bahrain

Fuad Ali Ahmed EKSAIL
Bahrain Teachers College, University of Bahrain, Zallaq, Kingdom of Bahrain
feksail@uob.edu.bh

ABSTRACT
Many studies have been conducted to investigate the effect of using smartphones in the teaching and learning process. The purpose of the present study was to identify the factor structure and the psychometric properties of a smartphone questionnaire. The questionnaire was translated into Arabic and administered to 203 students at a university in Bahrain. Both exploratory factor analysis and confirmatory factor analysis were used to explore the reliability and factorial validity of the Arabic version of the questionnaire. The results showed that the four-factor structure is appropriate. The findings obtained in this study indicate that the translated version of the smartphone questionnaire can be effectively used in Arabic-speaking countries.
Keywords: Confirmatory factor analysis, Mobile learning, Reliability, Smartphone.

INTRODUCTION
In recent years, technology has affected many aspects of human life, such as health, economy, politics, and educational fields. In education, smart learning is defined as learning that occurs by using mobile phones or wireless devices (Aderinoye et al., 2007). Specifically, the term smart learning or mobile learning is described as the use of smartphones or any handheld devices that are used to communicate with others, exchange information and ideas with different people in different places. Smart devices could be used positively and productively inside the classrooms.

Much research had been constructed to explore and investigate the effect of using smartphones in the teaching and learning process. For example, Melhuish & Falloon (2010) found that the use of smartphones enables learner-centered approaches as well as increases the interaction between the learner and tutor. Additionally, Valk, Rashid, and Elder (2010) stated that mobile learning is not fixed in the classroom times, instead, it could be done any time. Moreover, Hulme and Traxler as cited in Clayton & Murphy (2016) indicated that the use of mobile learning provides diverse opportunities and chances for learners to explore independent investigation.

Research was done by Cheon, Lee, Crooks, and Song as cited in Clayton & Murphy (2016) and specified that mobile learning or smart learning supported the four types of learning including individualized learning, collaborative learning, informal learning, and situated learning. To illustrate, students control their learning pace, which represents individualized learning. In addition, students and teachers easily communicate and interact with each other using smart devices which represent collaborative learning. Also, students learn outside the classroom at their convenience this represents informal learning. Finally, students use their smart devices to learn in a real-life context and in an authentic way and that refers to situated learning.

Kemp (2018) revealed that smartphones enable learners to acquire learning and innovation skills such as critical thinking, creative thinking, communication, and collaboration to a certain degree. To be specific, the use of a smartphone lead students towards being a self-reliant lifelong learner. Also, it allows them to be well prepared for the future. To create new knowledge and innovation, learners must possess the ability to ask and answer important questions, provide a critical review, generate a solution for a problem, communicate and work with others in learning (Trilling & Fadel, 2009). As Trilling and Fadel (2009) mentioned, the process of learning gets easier when learners get quick access to additional resources while they are learning in the classrooms. Accessing information through smartphones encourages meaningful communication between teachers and learners in different ways such as social media, email, and messages.

However, other research disagrees with using a smartphone in the learning and teaching process as it has negative effects. According to (Corbeil & Valdes-corbeil, 2007) using a smartphone in learning can distract students' attention and their learning because it enhances chatting with others online. Although smartphones provide various learning resources to students, it also affects students negatively by distracting their learning process, lowering their academic performance, and developing psychological problems and social problems (Singh & Samah, 2018).

Also, some research mentioned that using smartphones in learning can create a feeling of isolation especially if the student didn't have the opportunity to have a smartphone like the rest of the students which can impact the student's emotions and indirectly will impact academic achievements. More importantly, excessive usage of smartphones can affect students' health. For example, past research has indicated that using mobile phones frequently might increase brain tumors and other brain diseases (Shudong & Higgins, 2005). Also, studies had been shown that mobile phone radiation increases blood pressure (Braune et al. as cited in Shudong & Higgins, 2005). Smartphone offers many functions, but students are more attracted to chatting and searching for new friends through social media and exchanging pictures that seem to be unrelated to their learning (Lee et al., 2014).

Desmal (2017) investigated the impact of using social media such as Instagram, Facebook, Twitter, etc on academic performance among 150 students in three universities in Bahrain. The results revealed that social media has a positive effect on academic performance, and more than half of the students prefer the mobile application, WhatsApp as a social media for their academic purpose. The Gulf Daily News has reported in their 28 August 2021 issue that the Ministry of Education in Bahrain could soon allow students to bring their smartphones and other personal devices to school to optimize their learning. They have therefore set up a pilot project "Bring Your Own Device" being run in 84 government schools. It is against this backdrop, and with the hope that the use of smartphones would enhance students' learning that this study of the use of smartphones in the learning process was undertaken.

The present study explored the validation and factor analysis of a smartphone questionnaire when translated into Arabic language and administered to higher institution students in Bahrain. In addition, the degree of using smartphones by the higher institution was determined.

METHOD

Objective of the study

The objectives of the study were to:

1. Examine the reliability and validity of a smartphone questionnaire in a Bahrain context.
2. Test the factor structure of the smartphone questionnaire from data provided by a sample of Bahrain students.
3. What is the degree of using smartphones among the students in higher institutions in Bahrain through their learning process?

Participants and data collection procedures

The present study was conducted with 203 university students who were randomly selected from a university located in Bahrain. 22 of the participants were preparing for careers in Arts and Science. 67 of the participants were preparing for careers in Business and Finance, and 114 were preparing for careers in Engineering. Of these, 54 (26.6%) were males and 149 (73.4%) were females. Their mean age was 21 years.

Translation

The smartphone questionnaire was initially developed in English and was translated into Arabic using back-translation, verification, and modification methods (Ercikan, 1998). Two independent professional translators from Bahrain translated each item into Arabic and back translated the Arabic version into English.

Instrument

The instrument was divided into two sections. The first section consists of demographic variables such as gender and students' specialization in the college. The second section consists of twenty items that were divided into four categories and were used to identify the degree of using smartphones in the learning process. These categories were 4 items for the presentation of information (PI), 4 items for browsing and searching for information (BSI), 4 items for organizing the work (OW), and 7 items for follow-up and communication (FC). An example of an item from the presentation of information scale is "I follow my grades through smartphone". An example from organizing the work scale is "I organize and arrange for my lectures and tests by smartphone". Also, an example of the follow-up and communication scale is "I communicate with my course professors through the smartphone". The items were constructed using the Likert-scale format and the students responded to the statement in a five-point scale ranging from strongly agree (5), agree (4), not decided (3), disagree (2), and strongly disagree (1). Table 1 shows the construct and the corresponding Items.

Table 1. Constructs and corresponding items

Construct	**Item**
Presentation of information (PI)	
PI1	I follow up my grades through using my smart phone.
PI2	I use my smart phone to do my course evaluations
PI3	I save my courses files on my smart phone
PI4	I use my smart phone to take notes on my lectures.
Browsing & searching for information (BSI)	
BSI1	I exchange messages with my classmates through the smart phone
BSI2	I use my smart phone to search for specific topics.
BSI3	I use smart phone to follow up my assignments.
BSI4	I browse the digital libraries through my smart phone.
Organizing the work (OW)	
OW1	I communicate with my classmates through the social networks by my smart phone.
OW2	I use my smart phone to follow up the university announcements.
OW3	I organize and arrange for my lectures and tests by my smart phone.
OW4	I read and browse my course textbooks [in PDF or word formats] through my mobile.
Follow-up and communication (FC)	
FC1	I use my smartphone to follow up my email communications.
FC2	I follow up urgent messages from the university by my smartphone.
FC3	I communicate with my course professors through the smartphone.
FC4	I hold meetings with my classmates through using smartphone applications.
FC5	I use some smartphone applications to send questions or inquiries to my professors.
FC6	I use smartphone to finish my academic university tasks.
FC7	I use the smartphone to do electronic presentations.

Data Analysis

Descriptive Statistics

The descriptive statistics of the smartphone items are shown in Table 2. All mean scores were greater than 3.00, ranging from 3.41 to 3.65. This indicates an overall positive response to the constructs measured in the study. All the standard deviations (SD) were all less than 1.00, ranging from .80 to .85, indicating that the item scores were around the mean. The data were examined for multivariate normality before assessing the factor structure of the responses as recommended by Tabachnick and Fidell (2019). All the items of the mobile phone showed a skew or kurtosis value less than the cut-offs of the absolute value of 3 or absolute value of 8 respectively, as recommended by Kline (2016), and this supported the univariate normality in the items. Mardia's coefficient (a standard measure of multivariate normality) was 87.63, which, as recommended by Raykov and Marcoulides (2008), was less than p (p + 2), where p is the total number of observed indicators (for this data, p = 19).

Table 2. Descriptive statistics for the constructs

Construct	Mean	Standard deviation	Skewness	Kurtosis
PI	3.41	0.854	-0.402	0.044
BSI	3.65	0.808	-0.664	0.392
OW	3.46	0.798	-0.293	0.234
FC	3.63	0.806	-0.749	0.312

To examine the degree of using smartphones among Bahrain college students in their learning process, the mean was calculated, as well as standard deviation and ranks to the use of smartphones in their learning process for every survey category and the whole survey. Table 3 reports the mean, standard deviation, and rank of using smartphones in presentations for the information category.

Table 3. Mean, standard deviation, and rank of using smart phones in presentations for information category.

Statement number		Statement	Mean	Std. deviation	Rank	Degree of use
3		I save my courses files	2.42	0.804	1	High

		on my smart phone				
4		I use my smart phone to take notes on my lectures.	2.28	0.837	2	Average
1		I follow up my grades through using my smart phone.	2.27	0.784	3	Average
2		I use my smart phone to do my course evaluations	2.25	0.756	4	Average
		Total	2.30	0.575		Average

The above table shows that the degree of using the smartphones in the presentations of information category by Bahrain college students was in the average level where the arithmetic mean of their uses is (2.30) and the standard deviation is (0.575). Moreover, the degree of usage was between average and high, and the arithmetic mean was between (2.25-2.42). Furthermore, the highest rank was at the first statement that said, "I save my courses files on my smartphone", where the arithmetic mean was (2.42) and standard deviation (0.804). This statement showed that Bahrain college students have a high degree of using smartphones in the process of following their grades. The second rank was for the second statement which was "I use my smartphone to take notes on my lectures." which had arithmetic mean equal to (2.28) and standard deviation (0.837). This statement showed that the year-four students in Bahrain college students have a high degree of using smartphones in the process of doing course evaluation.

The third rank which is explained by the statement: "I follow up my grades through using my smartphone." had an arithmetic mean of (2.27) and standard deviation equal to (0.784). This statement showed that Bahrain college students have an average degree of using smartphones in the process of saving course files. The last rank that is for the fourth statement "I use my smartphone to do my course evaluations", had an arithmetic mean (2.25) and standard deviation equal to (0.756). This statement showed that Bahrain college students have an average degree of using smartphones in the process of taking notes during lectures.

Table 4. Mean, standard deviation, and rank of using smart phones in browsing and searching for information category.

Statement number	Statement	Mean	Std. Deviation	Rank	Degree of use
5	I exchange messages with my classmates through the smart phone	2.65	0.653	1	High
7	I use smart phone to follow up my assignments.	2.41	0.801	2	High
6	I use my smart phone to search for specific topics.	2.40	0.781	3	High
8	I browse the digital libraries through my smart phone.	2.37	0.806	4	High
	Total	2.46	0.546		High

Table 4 explains the degree of using the smartphones in the browsing and searching for information category by year-four students was in high level which had an arithmetic mean (2.46) and a standard deviation equal to (0.546). Moreover, the degree of using smartphones ranges between high and average, and the mean was ranging between (2.65-2.37). Furthermore, the highest rank was the second statement that said "I exchange messages with my classmates through smartphone" where the arithmetic mean of it was (2.65) and the standard deviation was (0.653). This statement showed that students in Bahrain colleges have a high degree of using smartphones in the process of exchanging messages with their classmates. The second rank was for the statement which states "I use the smartphone to follow up my assignments" with arithmetic mean equal to (2.41) and a standard deviation (0.801). This statement showed that Bahrain college students have a high degree of using smartphones in the process of following up on assignments.

The third rank was for the first statement which states "I use my smartphone to search for specific topics" where it had arithmetic mean that was (2.40) and a standard deviation equal to (0.781). This statement showed that Bahrain college students have a high degree of using smartphones in the process of searching for information. The last rank was the fourth statement which said "I browse the digital libraries through my smartphone" which had an arithmetic mean of (2.37) and a standard deviation (0.806). This statement showed that students in

Bahrain colleges have a high degree of using smartphones in the process of and surfing and browsing in digital libraries.

Table 5. Mean, standard deviation, and rank of using smart phones in organizing work category in descending order.

Statement number	Statement	Mean	Std. Deviation	Rank	Degree of use
12	I read and browse my course textbooks [in PDF or word formats] through my mobile.	2.42	0.760	High	1
9	I communicate with my classmates through the social networks by my smart phone.	2.41	0.776	High	2
10	I use my smart phone to follow up the university announcements.	2.28	0.840	Average	4
11	I organize and arrange for my lectures and tests by my smart phone.	2.22	0.841	Average	3
	Total	2.33	0.535	-	Average

Table 5 shows the degree of using smartphones by Bahrain college students according to the third section which is the Organization of the work. This table demonstrated that using smartphones in organizing the work has an average degree where was (2.33) and the standard deviation was (0.535). In addition, the survey questions that were under this section ranges between high degree and the average degree of using the smartphones in the process of organizing the work where the arithmetic mean range between (2.44 – 2.22). Furthermore, the first rank was the statement "I read and browse my course textbooks in PDF or word formats] through my mobile" with arithmetic mean that was (2.42) and a standard deviation that was (0.76). This statement showed that Bahrain college students have a high degree of using their smartphones in the process of reading and browsing the course textbook and diverse written materials.

The second rank was the statement "I communicate with my classmates through the social networks by my smartphone" with arithmetic mean that was (2.41) and a standard deviation that was (0.776). This statement showed that students in Bahrain colleges have a high degree of using their smartphones in the process of communicating with their classmates through a social network. The third rank was the statement which states "I use my smartphone to follow up the university announcements" with arithmetic mean that was (2.28) and a standard deviation that was (0.840). this statement showed that students in Bahrain colleges have an average degree of using their smartphones in the process of following the university announcement. The fourth rank was the statement which states "I organize and arrange for my lectures and tests by my smartphone" with arithmetic mean that was (2.22) and a standard deviation that was (0.8411). This statement showed that Bahrain college students have an average degree of using their smartphones in the process of organizing and arranging their lectures and tests.

Table 6. The mean, standard deviation, and rank of using smart phones in follow up and communication category in descending order.

Statement number	Statement	Mean	Std. Deviation	Rank	Degree of use
17	I use some smartphone applications to send questions or inquiries to my professors.	2.56	0.720	1	High
15	I communicate with my course professors through the smartphone.	2.55	0.712	2	High
16	I hold meetings with my classmates through using smartphone applications.	2.54	0.690	3	High
18	I use smartphone to finish my academic university tasks.	2.48	0.753	4	High
13	I use my smartphone to follow up my email communications.	2.36	0.786	5	High
14	I follow up urgent messages from the university by my smartphone.	2.34	0.819	6	High
19	I use the smartphone to do electronic presentations.	2.28	0.823	7	Average
	Total	2.44	0.520		High

Table 6 shows the degree of using the smartphone in the follow-up and communication category by Bahrain college students. It is high since the arithmetic mean was equal to (2.44) with a standard deviation (0.520). The statements below this category were ranging between high and average which could be represented by the arithmetic mean that was ranging between (2.45-2.28). The first rank statement that was statement states "I use a smartphone to finish my academic university duties" which got arithmetic mean equal to (2.56) and a standard

deviation that was (0.720). This statement showed that Bahrain college students have a high degree of using smartphones. The statement which was states "I communicate with my course professors through the smartphone" got arithmetic mean equal to (2.55) and a standard deviation that was (0.712). This statement is showed Bahrain college students have a high degree of using smartphones to communicate with the course professor. The last rank statement stated, "I use the smartphone to do electronic presentations" with an arithmetic mean that was (2.28) and a standard deviation equal to (0.823). This statement showed that students in Bahrain colleges have an average degree of using smartphones.

Table 7. Number of responses, mean of all categories, sum of the arithmetic mean, standard deviation of each category, and the sum of standard deviation of total of each category.

Statement	Mean	Std. Deviation	Degree of use
Total presentation of information	2.30	0.575	Average
Total browsing & searching	2.46	0.546	High
Total organizing work	2.33	0.535	Average
Total follow up and communication	2.44	0.520	High
The average	2.38	0.457	High

Table 7 shows the arithmetic mean and standard deviation of each category regard using the smartphone in the learning process. According to the total presentation of the information category with arithmetic, the mean is equal to 2.3, and a standard deviation is 0.575. The total arithmetic means of using a smartphone in browsing and searching for the information category is 2.46 and the standard deviation is 0.546. The total arithmetic means of using a smartphone in organizing the work category is 2.33 and the standard deviation is 0.535. The total mean of using a smartphone in a follow-up and communication category is 2.44 and the standard deviation is 0.520. The average sum of each category the arithmetic mean is 2.38 and the average standard deviation is 0.457.

Exploratory Approach

Principal axis factoring with oblique rotation was used to examine the validity of the smartphone items used at the college level in Bahrain. The suitability of the data was examined for exploratory factor analysis (EFA) with the Kaiser-Myer-Olkin (KMO) measure of sampling adequacy and the Bartlett test of sphericity. As suggested by Tabachnick and Fidell (2019), criteria for suitability are KMO > 0.8 and a p-value for Bartlett's χ^2 of less than 0.01. Three techniques were used to assist in deciding the number of factors to be retained:

(1) Kaiser's (1974) criterion to retain eigenvalues greater than 1.
(2) Catell's (1966) scree test.
(3) Horn's (1965) parallel analysis.

Although the Kaiser's criterion and the scree test are well known, parallel analysis is not as widely known but according to Hayton, Allen & Scarpello (2004), it is the most accurate criterion to use in the assessment of the number of factors to retain, given that both Kaiser's criterion and Catell's scree test tend to overestimate the number of factors. Using Kaiser's criterion, only factors with an eigenvalue greater than or equal to 1 are retained. The Catell's (1966) scree, however, involves plotting each of the eigenvalues of the factors and checking the plot. The factors above the point where the shape of the curve changes and become horizontal are retained for further analysis (Pallant, 2013).

Parallel analysis, developed by Watkins (2000) is a Monte Carlo simulation technique that assists researchers in deciding the number of factors to retain in Exploratory Factor Analysis (Ledesma & Valero-mora, 2007). Principal axis factoring revealed the presence of seven components with eigenvalues exceeding 1, accounting for a total of 59.48% of the variance. From the results of Catell's scree test and parallel analysis, four components were kept for further analysis. The results showed only four components with eigenvalues exceeding the corresponding criterion values for a randomly generated data matrix of the same size (19 items × 203 respondents).

Confirmatory Approach

The factor structure of the smartphone was examined by confirmatory factor analysis (CFA) using AMOS 27. The model fit was evaluated by Chi-square statistics and fit indices including the Comparative Fit Index (CFI: Bentler, 1990), Tucker-Lewis Index (TLI: Bentler & Bonett, 1980). For both CFI and TLI, a value greater than 0.90 indicates an acceptable fit to the data. A value greater than or equal to 0.95 indicates a good fit (Hu & Bentler, 1999).

The values of RMSEA of 0.05 or less indicate close fit, less than 0.08 indicate a reasonable fit, less than 0.10 indicate a mediocre fit, and greater than 0.10 indicate an unacceptable fit (Brown & Cudeck, 1993). A value of SRMR less than 0.05 indicates a well-fitting model (Byrne, 2010). One of the most common fit indices is Chi-squared statistics (χ^2). As suggested by Hu and Bentler, 1999, χ^2 is strongly dependent on sample size, and so, χ^2/df ratios are presented for each model. As recommended by Byrne (2010), χ^2/df ratios ranging from 2 to 5 are adequate to model fit. Chi-squared change ($\Delta\chi^2$) statistics (Hu & Bentler, 1999) was used to test for differences in fit between the 1-factor and 4-factor models.

FINDINGS

The inter-item correlations between the smartphone items were adequate for factor analysis (KMO = 0.84; Bartlett's χ^2 = 1688.71, $p < 0.001$). Item and factor analyses were conducted to identify those items whose removal would improve the internal consistency reliability and factorial validity of the smartphone scales. Principal axis factoring with oblique rotation was used because one can assume that the scales of the smartphone are somewhat related (Coakes & Ong, 2010). In Table 8, factor analysis reports the structure for the smartphone comprising 19 items in 4 factors and the factor loadings for the sample of 203 students for the smartphone questionnaire. All the 19 items of the smartphone had a loading of at least 0.40 on their a priori scale and no other scale. The percentage of variance for different factors ranged between 6.06% and 36.91%, with the total percentage of variance accounted for by the 19 items being 58.90%.

The largest contribution to variance was for the Factor 1 scale (36.91%). The eigenvalues for different smartphone scales ranged from 1.15 to 7.01. The results for the factor analysis with oblique rotation, reported in Table 3, strongly support the factorial validity of the 19-item, 4-scale, smartphone questionnaire when used in university classes in the Kingdom of Bahrain.

Table 8. Factor loadings, percentage of variance and eigenvalues for the smart phone items

Items	Factor 1	Factor 2	Factor 3	Factor 4
PI1	0.70			
PI2	0.75			
PI3	0.71			
PI4	0.83			
BSI1		0.72		
BSI2		0.70		
BSI3		0.79		
BSI4		0.89		
OW1			0.59	
OW2			0.88	
OW3			0.79	
OW4			0.58	
FC1				0.73
FC2				0.82
FC3				0.83
FC4				0.61
FC5				0.76
FC6				0.59
FC7				0.58
Eigenvalue	7.01	1.72	1.31	1.15
% variance	36.91	9.03	6.90	6.06

Convergent Validity

The convergent validity of the 19 items of the smartphone questionnaire was examined. The results (Table 9) indicate that all the factor loadings of the 19-item smartphone constructs met the minimum requirement of 0.5 suggested by Hair et al. (2010), ranging from 0.58 to 0.89. The composite reliability of each construct indicated that all the four factors exceeded the minimum reliability value of 0.7 as suggested by Fornell and Larcker (1981), ranging from 0.81 to 0.88 (see, Table 9). The average variance extracted (AVE) was more than 0.5, ranging from 0.50 – 0.61 (Hair et al., 1992; Nunnally & Bernstein, 1994).

Table 9. Composite reliability and average variance extracted and inter-correlations of the constructs

Construct	C.R	AVE	Factor 1	Factor 2	Factor 3	Factor 4
PI (Factor 1)	0.84	0.56	**(0.75)**			
BSI (Factor 2)	0.86	0.61	0.60**	**(0.78)**		
OW (Factor 3)	0.81	0.52	0.60**	0.55**	**(0.72)**	
FC (Factor 4)	0.88	0.50	0.64**	0.69**	0.61**	**(0.71)**

**p < 0.01
AVE = Average variance extracted; C.R. = Composite reliability
The bold elements in the main diagonal are the square roots of AVE and the off-diagonal elements are the shared variance.

Discriminant Validity
Discriminant validity was assessed by comparing the square root of the average variance extracted for a given construct and all the other constructs. The discriminant validity was achieved, based on the results in Table 9, where all the AVEs were greater than the inter-construct correlation (Barclay et al., 1995).

Confirmatory factor analysis
Confirmatory factor analysis (CFA) was used to examine two 20-item smart mobile models using AMOS 27, with maximum likelihood procedure as the technique for parameter estimation. The first model tested a four-factor. The second model tested a one-factor model. The fit indices for the four-factor model and the one-factor model are given in Table 10. As reported in Table 10, The 4-factor model obtained an acceptable fit to the data (χ^2 = 200.51, CFI = 0.95, TLI = 0.93, RMSEA = 0.05, SRMR = 0.05). Also, the 1–factor model obtained an unacceptable fit to the data (χ^2 = 266.35, CFI = 0.91, TLI = 0.89, RMSEA = 0.08, SRMR = 0.06). According to Chi-squared change ($\Delta\chi^2$) test, the 4-factor model indicated a statistically better fit than the 1-factor model ($\Delta\chi^2$ = 65.84, df = 8, p < 0.001). Therefore, the four-factor model appears to be a relatively good approximation of the data.

Table 10: Fit indices of the 1-factor and 4-factor models

Fit index	Level of acceptable fit	1-factor model	4-factor model
χ^2	n.s at p > 0 .05	266.35, p < 0.05	200.51, p < 0.05
df		130	122
χ^2/df	< 5	2.05	1.64
CFI	> 0.9	0.91	0.95
TLI	> 0.9	0.89	0.93
RMSEA	< 0.06	0.08	0.05
SRMR	< 0.05	0.06	0.05

Discussion
This study aimed to assess the psychometric properties of smartphones. The reliability and validity of a smartphone questionnaire were assessed. Exploratory factor analysis and internal consistency reliability was used to determine convergent and discriminant validity.

It was determined that the square root of the average variance extracted (AVE) was greater than the inter-construct correlation. Hence, convergent and discriminant validity of the items in the smartphone questionnaire was established. In this study, the results of CFA supported a four-factor solution. This study is significant because it is one of the few studies that has explored the factor structure and psychometric properties of a questionnaire that assesses students' perception of the use of smartphones in learning on an Arab college sample.

Conclusion
The present study has shown that the smartphone questionnaire can be used to determine students' perceptions of using smartphones in learning with high reliability and validity. This study contributes to the existing literature on self-report questionnaires to check students' perceptions of using smartphones in learning.

Recommendations
This study involved only one university in Bahrain. So, future studies can include students from other universities and colleges in Bahrain. Since the study took account of only students, future studies should include professors and instructors to have their perspectives on incorporating smartphones in teaching.

Limitations

This study has some limitations. A relatively small number of students and classes were involved in this study, so the results should not be generalized to other populations in Bahrain. Despite this limitation, a translated smartphone questionnaire has been made available for researchers and educators in Arabic-speaking countries.

REFERENCES

Aderinoye, R., Ojokheta, K. & Olojede, A. (2007). Integrating Mobile Learning into Nomadic Education Programme in Nigeria: Issues and perspectives. *International Review of Research in Open and Distributed Learning*, *8*(2), 1–17. https://doi.org/10.19173/irrodl.v8i2.347

Barclay, D., Higgins, C., Thompson, R. (1995). The partial least squares (PLS) approach to causal modeling: Person computer adoption and uses as an illustration. *Technology Studies, 2,* 285−309.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107,* 238-246. https://doi.org/10.1037/0033-2909.107.2.238

Bentler, P. M. and Bonett, D. G. (1980), "Significance tests and goodness of fit in the analysis of covariance structures", *Psychological Bulletin*, *88*(1), 588-606. https://doi.org/10.1037/0033-2909.88.3.588

Brown, M. W. and Cudeck, R. (1993), "Alternative ways of assessing model fit", in Bollen, K. A. and Long, J. S. (Eds.), *Testing Structural Equation Models*. Newbury Park, CA, Sage, pp. 136–162.

Byrne, B. M. (2010), *Structural equation modeling with AMOS: Basic concepts, applications, and programming,* Routledge, New York, NY.

Clayton, K. and Murphy, A. (2016), "Smartphone Apps in Education: Students Create Videos to Teach (Smartphone Use as Tool for Learning)", *Journal of Media Literacy Education*, *8*(2), 99-109. https://doi.org/10.23860/jmle-8-2-5

Coakes, S., and Ong, C. (2010), "*SPSS: Analysis without anguish using SPSS version 18.0 for Windows*", John Wiley, Milton, Queensland.

Corbeil, J. and Valdes-corbeil, M. (2007), "Are You Ready for Mobile Learning?", *Educause Quarterly*, *4*(2), 51-58. https://doi.org/10.1504/IJMLO.2008.018717

Desmal, A. J. M. (2017), "The impact of using social media and internet on academic performance: case study Bahrain universities", *European Alliance for innovations*, *4*(13), 1–12. https://doi.org/10.4108/eai.28-6-2017.152748

Ercikan, K. (1998), "Translation effects in international assessments", *International Journal of Educational Research*, *29*(1), 543−553. https://doi.org/10.1016/S0883-0355(98)00047-0

Fornell, C. and Larcker, D. F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, *18*(1), 39−50. https://doi.org/10.1177/002224378101800104

Hair, J. T., Anderson, R. E., Tatham, R. L. and Black, W. C. (1992), *Multivariate data analysis with readings*, 3rd ed., Macmillan, New York, NY.

Hair, J. R., Black, J. E., Babin, W. C., Babin, B. J. and Anderson, R. E. (2010), *Multivariate data analysis*, 7th ed., Prentice-Hall, New Jersey.

Hayton, J. C., Allen, D. G. and Scarpello, V. (2004)' "Factor retention decisions in exploratory factor analysis: A tutorial on Parallel Analysis", *Organizational Research Methods*, 7(1), 191–205. https://doi.org/10.1177/1094428104263675

Horn, J. L. (1965), "A rationale and test for the number of factors in factor analysis", *Psychometrika*, 30(1), 179–185. https://doi.org/10.1007/BF02289447

Hu, L.T. and Bentler, P. M. (1999), "Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives", *Structural Equation Modeling,* 6(1), 1–55. https://doi.org/10.1080/10705519909540118

Kaiser, H. (1974), "An index of factorial simplicity", *Psychometrika,* 39(1), 31–36. https://doi.org/10.1007/BF02291575

Kemp, S. (2018), "Digital in 2018: World's Internet Users Pass the 4 billion mark", in We are social (2018). Available via https://wearesocial.com/blog/2018/01/global-digital-report-2018. Accessed 21 September 2021.

Kline, R. B. (2016), *Principles and practices of structural equation modelling*, 4th ed., Guilford Press, New York, NY.

Melhuish, K. and Falloon, G. (2010), "Looking to the future: M-learning with the iPad", *Computers in New Zealand Schools*, 22(3), 1-16.

Nunnally, J. C. and Bernstein, I. H. (1994), *Psychometric theory*, 3rd ed., McGraw-Hill, New York, NY.

Pallant, J. (2013), *SPSS survival manual: A step-by-step guide to data analysis using SPSS,* 5th ed., McGraw-Hill, New York, NY.

Raykov, T. and Marcoulides, G. A. (2008), *An introduction to applied multivariate analysis,* Taylor and Francis, New York, NY.

https://doi.org/10.4324/9780203809532

Shudong, Higgins, M. (2005). Limitations of mobile phone learning. International Workshop on Wireless and Mobile Technologies in Education,7(6). Retrieved 30 December 2018, from https://ieeexplore.ieee.org/document/1579260

https://doi.org/10.1109/WMTE.2005.43

Singh, M. K. K. and Samah, N. A. (2018), "Impact of Smartphone: A Review on Positive and Negative Effects on Students", *Asian Social Science*, 14(11), 83-89.

https://doi.org/10.5539/ass.v14n11p83

Tabachnick, B. G. and Fidell, L. S. (2019), *Using multivariate statistics*, 7th ed., Pearson Education, New York, NY.

Trilling, B. and Fadel, C. (2009), *21st Century Skills: Learning for Life in Our Times*. John Wiley & Sons, San Francisco, CA.

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

https://doi.org/10.1111/j.1467-8535.2007.00809.x

Watkins, M. W. (2000), *Monte Carlo PCA for parallel analysis* [computer software]. State College, Ed & Psych Associates, PA.

Valk, J., Rashid, A. and Elder, L. (2010), "Using Mobile Phones to Improve Educational Outcomes: An Analysis of Evidence from Asia", *International Review of Research in Open and Distance Learning*, 11(1), 118-140. https://doi.org/10.19173/irrodl.v11i1.794