Research Article

SAS-SV Smartphone Addiction Scale in Mexican University Students

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Objective. The aim of this work was to validate the statistical significance and unidimensionality of the construct formed by the variables of the revised and short version of the Smartphone Addiction Scale (SAS-SV), adapted into Spanish, when applied to Mexican university students. *Method.* The questionnaires were administered to 244 students of Bachelor's Degree in Administration of the Universidad Autónoma de San Luis Potosí, Mexico; 174 women and 70 men, aged 17 to 30 years, between August and December 2018. A confirmatory factor analysis was performed, and the parameters of the variables were checked by maximum likelihood and also by Bayesian analysis. The reliability of the instrument was verified through Cronbach's alpha. As a final analysis, estimates of nonstandardized weights for the maximum likelihood method were compared against Bayesian a posteriori distribution estimates. *Results.* As a result, the model was found to adequately describe the sample data, presenting very small standard error estimates, and it was validated with Cronbach's alpha of 0.885. In both Bayesian and maximum likelihood analysis, it is consistently evident that the construct is unidimensional. However, for the sample studied, it was observed that 3 of the variables did not reach a significant weight for the model. *Conclusion.* It concludes that the variables that measure smartphone addiction on the SAS-SV scale adapted to Spanish, indeed, form a unidimensional construct when applied to Mexican university students, which is consistent with results from previous studies. However, it is identified necessary to conduct further studies, in order to explain the low significance obtained for 3 variables of the model.

1. Introduction

The emergence and mass adoption of information and communication technologies has led to a transformation of social coexistence. Accelerated technological innovation imposes new challenges of adaptation on people, as their relationship with the world is constantly changing. From this, there are changes in human behavior, among which arise the so-called technological addictions, related to the use of the Internet, mobile phone, video games, and social networks [1].

There is a high level of mobile phone addiction among college students, who show a strong interest in having smartphones. This condition has been encouraged by competition among phone companies to offer low-priced devices [2, 3]. This matches with what Lipscomb observed and with Head and Ziolkowski [4], who claim that mobile telephony has a notable presence among young people, mainly in the segment of university students. They are characterized by keenly following technological advances, acquiring new models to discard their current devices, regardless of whether they benefit or not.

Studying the problem of cell phone addiction in higher-level students is paramount in universities, as it is frequently observed in classrooms more students focused on their phones than on the class, affecting their academic performance adversely [5].

In order to identify this type of addiction, various tests have been developed, such as the revised and short version of the smartphone addiction scale (SAS-SV) developed by

Kwon et al. [6] and then adapted into Spanish by López-Fernández [7]. This adaptation was validated in Spain, showing that its variables make up a unidimensional structure.

Hence, the questions that give rise to this study arise: Are the variables contemplated by the SAS-SV equally applicable to identifying smartphone addiction in Mexican university students? Is its unidimensional structure preserved in this case?

2. Current State of Cellular Telephony

The sale of smartphones has increased in recent years. Cooper [8] shows the results reported by Canalys Research, which indicate that more smartphones than computers were sold in 2011. This information gives an account of the magnitude of this phenomenon.

In Mexico, the National Survey on the Availability and Use of Information Technologies in Homes 2017 [9] reported than 72.2% of Mexicans over 6 years of age have a mobile phone, which they also use to carry out various activities, such as reviewing social networks, listening to music, and browsing the Internet. Of the total number of smartphone users in Mexico, 65% report actively browsing, with an average browsing time per day of 5 hours and 32 minutes.

The same survey revealed that smartphone usage increased from 60.6 million to 64.7 million between 2016 and 2017, and the number of users connecting to the Internet from a smart phone grew from 89% to 92% in the same period. Of the smartphone users, during that year, 36.4 million installed applications on their phones: 92.1% instant messaging, 79.8% social network tools, 69.7% audio and video content applications, and 16.0% mobile banking.

2.1. Cell Phone Use. According to Organista-Sandoval et al. [8], students have adopted the smartphone as a common tool in their academic activities, mainly for the opportunity to communicate with colleagues or teachers, as well as for the search and consultation of information.

By exploring the educational and social use of smartphones in Spanish and Hispanic American universities, Vázquez-Cano and Sevillano García [10] found that university students, in general, use these devices primarily for exchanging academic information, coordination of group work, and consultation of university services and that Hispanic American students most often use their smartphones for educational purposes outside the campus.

Research based on 244 Mexican upper-middle-level students, between 17 and 26 years of age, found that 95.4% use the cell phone and that the number of calls made per day ranges from 1 to 5, for 63.5% of respondents [11].

In the area of Tampico, in the state of Tamaulipas, Mexico, Treviño Espinosa and Millán Orozco [12] observed that smartphones have a growing dominance in the social environment of university students, but they highlight that one of the reasons for use is as a precautionary and alert tool, due to the social insecurity environment in that region.

In another Mexican study, conducted by Organista-Sandoval, et al. [8], based on 954 students and 246 teachers from the total population of the two campuses of the Universidad Autónoma de Baja California in Ensenada, it was observed that 96% of students and 97% of teachers have, at least, one cell phone and that 53% of students and 63% of teachers own a smartphone. They also reported that students very often use their smartphones for applications related to music, games, videos and social media programs such as Facebook.

As observed by Álvarez [11], 50.8% of students declare to return by their cell phone when they have forgotten to bring it with them; 23% wait until they have to return to the place where they left off; 19.4% ask for another cell phone if they need to make a call, and only 4.5% use a pay phone.

Flores, et al. [13] state that the cell phone is not only regarded as a technological device but also has become a personal and social object, as it provides identity and is subject to the influence of fashion. Young people overuse the cell phone, accusing dependence, due to the different applications offered by smartphones, and especially because they can access the Internet. This reinforces that pointed out by Abojedi [2], who warned that the likelihood of cell phone addiction increases when students spend much of their time on it.

About this, in Mexico, Pérez Caballero and Solís Centeno [14] found that 12.6% of students at the School of Psychology of the Universidad Autónoma de Nuevo León (UANL) had high levels in cell phone use.

Regarding the implications, there are people who become depressed when they are deprived of cell phone use for some time; hence, this becomes an addictive object [15]. On this subject, Criado (cited by [13]) points out that the cell phone changes the behavior of young people because when they forget or misplace it, their mood changes; some feel anxious, some insecure, or do not feel like able to do any activity until they have their phone again. For its part, Griffiths [16] notes that any rewarding activity is potentially addictive, but only those marked by social disapproval for their associated risks are considered "addictions" and not mere habits. In the case of mobile phones, the reasons for their addictive consideration relate mainly to the hatching in the private sphere of children and adolescents, the time and attention used by these populations in the use of mobiles, the replacement of other activities, and loss of control (p. 140).

Parenthetically, Muñoz-Rivas and Agustín [17] propose that the concept of addiction by the excessive use of the mobile phone can be expressed as "*the inability to control or interrupt its use by blocking calls or quota, disconnecting the sound, or turning off the terminal*" (p. 302). However, other authors do not agree that overuse generates dependence [18].

On the other hand, López-Fernández [7] found that users of the cell phone use it in an inappropriate way, which can develop dependence, thus producing negative consequences in their interpersonal relationships. Additionally, such users may be negatively affected in their ability to perform tasks, due to the need to constantly verify notifications on the cell phone.

The study conducted by the Carphone Warehouse and London Economic School of Economical and Political Science [19] analyzed cell phone use in three areas: society, family, and interpersonal and labor relations. The results showed that 9% of respondents between the ages of 18 and 24 admitted to being addicted to their cell phones, preferring the phone to television.

Conversely, a study of 144 students from 19 years of public high schools in Catania, Italy, found that students are spending more and more time in front of the smartphone and the Internet, mainly to communicate with others through messages, social networks, and calls, because they have found on these devices a more accessible, easy means of communication, as well as free of anxiety and fear. The study also revealed that women do not suffer from smartphone addiction, unlike their male counterpart which shows significant addiction [20]. The latter differs from that published by Ruiz Olivares et al. [17], who, five years earlier, found that it is women who send the most messages and spend more time talking on a cell phone.

In this regard, Aljomaa et al. [3] reported that of 416 undergraduate, master's, and doctoral students at King Saud University, 48% were shown to be cell phone addicts, with undergraduate students with the highest level of addiction. In the same vein, López-Fernández [7] measured the prevalence of potential excessive use of smartphones in students in Spain (12.5%) and Belgium (21.5%) and found that, at least, 60% of addicted users showed symptoms of withdrawal and tolerance. These data suggest that young people are very sensitive to social pressure and are perceived as this way. Carbonell et al. [21] explain that, for this reason, some persons consider themselves addicts to cell phone; they also point out that they never leave home without it, they do not turn it off at night, they are always waiting for calls from family or friends, and they overuse it in their work or social life.

2.2. Mobile Phone Addiction Issues.
Improper and uncontrolled use of cellular telephones can cause behavioral, affective, and social problems. In addition, it presents withdrawal symptoms, lack of control, and problems arising from its use, as well as tolerance and interference with other activities. These elements correspond to those recognized by the Diagnostic and Statistical Manual of Mental Disorders as factors of addictive disorder [22].

In addition, the excessive use of smartphones can affect forms of interaction and social relationship, with adverse effects such as isolation, impact on family relationships, problems in forms of expression, and changes in leisure activities [23]. However, not all students agree that excessive cell phone use can create dependence [18].

The use of the cell phone may modify behaviors related to sociability, self-confidence, fun, social status, mobility, permanent access, identity, family reconciliation, and individualization of goods. However, although a nonaddicted user may spend the same amount of time on the cell phone as an addicted user, their manifestations are different, since the time of the nonaddicted user is constant, more focused on specific tasks and less dispersed [24].

Sánchez-Carbonell et al. [18] consider it inappropriate to recognize the existence of cellphone addiction and ponder that the most appropriate term is "abuse," as it is a phenomenon that leads to rapid emotional changes and alternation of false identities, in the likeness of what happens when the medium used is the Internet.

2.3. Characteristics of Maximum Likelihood and Bayesian Methods.
Volinsky and Raftery [25] point out the importance of identifying criteria for selecting a statistical model and mention that the most commonly used model selection criteria are Akaike information criteria (AIC) and Bayesian information criterion (BIC). The information criteria are based on the principle of parsimony, so that they assess the likelihood of the model based on its goodness of fit to the data and its complexity [26].

Akaike's information criterion is a measure of the goodness of fit of a statistical model and describes the relationship between bias and variance in model construction. The AIC is not a test of the model, but a means of comparing models given a data set. Several candidate models can be classified according to their AIC value, better considered the model that has the minimum value. The selection of models is usually based on differences in the information criterion (AIC) between comparable models. As a guideline rule, ΔAIC >2 is used to consider that there is empirical support for the most complex model [26], and the inference of multiple models allows to calculate the mean of all of them when there is no clear empirical support grade for a model [27].

The Bayesian Information Criterion (BIC) makes explicit use of probability to quantify inference uncertainty. It is an iterative learning process in which conclusions are reached about a phenomenon (probability a posteriori) from prior knowledge about the system (probability a priori) and new evidence (information from the data). That is, the results of a new study could be used to update knowledge about the system and include it in subsequent studies [26].

The Bayesian statistic is based on specifying a probability model $f(x)$ for the observed data, x, given an unknown value parameter vector θ. Bayes's theorem states that $\pi(\theta|x)\alpha f(x|\theta) \cdot \pi(\theta|\eta)$, where $f(x|\theta)$ is the conditional probability of having obtained the x data if θ had been the true state of nature [28].

Mesa Páez et al. [29] highlight that this method allows adjusting complex models, as well as achieve more accurate estimates of parameters, when the sample size is small, and, in addition, the interpretation of the results is easy and direct, since they indicate the probability that a parameter takes a certain value. Uncertainty measures, lost data, and different levels of variability may also be included; it allows error propagation, as well as to specify the distributions of the parameters (dependent, in turn, on other parameters) when a priori it is known how they are distributed (priors), and minimizes the use of arbitrary limits to make decisions.

TABLE 1: Analysis of the items of the smartphone addiction scale.

Variables	Mean = 3.13 S.D. = 1.456		Sample = 244 Cronbach's alpha = 0.885	
	Mean	S.D.	Total correlation	Cronbach's alpha if item deleted
1. Missing planned work	2.89	1.409	0.564	0.878
2. Concentration	3.05	1.407	0.645	0.872
3. Pain	2.65	1.366	0.508	0.882
4. Need to have	3.08	1.440	0.652	0.872
5. Impatient and fretful	2.89	1.556	0.703	0.868
6. Always in mind	3.12	1.552	0.680	0.870
7. Daily life affected	3.38	1.420	0.711	0.868
8. Constantly checking	3.67	1.451	0.605	0.875
9. Using long time	3.62	1.387	0.634	0.873
10. Surrounding people	2.96	1.569	0.488	0.884

Source: own.

TABLE 2: Maximum likelihood estimators.

Regression weights			Estimate	S.E.	C.R.	p	Standardized regression weights
SP2	<---	$F1$	1.000				0.678
SP4	<---	$F1$	1.055	0.113	9.302	* * *	0.699
SP6	<---	$F1$	1.107	0.122	9.094	* * *	0.681
SP7	<---	$F1$	1.147	0.114	10.065	* * *	0.771
SP8	<---	$F1$	1.007	0.113	8.882	* * *	0.662
SP9	<---	$F1$	1.040	0.110	9.486	* * *	0.716
SP1	<---	$F1$	0.853	0.092	9.270	* * *	0.578
Intercepts							
SP2			3.050	0.091	33.439	* * *	
SP4			3.080	0.093	32.994	* * *	
SP6			3.118	0.101	30.994	* * *	
SP7			3.382	0.092	36.734	* * *	
SP8			3.668	0.094	39.007	* * *	
SP9			3.622	0.090	40.283	* * *	
SP1			2.895	0.091	31.702	* * *	
Covariances							
$e2$	<-->	$e1$	0.332	0.093	3.575	* * *	
Variances							
$F1$			0.908	0.164	5.547	* * *	
$e2$			1.064	0.114	9.305	* * *	
$e4$			1.055	0.115	9.174	* * *	
$e6$			1.286	0.138	9.342	* * *	
$e7$			0.815	0.099	8.249	* * *	
$e8$			1.176	0.124	9.491	* * *	

Source: own.

3. Method

This study was designed to verify whether the variables of the revised and short version of the Smartphone Addiction Scale (SAS-SV) form a unidimensional structure when applied in Mexican university students.

Specifically, the SAS-SV scale, validated in Korea by Kwon et al. [6] was studied to identify the level of risk of cell phone addiction and distinguish the high-risk group in adolescents, in its adaptation to Spanish by López-Fernández [7]. The questionnaire includes 10 questions for each item, and each question asks the participants to express their opinion on a 6-point scale, ranging from 1 (strongly disagree) to 6 (strongly agree). The scale differentiates between men and women. Men are considered addicted if they score more than 31 points, while between 22 and 31, high risk is inferred. Women, meanwhile, are considered addicts for scores above 33 and at high risk between 22 and 33.

The study was conducted in Mexico, with students of Bachelor's Degree in Administration of the Universidad Autónoma de San Luis Potosí, city of Rioverde, S.L.P., during the semester August-December 2018. The questionnaire was applied to 244 students, 28.7% male and 71.3% female, whose ages ranged from 17 to 30 years.

A confirmatory factor analysis was performed using IBM SPSS Amos software (version 23.0), and variable parameters

TABLE 3: Goodness-of-fit indices.

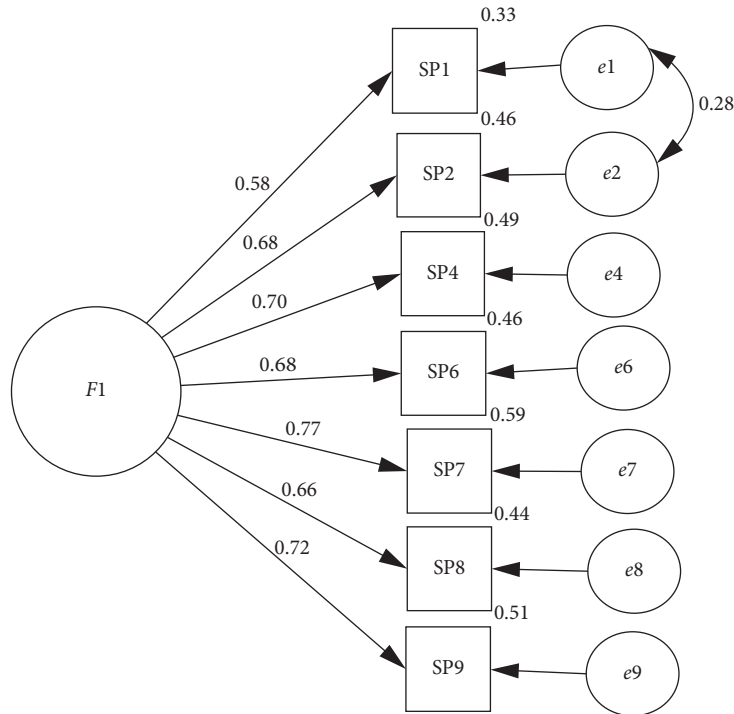| Index	Value	p
Chi-square	18.073 (13·df).	0.155
NFI	0.972	
CFI	0.992	
RMSEA	0.041	

Source: own.

FIGURE 1: Model of smartphone addiction.

were checked by maximum likelihood and also using Bayesian analysis. To evaluate the reliability of the instrument, Cronbach's alpha was calculated, using IBM SPSS Statistics for Windows software (version 25.0).

4. Results

The application of the questionnaires in the student sample yielded the statistics shown in Table 1. The reliability analysis obtained Cronbach's alpha value very close to the 0.88 obtained by López-Fernández [7] for the sample in Spain.

Table 2 shows the estimates of maximum likelihood. To check the fit of the model was taken into account: the feasibility of the parameter estimates, the adequacy of the standard error, and the statistical significance of the parameter estimates.

Note that variables 3, 5, and 10 did not show significant weight for the model. These are (1) feeling pain in the wrists or at the back of the neck while using a smartphone; (2) feeling impatient and fretful when I am not holding my smartphone; and (3) the people around me tell me that I use my smartphone too much.

These results show that the parameters are feasible as the values of the variances and covariances are positive. The values of standard errors are small, indicating that the parameters have been accurately estimated. In addition, all critical reasons are greater than 1.96, so the statistical significance of each parameter's estimates is 0.05 or better.

The abovementioned results reflect that the model fits the data. Additionally, the goodness-of-fit indices, shown in Table 3, demonstrate the fit of the model as a whole.

Figure 1 shows the unidimensional model, and Table 4 describes the model variables.

5. Bayesian Model

Table 5 shows the results obtained by the Bayesian method. The first column (Mean) represents the average value of a subsequent distribution. This is the Bayesian estimate based on the data and the previous distribution.

The estimate of the standard error is analogous to the standard error in the maximum likelihood estimates. The values observed in all cases indicate a very small likely distance between the hidden mean and the unknown true parameter.

Table 4: Model variables.

SP1 = Missing planned work due to smartphone use
SP2 = Having a hard time concentrating in class, while doing assignments, or while working due to smartphone use
SP4 = Won't be able to stand not having a smartphone
SP6 = Having my smartphone in my mind even when I am not using it
SP7 = I will never give up using my smartphone even when my daily life is already greatly affected by it
SP8 = Constantly checking my smartphone so as not to miss conversations between other people on Twitter or Facebook
SP9 = Using my smartphone longer than I had intended

Table 5: Bayesian parameters.

| Regression weights	Mean	S.E.	S.D.	C.S.	Median	95% lower bound	95% upper bound
SP4 <-- *F*1	1.1077	0.0057	0.1274	1.0010	1.1007	0.8822	1.3755
SP6 <-- *F*1	1.1701	0.0068	0.1417	1.0011	1.1593	0.9228	1.4859
SP7 <-- *F*1	1.2075	0.0048	0.1283	1.0007	1.1983	0.9793	1.4877
SP8 <-- *F*1	1.0580	0.0057	0.1242	1.0011	1.0497	0.8344	1.3239
SP9 <-- *F*1	1.0911	0.0049	0.1241	1.0008	1.0826	0.8704	1.3535
SP1 <-- *F*1	0.8871	0.0039	0.0991	1.0008	0.8805	0.7122	1.0942
Intercepts							
SP2	3.0505	0.0030	0.0888	1.0006	3.0516	2.8719	3.2224
SP4	3.0809	0.0041	0.0910	1.0010	3.0811	2.9009	3.2596
SP6	3.1103	0.0040	0.0954	1.0009	3.1107	2.9247	3.2989
SP7	3.3817	0.0026	0.0913	1.0004	3.3809	3.2034	3.5580
SP8	3.6658	0.0034	0.0932	1.0007	3.6668	3.4827	3.8483
SP9	3.6210	0.0036	0.0903	1.0008	3.6206	3.4430	3.7962
SP1	2.8967	0.0036	0.0926	1.0008	2.8970	2.7135	3.0748
Covariances							
*e*2<->*e*1	0.3588	0.0051	0.1023	1.0012	0.3523	0.1754	0.5781
Variances							
*F*1	0.8577	0.0062	0.1648	1.0007	0.8501	0.5557	1.2130
*e*2	1.1223	0.0048	0.1246	1.0007	1.1148	0.8935	1.3864
*e*4	1.0865	0.0029	0.1161	1.0003	1.0812	0.8755	1.3298
*e*6	1.3116	0.0047	0.1427	1.0005	1.3004	1.0607	1.6230
*e*7	0.8438	0.0046	0.1034	1.0010	0.8371	0.6600	1.0622
*e*8	1.2134	0.0056	0.1279	1.0010	1.2062	0.9806	1.4810
*e*9	0.9639	0.0041	0.1086	1.0007	0.9595	0.7692	1.1907
*e*1	1.3709	0.0053	0.1386	1.0007	1.3624	1.1252	1.6690

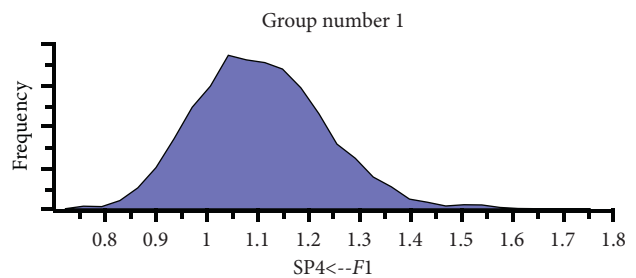Source: own.
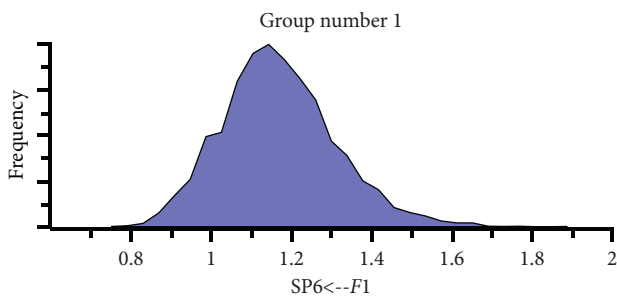
Figure 2: Bayesian diagnostic SP6.

Figure 3: Bayesian diagnostic SP4.

In the two columns of the far right, the bounds less than and greater than 95% are observed, showing that, with 95% certainty, the unidimensional model in Figure 1 is feasible. It is also noted that all parameter values between the upper and lower bounds are greater than zero, indicating that there is sufficient evidence to explain that the addiction to the cell
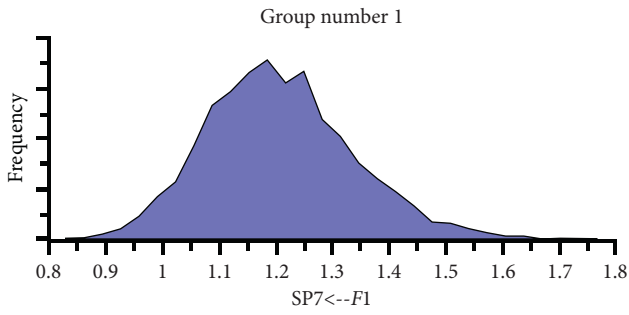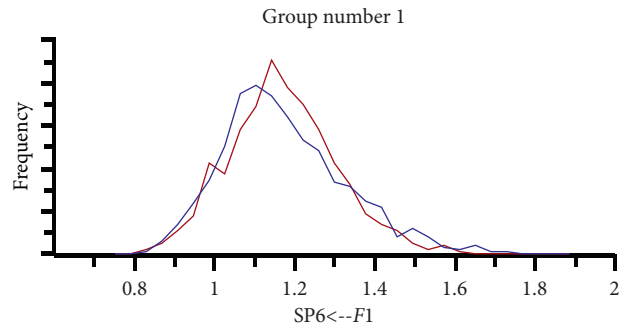
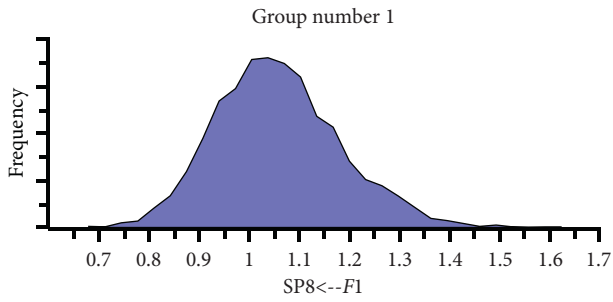Figure 4: Bayesian diagnostic SP7.

Figure 5: Bayesian diagnostic SP8.

Figure 6: Bayesian diagnostic SP9.

Figure 7: Bayesian diagnostic SP1.

Figure 8: First and last combines polygon SP6.

Figure 9: First and last combines polygon SP4.
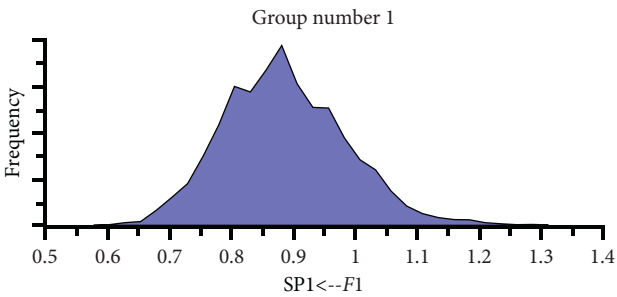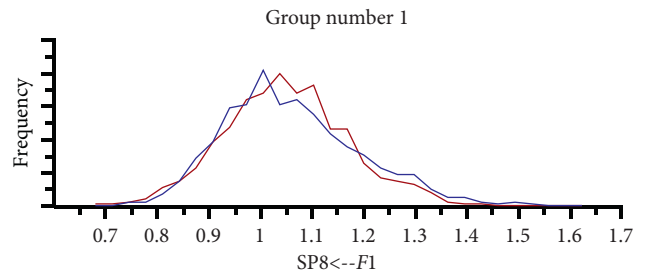

Figure 10: First and last combines polygon SP7.

Figure 11: First and last combines polygon SP8.
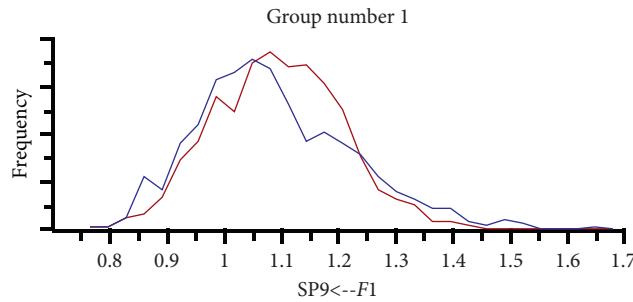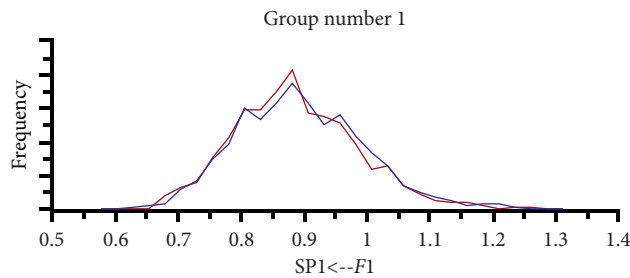
Group number 1

FIGURE 12: First and last combines polygon SP9.

Group number 1

FIGURE 13: First and last combines polygon SP1.

TABLE 6: ML and Bayesian parameters.

Parameter	ML	Bayesian	Symptoms
SP2 <--- F1	1.000		Having a hard time concentrating in class, while doing assignments, or while working due to smartphone use
SP4 <--- F1	1.055	1.1077	Won't be able to stand not having a smartphone
SP6 <--- F1	1.107	1.1701	Having my smartphone in my mind even when I am not using it
SP7 <--- F1	1.147	1.2075	I will never give up using my smartphone even when my daily life is already greatly affected by it
SP8 <--- F1	1.007	1.0580	Constantly checking my smartphone so as not to miss conversations between other people on Twitter or Facebook
SP9 <--- F1	1.040	1.0911	Using my smartphone longer than I had intended
SP1 <--- F1	0.853	0.8871	Missing planned work due to smartphone use

Source: own.

phone is a unidimensional structure.

Figures 2–7 show the distributions of nonstandardized weights of model parameters. Note that each value is greater than zero.

Figures 8–13 show the combination of the first and last polygons of the model items.

As a final analysis, estimates of nonstandardized weights were compared for the maximum likelihood method against the subsequent Bayesian estimate. As can be seen in Table 6, both estimates are very similar, which speaks well of the hypothesized structure.

6. Conclusions

This research found that the variables of the revised and short scale of smartphone addiction SAS-SV of Kwon et al. [6], adapted into Spanish by López-Fernández [7], indeed form a unidimensional construct when applied to Mexican university students.

However, for the sample of Mexican students used in this work, three of the items on the scale did not show significant weight for the model. They are (1) feeling pain in the wrists or at the back of the neck while using a smartphone; (2)

feeling impatient and fretful when I am not holding my smartphone; and (3) the people around me tell me that I use my smartphone too much.

While this fact could be attributed to differences in the lifestyle and customs of Mexican university students, the need to conduct further studies in different university spaces along the country is recognized, in order to formally explain the scant observed significance of these three variables.

Data Availability

Data can be obtained upon request through e-mail.

Conflicts of Interest

The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements) or nonfinancial interest (such as personal or professional relationships, affiliations, knowledge, or beliefs) in the subject matter or materials discussed in this manuscript.

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