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ORIGINAL RESEARCH

Mobile Phones in Schools: With or Without you? Comparison of Students' Anxiety Level and Class Engagement After Regular and Mobile-Free School Days

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Abstract
Mobile phones are important for people, especially for young adults and adolescents. As people tend to form attachments to not only social partners, but inanimate targets as well, mobile devices can become important objects that provide safety and security. This could lead to separation anxiety, also known as "nomophobia". Constant need for mobile use may result in problematic behaviors in schools, cause distraction in class, it is important to explore the students' relationship to devices. Our study compares state anxiety level of high school students on a regular school day and on an experimental "mobile-free day", when participants do not carry their mobile phones during classes. We hypothesized that separation from the mobiles would increase anxiety and decrease class engagement, especially in students with higher mobile attachment scores. The sample consisted of 235 secondary school students. Results of Repeated Measures ANCOVA showed that anxiety levels increased on the mobile-free school day, but class engagement was not affected by the experiment. Linear regression analysis revealed 'Safe Haven' mobile attachment to be a significant predictor of state anxiety on the mobile free school day. Moreover, correlation analysis revealed that mobile use habits linked to social media and instant message services were associated with higher anxiety scores on the mobile-free school day. Our results provide more insights on both use of mobile phones in learning environment and regarding school regulations of students' device use.

Keywords Mobile phone · Cell phone · Mobile phone attachment · State anxiety · Nomophobia

1 Introduction

Mobile phones are important to people. As of 2018, more than 5.1 billion people have mobile phone subscription (The GSMA Mobile Economy, 2019) and among them there are 3.9 billion unique mobile internet subscriptions (Statista, 2019). Although mobiles can

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be used in different ways, their contribution to individual well-being may raise questions, as increased mobile phone use is often associated with lower life satisfaction (Volkmer & Lermer, 2019). This is especially true when the device is used excessively for pass-time activities and non-communication purposes (Chan, 2015). These outcomes can be explained by two processes, which affects individual well-being in opposite ways: mobile use can be a source of joy, euphoria and other positive emotions, because it can enhance communication with significant others, and thus it is able to make social support available (Chan, 2018). Contrarily, excessive use of the devices could be associated with maladaptive emotion regulation, lower self-esteem and even with such addiction-like symptoms as craving and feel of dependence (Billieux, 2012). Throughout this article we refer to mobile phones, cell phones and smartphones as mobile phones, without further seaparating them into feature-based categories.

Mobile addiction is a frequently used expression to describe problematic phone-related behaviors, which are explored in a growing number of studies (see e.g., Chen et al., 2017; Noë et al., 2019; Wolniewicz et al., 2018). However, the diversity of research on this field highlights that problematic mobile use is a heterogeneous phenomenon, therefore some of its forms can be distinguished from other addictions (Billieux, 2012). Mobile-related problem behaviors beyond excessive device use include regular checking habits (Oulasvirta et al., 2012) or "ringxiety", which describes the false sensation of receiving calls and messages, leading to constantly checking the mobile phone (De-Sola Gutiérrez et al., 2016; Subba, 2013).

Nevertheless, the most frequently studied problem behavior is excessive mobile phone use, which is associated with internet addiction among adolescents. Consequently, these addictions are being linked to more frequent involvement in cyberbullying either as a victim or a perpetrator (Tsimtsiou et al., 2018). Moreover, the excessive use of social media platforms can be associated with a greater likelihood of developing anxiety. This form of anxiety is often linked to receiving negative feedback or cyber-bullying from peers, becoming more aware of stressful events occurring in other people's lives and internalizing the pressure to maintain social network updates (Vannucci et al., 2017). It is also possible that using such platforms is used as a coping mechanism for people struggling with anxiety or depression (Dhir et al., 2018). Besides, problematic use of mobile phones is associated with sleep disorders (Tamura et al., 2017), which relationship is mediated by various other factors such as lower mindfulness level (Liu et al., 2017). Nevertheless, problematic mobile phone use is ubiquitous, as 12–21% of the adult population of different countries report high scores on scales measuring problematic use of mobiles (Lopez-Fernandez, 2017). Most of the research of mobile use focus on adults (Lopez-Fernandez, 2017) and adolescents (Kwon et al., 2013; Liu et al., 2017, 2018; Tamura et al., 2017; Tsimtsiou et al., 2018) when discussing problems associated with utilization of the devices, but results show that even infants and toddlers are inclined to use mobile phones regularly if their parents use the devices as a tool for behavioral regulation (Levine et al., 2019).

1.1 Nomophobia and Attachment

Despite the critics and limitations of the theory of 'mobile addiction', increasing number of studies use the term (see e.g., De-Sola Gutiérrez et al., 2016; Liu et al., 2018; Volkmer & Lermer, 2019) along with another mobile-related notion, nomophobia ("no-mobile-phobia"). Latter refers to the negative emotions (fear, anxiety, etc.) linked to not being able to use the device and its services (King et al., 2010; Tams et al., 2018). One core

component of nomophobia is the phenomenon of "Fear of Missing Out" (FoMO; Wolniewicz et al., 2018), which refers to the unpleasant emotional state experienced while not being able to access to information and to communicate with others (King et al., 2013). Higher levels of FoMo are also associated with the higher risk of social media addiction (Blackwell et al., 2017). As the functions of the devices offer ways to seek social support, mobiles may become a frequently used strategy for emotional regulation (Hoffner & Lee, 2015). Higher levels of nomophobia are associated with lower mindfulness (Arpaci et al., 2019), and increased stress (Tams et al., 2018), beside maladaptive coping styles in case of withdrawal (Bragazzi et al., 2019). Other results indicate that negative emotions related to the FoMO phenomenon are associated with higher rates of smartphone addiction and problematic phone use (Wolniewicz et al., 2018). The notability of nomophobia is highlighted by findings that state that the negative emotions linked to withdrawal situations can be detected even on a physiologic level, such as increased heart rate (Konok et al., 2017) and blood pressure (Clayton et al., 2015).

Attachment theories offer possible explanations for the development of nomophobia. As Bowlby (1969) described, the motivation to maintain proximity to parents and peers is common among humans and many other animal species. Humans, attach not only to peers, but to material objects as well. Children often use attachment objects when alone at night (Wolf & Lozoff, 1989), while attachment to specific objects with affective value is also described among elder people in nursing homes (Cipriani et al., 2009). People form attachment towards places in different ways as well (Scannell & Gifford, 2010). Although developing emotions towards object is observed widely, there are differences in the way people form these attachments in one culture or another (Wallendorf & Arnould, 1988).

Scientific evidence indicates that mobile phones can easily become objects of emotions. Recent studies revealed similar patterns in attachment to mobiles and attachment to peers (Konok et al., 2016). Attachment-like reactions to mobile phones have been reported, such as proximity seeking and showing stress response when separated from the device (Konok et al., 2017). These reactions reveal four different aspects of mobile attachment: *separation anxiety*, which refers to the appearance of negative emotions when the device is not available, *separation insecurity*, which represents the general decrease of security in case of withdrawal, *safe haven* (using the mobile as a way to reduce feeling of stress) and *secure base*, which represents the increase of confidence when the mobile is available (Konok et al., 2017).

1.2 Mobile use in Schools

Mobile use in schools nowadays is a frequently debated and studied topic. Growing number of students have access to mobile devices worldwide. Although there are differences between countries in how widespread mobiles are (Lopez-Fernandez et al., 2017), in many regions the majority of the students possesses mobile phones, and they are regularly using it during school time. For example, statistics show that in the United States 95% of the teenagers have smartphone access (PEW Research Center, 2018). Data show that students tend to possess and use mobile phones especially in high schools, more frequently than in elementary- and middle schools (Gao et al., 2019).

In education, some aspects highlight the advantages of using information technology, such as enhancing the teacher-student communication via instant messages (Bouhnik & Deshen, 2014; Rau et al., 2008), increasing performance and accomplishment rates with using mobile-based learning websites (Chen et al., 2008), improving speaking skills with

mobile phone video recording (Gromik, 2012) or strengthening learning interest and attitudes with devices (Hwang & Chang, 2011). Research shows teachers are generally open towards the idea of using mobile learning strategies during class. However, they often consider their abilities imperfect to implement such practices, therefore training programs are needed (Lai & Hwang, 2015).

In spite of the obvious advantages and future possibilities of using the newest technology in learning environment, there are also some drawbacks and obstacles in doing so. The first and most frequent problem related to mobile use in school is the distraction caused by the non-educational use of devices during classes (Campbell, 2006). Another possible problem caused by devices is cheating during exams, (Curran et al., 2011; O'Bannon & Thomas, 2015). Cheating with mobile phones is reported to be more frequent in high schools than in elementary schools (Gao et al., 2019). Investigations of teachers' perception of students' mobile use show that teachers are mostly annoyed when students are texting, playing games or tweeting during class (O'Bannon & Thomas, 2015). Experiments show that using instant message services during the learning process is proved to have a negative impact on grade and information recall. However, this effect is present only if the content of the messages is unrelated to the study material (Kuznekoff et al., 2015).

Regarding the regulation of mobile use in school, there are several approaches to the problem. As various studies pointed out, complete ban of mobiles from schools would make it impossible to use the devices' advantages (Gao et al., 2014, 2019). Therefore, different regulations coexist regarding students' mobile use in school. For example, high schools are more permissive regarding mobile use, while 84% of Chinese elementary schools generally ban using such devices in school (Gao et al., 2019). On the other hand, student experiences show that mobile-related regulations are not implemented in practice, as majority of the students feel that they are able the "get around" those rules and use their mobiles in school eventually (Selwyn & Bulfin, 2016). Regarding the distracting effect of device use it is important to note that due mobile-related regulations are widespread not only in the education system, but also in corporate environment. There are growing number of best practices which restrict the use of mobile phones during meeting because of the distraction created by the devices (Forbes, 2014).

As mobile use is more and more widespread among students (PEW Research Center, 2018), and device withdrawal is revealed to be associated with anxiety and craving (Billieux, 2012; Chen et al., 2017; Noë et al., 2019), it seems to be important to explore the psychological consequences of strict policies in schools regarding students' mobile use.

1.3 Current Study

The main goal of the current study was to explore the effects of a trial school program called "mobile-free school day". We examined whether attending school without their mobile devices would affect students' state anxiety and class engagement. State anxiety and class engagement levels were assessed after a regular school day as baseline for the comparison.

Our initial hypothesis was that anxiety levels would increase compared to a regular school day if students would be separated from their devices between their first and last classes (H1), because disunion from mobiles can induce stress (Clayton et al., 2015; Konok et al., 2017). Besides, as different components of mobile attachment re described (Konok et al., 2016), we assumed that the anxiety levels would increase more among students who show signs of stronger attachment to their devices (H2; Konok et al., 2016, 2017). Although

higher levels of anxiety decrease class engagement due to former studies (González et al., 2016), we stipulated that the core problem with students using their mobiles off task during classes is the decreased attention level, so we assumed increased class engagement on the mobile-free day (H3; Campbell, 2006; Kuznekoff et al., 2015). Regarding the reception of the mobile-free school day, we assumed that students who have stronger attachment to mobiles (H4), and experienced higher levels of anxiety during the experiment day (H5) were more likely to reject the idea of implementing mobile-free school regulations permanently. Finally, we assumed that those students who use their devices more frequently for instant message services and for social networks (H6) would have higher anxiety scores on the mobile-free day. The reasoning behind the expected relationship here was that these services may serve as a coping mechanism for people dealing with anxiety and taking them away may result in an increase in anxiety levels (Dhir et al., 2018).

2 Methods

2.1 Participants

The sample consisted of students of a small-town secondary school in Hungary. There were 324 students participating, but due to dropout, only 179 girls and 56 boys (N = 235) were analyzed. Their ages were between 14–20 years, and their mean age was 16.57 years (SD = 1.38). There was a 27% drop-out rate between the normal and the mobile-free day, meaning that 73% of the participants of the first stage were present during the second stage of the study as well. The mean age of the drop-out participants was 17.11 years (SD = 1.49). There were 73 girls and 16 boys among them. We did not find significant difference between the drop-out participants and the represented participants in terms of mobile attachment scores ($t(322) = 1.002$, $p = 0.66$), state anxiety scores ($t(322) = -1.546$, $p = 0.753$), class engagement scores ($t(322) = -2.401$, $p = 0.448$) and use of mobile phone for making calls ($t(322) = -0.098$, $p = 0.369$), text messages ($t(322) = 0.807$, $p = 0.858$), surfing ($t(322) = 1.787$, $p = 0.421$), social media ($t(322) = -0.271$, $p = 0.364$), chat ($t(322) = -0.871$, $p = 0.061$) and games ($t(322) = -1.190$, $p = 0.746$). In case of chatting, scores of the two sample were compared because of the low significance value. Students in the drop-out group use their mobiles for chatting less frequently (M = 4.43) than participants who were present at both T_1 and T_2 (M = 4.53). Only the participants with complete data sets are represented in the current study.

2.2 Experiment Procedure

The experiment procedure consisted of two phases. At Time 1 (T_1) students participated in the data collection at the end of their last class on a regular school day. One week later at Time 2 (T_2), on the mobile-free day, the students gave their mobile phones to their form-teachers before their first class in the morning, and the devices were stored in the teachers' room until the end of the day. The students got back their mobile phones after their last class. The idea of the mobile-free day originated from the school staff and the school principal, as the problem of students using their mobiles regularly during class had been detected previously. The procedure of the mobile-free day was executed according to the institute's regulations. The students and their parents were informed about the upcoming mobile-free day about a month before. All parents and students

agreed to participate. T_1 and T_2 did not differ in any important parameter (e.g., there were no vacations or school-breaks before and after the weeks of data collection, exams or mid-term tests were not scheduled in these weeks, etc.)

The data collection took place in the classrooms of the school on two following Fridays. This way the students met similar conditions (e. g. same teachers, same classes) during the normal and the mobile-free day. Doing so was necessary because we wanted to reduce the chance of other stimuli influencing the rate of state anxiety or class engagement. During the first day of the study, participants had to take the Mobile Usage Scale (Konok et al., 2016), the Mobile Attachment Questionnaire (Konok et al., 2017), the Spielberger State Anxiety Inventory (STAI-S, Sipos et al., 1994) and a questionnaire about Class Engagement. For the second part of the study, participants had to take the Spielberger State Anxiety Inventory and the questionnaire about Class Engagement again, and a questionnaire about their feedback on the mobile-free day. Participants could also express their thoughts about the mobile-free day in writing. On both days of the study participants had to write their gender, their age, their grade and the last four digits of their student card numbers so we could pair the questionnaires from the two days. In this way anonymity could be assured, as the students were unidentifiable.

Prior to data collection the school principal reviewed the aims and methods of the study, and after obtaining approval and support, the parents of the minors were sent an informed passive consent with no refusals. Then students were informed about the study, and they were asked to participate voluntarily in the data collection. They were assured about confidentiality and anonymity of data handling. The students could have decided not to participate in the study without any consequences. Data collection took place in the classes during school hours. The study procedures were carried out in accordance with the Declaration of Helsinki. The study was approved prior to data collection by the Ethical Board of the Institute of Psychology [Ethical Board of the Institute of Psychology, University of Szeged].

2.3 Materials

2.3.1 Demographics

We measured the frequency of students using mobile phones for different activities with the Mobile Usage Scale (Konok et al., 2016). Participants had to rate on a 5-grade scale how much they use their mobile phones for phone calls, sending text messages, surfing the internet, social media, chat and games. Besides, participants answered questions about their gender, age and grade.

2.3.2 State Anxiety

To compare the rate of anxiety on a normal day and a mobile-free day, we used the Spielberger State Anxiety Inventory (STAI-S) (Sipos et al., 1994). It consists of 20 statements about which participants had to decide how characteristic they were to them and they had to rate it on a 4-grade scale. The scale had excellent internal reliability both at T_1 (Cronbach $\alpha = 0.884$) and T_2 (Cronbach $\alpha = 0.899$).

2.3.3 Mobile Attachment Questionnaire (MAQ)

For measuring the rate of nomophobia and the attachment to mobile phone we used the Mobile Attachment Questionnaire (Konok et al., 2017). The questionnaire includes 14 statements about proximity seeking, separation anxiety, mobile phone as a secure base and safe haven and need for continuous contact with others through the mobile phone. Participants had to rate each statement on a 5-grade scale based on how characteristic they were to them.

Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were used to test the scales on the current sample. Results of EFA using maximum likelihood method with oblimin rotation revealed a four-factor structure almost identical to the original. The number of factors was determined using parallel analysis (Horn, 1965). One item was removed from analysis due to lower than 0.33 factor loading (Tabachnick & Fidell, 2001), and item was moved from Separation Insecurity scale to Safe Heaven scale. Then this modified structure was tested using CFA. Based on the modification indices correlated errors were added to the model between two item-pairs belonging to the same factors (SA2–SA3 and SI3–SI4), where high correlation between the items were justifiable based on specific item content (Brown, 2015). This final model proved to have good fit indices according to the cutoff criteria of Hu & Bentler (1999): χ^2 (157) = 120, $p < 0.001$; χ^2/df = 2.1; RMSEA = 0.068; 0.0516 ≤ 90% CI ≤ 0.0859; SRMR = 0.047; CFI = 0.961; TLI = 0.946). The indicators of scale reliability ranged from acceptable to good (0.732 < Cronbach α < 0.827, see Table 3).

2.3.4 Class Engagement (CE)

To measure class engagement we created a questionnaire which consisted of 12 items about being active, being able to pay attention and the feeling of learning during the lessons. Participants had to rate the statements on a 5-point Likert-scale (1–Completely disagree, 5–Totally agree). Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were used to test the scales on the current sample. Results of EFA using maximum likelihood method with oblimin rotation revealed a three-factor after deleting items with factor loadings lower than 0.33, or higher cross-loadings to multiple factors (Tabachnick & Fidell, 2001). The number of factors was determined using parallel analysis (Horn, 1965). First factor was Attention (3 items, e.g. "It was easy to pay attention today during classes."), the second was Engagement (3 items, e.g. "I was active during classes today.") and the third was Knowledge Gain (2 items, e.g. "This school day helped me learning the material"). This scale structure was tested with CFA, which results show excellent fit indices according to the cutoff criteria of Hu & Bentler (1999): $\chi 2$ (17) = 21.4, $p = 0.21$; $\chi 2$/df = 1.25; RMSEA = 0.033; 0.00 ≤ 90% CI ≤ 0.0714; SRMR = 0.0278; CFI = 0.993; TLI = 0.988). The indicators of scale reliability ranged from acceptable to good (0.698 < Cronbach α < 0.773, see Table 3).

2.3.5 Feedback on the Mobile Free-Day

The participants experiences and thoughts about the mobile-free day were measured by a 5-item questionnaire. Participants had to rate the statements on a 5-point Likert-scale (1–Completely disagree, 5–Totally agree). Two items measured negative emotions (e.g.

"I felt inconvenient because I did not have my mobile with me"), another two referred to positive emotions (e.g. "It was easier two pay attention today than on other days") and explored the participants support for the idea of the mobile-free day for other occasions ("I would support to have mobile-free days another time").

2.4 Statistical Analysis

SPSS for Windows 24.0. and Jamovi 0.6.9.6 (The Jamovi Project, 2019) software were used for statistical analysis. Data analysis consisted of four steps. First, the distribution of the data was checked using descriptive statistics. Values of skewness and kurtosis was compared to the criteria value of |2.58|, which can indicate the normal distribution of the data set in case of large sample sizes (Ghasemi & Zahediasl, 2012). As all measures met the criteria values, normal distribution of the dataset was assumed.

Secondly, the structure and reliability of the scales were analyzed with EFA, CFA and Cronbach α as described in the Measures section, then the mean scores of the scales were calculated. Thirdly, intercorrelations among the variables were explored using Pearson's correlation analysis. In the final step Repeated Measures Analysis of Covariance (ANCOVA) was applied to test hypothesizes regarding differences between T_1 and T_2 measures. When describing the results, *df* and *p* values are reported together with partial eta-squared (η^2_p) as the measure of effect size. Beside examining the main effect of the experiment, interaction effects of gender and MAQ scores were also tested using the variables as covariates. Finally, linear regression analysis was applied to further explore the results.

3 Results

3.1 Descriptive Statistics

Descriptive statistics for mobile use scores are shown in Table 1, while data regarding feedback on mobile-free school day are available in Table 2. Descriptive statistics for MAQ, STAI and Class Engagement are shown in Table 3.

Table 1 Descriptive statistics for mobile use and correlations with state anxiety levels

Phone use	Mean	SD	Range	Correlation with state anxiety at T_1	Correlation with state anxiety at T_2
Telephone calls	3.26	1.03	1–5	−0.048	−0.022
Text message	2.24	1.05	1–5	0.093	0.092
Browsing the internet	4.02	0.851	1–5	0.06	0.034
Social networks	4.31	0.872	1–5	0.123	0.211**
Chat/instant messages	4.53	0.791	1–5	0.084	0.182**
Games	3.0	1.28	1–5	0.051	−0.04

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 2 Descriptive statistics for feedback on mobile-free school day and correlations with state anxiety levels and MAQ scores

				Correlations					
	Mean	SD	Range	State anxiety T_1	State anxiety T_2	MAQ SA	MAQ SI	MAQ SB	MAQ SH
Feedback on the mobile-free day									
Positive emotions	2.38	1.11	1–5	−0.019	−0.21**	−0.032	−0.044	0.089	0.034
Negative emotions	2.63	1.24	1–5	0.25***	0.596***	0.530***	0.445***	0.421***	0.469***
Support for mobile-free day	2.22	1.46	1–5	−0.021	−0.27***	−0.162*	−0.104	−0.034	−0.049

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 3 Descriptive statistics for and intercorrelations among the measures

Scale	MAQ				STAI T_1	STAI T_2	Class Engagement T_1			Class Engagement T_2		
	SH	SB	SA	SI			Att	Eng	Kno	Att	Eng	Kno
MAQ												
Safe Haven (SH)	–											
Secure Base (SB)	0.599***	–										
Separation Anxiety (SA)	0.594***	0.576***	–									
Separation Insecurity (SI)	0.546***	0.487***	0.64***	–								
STAI T_1	0.312***	0.3***	0.324***	0.296***	–							
STAI T_2	0.401***	0.312***	0.396***	0.355***	0.556***	–						
Class Engagement T_1												
Attention (Att)	−0.079	−0.159*	−0.155*	−0.12	−0.326***	−0.257***	–					
Engagement (Eng)	−0.2**	−0.176**	−0.149*	−0.184**	−0.346***	−0.295***	0.57***	–				
Knowledge Gain (Kno)	−0.08	−0.085	−0.088	−0.155*	−0.24***	−0.251***	0.449***	0.41***	–			
Class Engagement T_2												
Attention (Att)	−0.158*	−0.216***	−0.162*	−0.193**	−0.211**	−0.416***	0.446***	0.41***	0.308***	–		
Engagement (Eng)	−0.169**	−0.221***	−0.206**	−0.219***	−0.316***	−0.426***	0.407***	0.561***	0.262***	0.649***	–	
Knowledge Gain (Kno)	−0.19**	−0.228***	−0.149*	−0.169**	−0.289***	−0.418***	0.309***	0.312***	0.389***	0.499***	0.533***	–
Range	1–5	1–5	1–5	1–5	1–4	1–4	1–5	1–5	1–5	1–5	1–5	1–5
M	2.6	2.43	2.83	2.76	1.88	1.98	3.44	3.37	2.83	3.38	3.4	2.86
SD	1.03	0.99	1.06	1.09	0.507	0.574	0.938	0.867	1.01	0.863	0.88	1.02
Cronbach α	0.793	0.732	0.823	0.827	0.908	0.923	0.773	0.698	0.703	0.718	0.775	0.831

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

3.2 Intercorrelations

The intercorrelations among the variables were examined using Pearson's correlation analysis (see Tables 1–3). Results showed the subscales of MAQ to be associated with anxiety scores positively at both T_1 and T_2. The correlation coefficients between MAQ subscales and anxiety scores did not differ significantly at T_1 and T_2 according to Fischer transformation ($p > 0.05$). This result contradicts our hypothesis (H2). Moreover, class engagement scores were linked negatively to anxiety both at T_1 and T_2. The correlation coefficients between class engagement and anxiety scores did not differ significantly at T_1 and T_2 according to Fischer transformation in case of attention and engagement ($p > 0.05$), but the association was significantly stronger at T_2 in case of knowledge gain ($p = 0.03$).

Positive feedback on the mobile-free day was negatively linked to state anxiety at T_2, but was not linked to scores on the subscales of the MAQ. On the other hand, negative emotions were positively associated with both state anxiety scores, and with all subscales of the MAQ. Support of the mobile-free school day was negatively linked to state anxiety at T_2, but was not associated with subscales of MAQ. These results mostly supported our hypothesis (H4 and H5).

At T_1 only the frequency of using the mobiles for accessing social networks had a weak significant correlation with state anxiety scores. However, at T_2 both frequencies to use the mobile "to accessing social networks" and "instant message services" were positively linked to anxiety scores, which supported our hypothesis (H6, see Table 1).

3.3 Experiment Effects

The effects of the experiment were tested by repeated measures ANCOVA to compare anxiety scores at T_1 and T_2. The results revealed significant differences between the mean scores at T_1 ($M = 2.06$) and T_2 ($M = 2.16$; $F(1,217) = 7.19$, $p = 0.008$, $\eta^2_p = 0.032$). These results confirmed the initial hypothesis (H1), as state anxiety scores at T_2 were significantly higher than at T_1. Secondly, gender differences were tested by adding gender as a between-subject factor in the analysis. Results showed significant main effect ($F(1,216) = 4.111$, $p = 0.044$, $\eta^2_p = 0.019$). Girls scored higher than boys at both T_1 ($M_{girls} = 2.17$, $M_{boys} = 1.96$) and T_2 ($M_{girls} = 2.27$; $M_{boys} = 2.03$), but there were no significant interaction effects for gender differences ($F(1,216) = 0.17$, $p = 0.681$, $\eta^2_p = 0.001$). Therefore, it is assumed that gender did not affect the results of the experiment. To control the effect of mobile attachment on change in anxiety scores, hierarchical linear regression analysis was used. Model 1 contained the state anxiety score at T_1 as a dependent variable, and the four subscales of MAQ as independent variables. The analysis showed MAQ subscales predicted significant amount of variance of anxiety scores ($F(4,211) = 9.06$, $p < 0.001$, $R^2_{adj} = 0.13$). Thus, mobile attachment scores predicted 13.0% of the variance of anxiety scores at T_1, but the individual effect of the subscales was not significant (all $p < 0.001$; see Table 4. for details). In the next step Model 2 was built with the same independent variables, but with anxiety score at T_2 as dependent variable. The subscales of MAQ predicted significant amount of variance of anxiety scores ($F(4, 199) = 14.5$, $p < 0.001$, $R^2_{adj} = 0.211$). Thus, mobile attachment scores predicted 21.1% of the variance of anxiety scores at T_2, 8.4% higher than at T_1. Safe Haven subscale was positively related to anxiety score ($\beta = 0.229$; $p = 0.009$). The other three subscales of MAQ were not significantly connected to anxiety scores ($p > 0.05$; see Table 4.). These results were in accordance with our hypothesis (H2).

Table 4 The results of the hierarchical linear regression analysis

	β	R^2_{adj}	F
Model 1: Anxiety Score at T_1		0.13	9.06**
MAQ Separation Anxiety	0.121		
MAQ Separation Insecurity	0.103		
MAQ Secure Base	0.111		
MAQ Safe Haven	0.129		
Model 2: Anxiety Score at T_2		0.211	14.5**
Step 1			
MAQ Separation Anxiety	0.164		
MAQ Separation Insecurity	0.104		
MAQ Secure Base	0.067		
MAQ Safe Haven	0.229*		
Step 2		0.38	25.8**
MAQ Separation Anxiety	0.107		
MAQ Separation Insecurity	0.062		
MAQ Secure Base	0.02		
MAQ Safe Haven	0.177*		
Anxiety Score at T1	0.442**		

*$p < 0.05$, **$p < 0.001$

In the final step of the analysis, anxiety score at T_1 was added to the model as an independent variable. The model predicted significant amount of variance of anxiety scores ($F(5, 198) = 25.8$, $p < 0.001$, $R^2_{adj} = 0.38$). Therefore, controlling for anxiety scores at T_1 almost doubled the explained variance in anxiety scores at T_2, as it was positively related to the dependent variable ($\beta = 0.442$, $p < 0.001$). Safe Haven subscale was also positively related to anxiety scores ($\beta = 0.177$; $p = 0.023$), while the three other subscales of MAQ were not significantly connected to the dependent variable ($p > 0.05$, see Table 4.).

The effects of the experiment on class engagement were also tested by repeated measures ANOVA, but neither of its scales showed significant differences between scores at T_1 and T_2 ($p > 0.05$). These results did not support our initial hypothesis (H3), as we assumed increased class engagement on the mobile-free day.

4 Discussion

The main goal of the current study was to explore the effects of an experimental mobile-free school day on the anxiety level and the class engagement of secondary school students. Our research was built on previous findings that people tend to form attachment to their mobile phone (Konok et al., 2016), therefore separation from the devices can provoke stress (Clayton et al., 2015; Konok et al., 2017). The results showed that anxiety scores indeed increased on the mobile-free school day compared to the scores measured one week before on a regular school day. This supported the hypothesis that separation from the devices could lead to experiencing stress, which is in accordance with previous findings (Clayton et al., 2015; Konok et al., 2017). On the other hand, class engagement scores did not increase on the mobile free day. These findings are considered important because

similar experimental studies are rarely conducted in schools, and similar research are especially lacking in the context of Hungarian education system.

The increase in anxiety scores was not mediated by gender, and we found that only one subscale of the MAQ, Safe Haven was a significant predictor of anxiety scores on the mobile-free day. The results partly supported our hypothesis that higher mobile attachment will result in higher increase in state anxiety, because anxiety scores on the mobile-free day were more strongly predicted by previous anxiety score than the components of mobile attachment. Although it seems that anxiety on the mobile-free day was not explained generally by mobile attachment, but mainly by specific aspect of attachment, Safe Haven.

Moreover, correlation analysis showed that mobile attachment scores were positively associated with anxiety scores at both T_1 and T_2. As students are not allowed to use their mobile during classes on regular school days either, feeling separated from their devices can induce anxiety among students who form strong attachment to their mobiles. Therefore, the consequences of a regulation which promotes mobile-free school can contribute to higher anxiety levels on regular days as well.

The results regarding mobile attachment, especially Safe Haven subscale of MAQ are in line with previous studies (Konok et al., 2016, 2017) which claim that students tend to use their mobile as a stress-reducing strategy in inconvenient situations, therefore not accessing to them contributes to elated anxiety. These findings are also in concordance with other results suggesting that people tend to use mobile phones to regulate negative emotions (Hoffner & Lee, 2015). Moreover, results revealed that anxiety levels on the mobile-free school day was linked to specific uses of the devices. Anxiety levels on the mobile-free day were higher among those students who more frequently use their mobile to access to social networks, while other aspects of mobile use were not associated with the anxiety scores. This result is in accordance with the phenomenon of FoMO (Przybylski et al., 2013; Wolniewicz et al., 2018), because those students who are used to being connected to others continuously via social media and instant message functions of their mobile phone may experience negative feelings in case of being separated from the online world, and therefore from their peers. This corresponds with other studies that found a significant mediating effect of nomophobia with separation anxiety. The participants feared of being out of touch with the events or conversations happening in their social circles (Mir & Akhtar, 2020). Although FoMO can result in negative outcomes because frequent checking of notifications can disrupt study activities (Rozgonjuk et al., 2019), based on the results of our study it seems that separating students from their devices through more strict school regulations could generate other problems instead of higher engagement, such as elevated anxiety levels.

Our findings should be interpreted considering some other aspects. As students were not used to being separated from their devices, the experience of the mobile-free day was completely unfamiliar to them. It also means that however there was a significant increase in the anxiety scores, supposedly the newness of the situation could have contributed to these results. Therefore, further research would be necessary to explore whether mobile-free school regulations increase anxiety in the long run. It can be supposed that students would accommodate to the situation in which they are separated from their devices, which could reduce anxiety levels in case of withdrawal.

In contrary to our hypothesis, results showed class engagement was unaffected by the experiment, presumably because the stress-evoking effect of the separation and the engagement-improving impact of less classroom distraction was taking opposite effects. As mobile use related to the learning process is associated to increased engagement and increased academic performance (Gómez-García et al., 2020; Kuznekoff

et al., 2015), this result could implicate that best practices for utilizing the devices for the favor of studying could be more efficient than the complete ban of mobile use in schools. Such school programs are available, such as the Good Behavior Game, which is a classwide behavioral intervention method which helps students reducing the disruptive mobile use (Hernan et al., 2018). Moreover, there is growing support for the integration of mobiles in schoolwork as augmented reality games for primary school students are available (López-Faican & Jaen, 2020). Although, teachers seem to need help in form of training programs to apply these best practices (Liu et al., 2018; Spiteri & Chang, 2020). Due to the Corona virus pandemic teachers were required to be very flexible and ready to learn new technologies to be able to teach online. This might have induced a change in the attitude towards using mobile devices in school as they seemingly enhance learning (Ali, 2020).

These results suggest that banning mobiles from schools can increase anxiety and discourage the educational use of modern technology. On the other hand, there is a growing support among teachers and parents for such strict school policies (Selwyn & Aagaard, 2021). While such action may target tangible problems such as distraction, cyberbullying or addiction (Selwyn & Aagaard, 2021), the results of this study show the possible drawbacks of complete ban of mobiles. Therefore, integration of mobiles instead of enforced absence of the devices may imply the golden mean for the problem.

Besides, stricter school regulations lack student support. Student opinions showed the participants had more negative feelings regarding the mobile-free school day, and generally they did not support the idea of the stricter school regulations on mobile phones. The negative emotions were positively linked to all subscales of MAQ, which confirmed the hypothesis regarding the positive link between nomophobia and separation anxiety (Konok et al., 2016, 2017). In future experiments it would be interesting to examine how teachers perceive mobile-free school days, as they experience the majority of the problematic behaviors related to using mobiles in the classroom. It is possible that even if the students have not reported increase in class engagement, teachers would have experienced advanced student activity and attention during the mobile-free day.

Beside the questionnaires, the participants of the study were able to express their thoughts and feelings about the mobile-free day in free writing. Although we did not conduct a qualitative analysis of these writings, we find them important for the deeper understanding of our results. Part of the students found the mobile-free school day worthless and boring. In our opinion, this may mean that these students could not really spend their free-time valuably without their mobile phones, that is why they only saw the negative side of the program. Others expressed that they did not want to repeat the mobile-free day because being separated from their phones made them anxious. Some students reported more positive emotions related to the mobile-free day as they said that they could speak to their classmates more easily, they played board games in the breaks between classes, they studied together, and this way it was not so difficult without their mobiles. Other students had quite a neutral opinion about the mobile-free day. Their only problem was that the classrooms in the school had analogical clocks, and they did not know what time it was, because they can only tell the time from digital clocks. These additional thoughts are in correspondence with the results of the statistical analysis, revealing that students reacted differently to the mobile-free school day program, but the main emotions expressed were boredom and anxiety.

5 Limitations

The current study accepts several strong limitations. To begin with, the sample size was below optimal, as a significant proportion of the students dropped out between the two measurements. Primarily the cause of the dropout was that the students were absent in either cases. Therefore, repetition of the experiment is strongly considered, preferably with more participating schools, which could enable using a control group. Another delimitation of the research design is the lack of re-test after the experiment phase (T_2). A third data collection a week later would have verified the differences found between T_1 and T_2. Moreover, the statistical analysis showed low effect sizes. School tasks or interpersonal conflicts are non-controllable aspects of school life which can affect anxiety level of the students. The effects of these non-controllable factors could be decreased with repeated experiments and larger sample sizes.

6 Conclusion

The idea of having mobile-free schools emerge periodically because of problematic mobile usage during classes, which caused distraction and makes class management more difficult for teachers. Although our results indicate that separating students from their mobiles could increase their anxiety level, especially in case of those who are more attached to their devices. On the other hand, class engagement has not increased on the mobile-free day. Therefore, strict regulations for device use should be thoroughly reconsidered. Hereby mobile phones and similar devices could be integrated in the learning process, which would make the exploitation of their advantages possible.

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Declaration

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