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Article

Students' Attitude Towards the Sustainable Use of Mobile Technologies in Higher Education

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Abstract: Our study aims to identify students' attitudes towards the use of mobile technologies (MT) during learning activities in higher education. Data were collected using the Mobile Technologies Questionnaire/MTQ, a ten-item brief questionnaire that was designed to determine attitudes towards the use of mobile technologies in the learning process among university students and academic staff. The MTQ was completed by 575 students from a state university in the north-eastern region of Romania. Exploratory and confirmatory factor analyses revealed two latent factors: MT facilities for study resources and communication and MT facilities for learning. Along with general analysis of the statistical indicators regarding the attitude towards the use of MT, the relationships between the use of MT and five socio-demographic variables (gender, age, place of residence, year of study, academic status and study program) were analyzed. Comparative data showed some statistically significant differences but with small or modest effect sizes, depending on age, year of study, place of residence, academic status and the study program in which the students were enrolled. This study provides additional support for the construct validity of a brief tool that was designed to measure students' attitudes towards the use of MT during learning activities carried out in higher education.

Keywords: mobile technologies; higher education; learning activity; Mobile Technologies Questionnaire; factor analysis; university students

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1. Introduction

Mobile technologies (MTs)are not simple technologies, due to their growing impact on large demographics of people everywhere. There are many uses associated with these new media: cultural tools that revolutionize everyday life [1]. The implementation of MT in higher education is strongly recommended because students are part of a digital generation and because during pandemic times we need to adapt to online learning and teaching [2–4]. It is the first time that all devices must be rethought, including the ICT infrastructure and digital abilities of the entire educational system [5]. This challenge will involve reshaping pedagogical paradigms and influencing the educational process [6,7].

Implementing learning with mobile devices such as notebooks, mobile phones and laptops has become an emerging topic of research all over the world. Today, all students use information and communication technologies for educational purposes, yet the conditions for their adoption and their consequences have been hardly studied. Technology is a force with an extraordinarily strong impact that is already a constant presence in the lives of teachers and students. There are many studies that underline the educational benefits of MT in the learning process [8–10]. Sharples et al. [11] have laid out a binding framework for the implementation of educational technology that is also valid in higher education. This frame comprises the learner, the educator and the technology itself. All these poles are important: the teacher initiates and decides on the strategy of using the technology, and the students are the clients; they support the educational action. The students are extremely interested in using MT, and these devices motivate and influence learning, teaching and acquisition assistance [12]. MTs are used in learning and teaching [13], and they are a great help in the use of open educational resources [14,15]. Gikas and Grant [16] integrated mobile devices (cell phones and smartphones) into courses for at least two semesters, then they used an interview method with students to highlight the "advantages" and "frustrations" arising from using this resource. With the help of content analysis, the strengths were revealed: accessing information quickly, the constant connectivity available to students, and the variety of ways to learn situated and contextualized learning. The "frustrations" associated with learning using mobile computing devices were anti-technology instructors in other classes, device challenges (applications that did not work) and devices being used as a distraction. In other studies, authors [17,18] indicate the following advantages: temporal, user-friendly, minimal cost and multi-modality features. These authors specify the ways that MT can be used in education: for learning diaries, dialogic transmissive, constructionist with peer feedback, helpline and evaluation, and they demonstrate the positive impact on students' cognitive outcome. MTs are easier to use in the social context of educational activities than other forms of computer-mediated communications. They are also more trusted, have characteristics and personal qualities, contexts, and perceived usefulness of use [10].

Kuznekoff and Titsworth [19] examined the impact of mobile phone usage during a class lecture on student learning in three different study groups (control, low-distraction and high-distraction). Students who were not using their mobile phones had better intellectual performance: they wrote down 62% more information in their notes, took more detailed notes, were able to recall more detailed information from the lecture, and scored a full letter grade and a half higher on a multiple-choice test than students who were actively using their mobile phones.

Alrasheedi, Capretz and Raza [20], analyzing 30 articles (published between 2004 and 2015) on factors of the learning process that are influenced by new technology, discovered the most factors for success occurred when the learner observed that their performance was increasing after using mobile phones. Consequently, they wanted to maintain m-learning technology in their future activities.

A striking aspect is that teachers have incorporated mobile learning into teaching to a much lesser degree compared with students, which leads to the conclusion that students have often acted "on their own" in this endeavor. This is a particularly strong motivation to investigate the benefits and obstacles brought about by MT in learning for students. For students, quick connectivity may lead to innovation in language learning, improving knowledge of vocabulary and participation in more collaborative learning environments [1,21–22]. For teachers, MT allows for the sending of instructional messages in flexible ways, favors collaborative reflective practice in academic activities, and is an ideal method for capturing the spontaneity of learning moments [23]. Yorganci [24] investigated self-efficacy and attitudes towards m-learning usage as main factors that serve in understanding if students accept m-learning technology. In another study, the 100 most-cited papers about mobile learning were analyzed [25], and the results showed four advantages: new learning strategies, subjects, and domain for applying mobile learning and discussed issues. This article focused on learners' higher thinking performance and their learning behaviors.

Investigating students' attitudes toward the use of MT [26] in the learning process is important because it influences academic performance and motivation to study. Depending on how they are used, MT can lead to passive learning and non-interactivity or to active learning, in which the student is the central player. Teachers and researchers will know what neuralgic points they need to control and also the strengths to support when using new technologies.

A first objective of the current study was to determine the construct (internal) validity of Romanian version of the Mobile Technologies Questionnaire/MTQ [2]. This brief tool was designed to measure the attitude towards the use of mobile-based learning in higher education. An initial validation study was conducted on a convenience sample with a total of 384 university students who resided in two countries from the Arab Gulfregion (i.e., Oman and United Arab Emirates).

The second objective of our study was to identify the attitude of university students toward the use of MT in the learning process in terms of their gender, place of residence, year of study, academic status and academic major (i.e., study program). Investigating students' attitudes towards the use of MT in higher education is of practical importance. Thus, a favorable attitude could help students in deciding whether or not to adopt the mobile-based learning strategy. Attitudes towards the use of MT in individual/ group study may vary depending on the age, gender, academic major or education level of the students. Understanding how these factors interact with the use of MT in the academic learning process can contribute to the successful implementation of the educational programs that universities develop.

2. Materials and Methods

2.1. Participants

The research sample consists of 575 students from the "Vasile Alecsandri" University of Bacau (Romania). According to the socio-demographic/independent variables, the sample was divided as follows (Table 1).

Table 1. Distribution of participants according to socio-demographic variables.

Socio-Demographic Variables	Categories
Gender	423—female, 152—male
Place of residence	359—urban, 216—rural
Year of study	305—first year, 210—second year, 60—third year
Study program	99—Philology, 115—Education Sciences, 62—Engineering, 117—Physical Education and Physical therapy, 137—Sciences, 45—Economics
Academic status	376—undergraduates, 199—master's students

Out of the total participants, 43 did not complete the open questions of the standardized protocol. Therefore, the final dataset included complete protocols of 532 students (Figure 1).

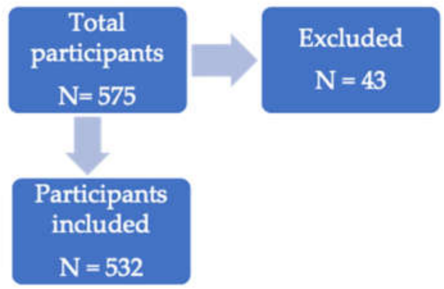

Figure 1. Flow chart of the sampling procedure.

The stratified sampling technique has been used, as it can appropriately capture the socio-demographic characteristics of the population of university students [27].

2.2. Method

The instrument used to explore the students' attitudes and perceptions was the Romanian version of the MTQ [2]. The questionnaire contained ten closed-ended items (see Appendix A). Some items have been adopted from other studies in order to ensure their content validity. Other items were formulated by the authors of MTQ. Items 1, 8 and 9 refer to the usefulness of using the MT in order to organize and manage the individual study. Items 3, 5 and 7 cover the information and materials access and exchange. Items 2 and 6 refer to the increased opportunity of communicating with colleagues and instructors. Items 4 and 10 refer to the perception of self-improvement and development of learning skills. The content validity of the MTQ items was confirmed by qualitative evaluations carried out by three experts (professors at the British University in Dubai). A five-point Likert-type scale has been used as a format for responses. For each item, participants had to choose between five options of answers, where 1 was "Strongly Disagree" (SD), 2—"Disagree" (D), 3—"Undecided" (U), 4—"Agree" (A) and 5—"Strongly agree" (SA). The questionnaire was distributed to the students in printed format at the seminars, because the learning activity predominates in that context. The exploratory factor analysis using the principal component method with Varimax rotation revealed one latent factor. Factor loadings ranged between 0.72 and 0.84. The internal consistency was high (Cronbach's alpha = 0.93).

2.3. Data Analysis

Data analyses were performed using SPSS, version 20.0 (IBM SPSS, Chicago, IL) and AMOS, version 20.0 [28]. In order to determine the factor structure of the MTQ, an exploratory factor analysis using principal components analysis with Varimax rotation and Kaiser normalization was performed. It has been suggested that principal component analysis should be used in establishing preliminary solutions in exploratory factor analysis [29]. The analysis was based on the matrix of correlations among items. To test the suitability of raw data for the reduction of items, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy [30] and Bartlett's test of sphericity [31] were used. The KMO statistic varies between 0 and 1. Kaiser recommended accepting values ≥ 0.50. Furthermore, Kaiser suggested that values between 0.50 and 0.70 are modest, values between 0.70 and 0.80 are good, values between 0.80 and 0.90 are great and values greater than 0.90 are excellent [30]. Furthermore, factor analysis is suitable when Bartlett's test is statistically significant [31]. An extracted factor was retained when its eigenvalue ≥ 1.00. In addition, item absolute loadings of 0.40 or higher were considered significant [32].

In order to test the internal validity of the MTQ, a confirmatory factor analysis with AMOS was carried out. The hypothesized measurement model included two intercorrelated latent factors. The items 1, 2, 3, 5, 6 and 7 (see Table 2) were constrained to load on one first latent factor (i.e., MT facilities for study resources and communication). Item 4, 8, 9 and 10 were taken as observed indicators of the other latent factor (i.e., MT facilities of learning). The analysis was run using the maximum-likelihood (ML) estimation method. The structural equation modeling with the ML method assumes that observed variables have normal distributions [33]. In the present data set, the univariate normality of the distribution for each observed variable (i.e., item score) was evaluated by examining values of skewness and kurtosis. Absolute values of the skewness ranged from 0.63 to 1.96. For kurtosis, the absolute values ranged from 0.02 to 4.78. The multivariate kurtosis (Mardia's coefficient) was equal to 77.10 and was significantly different from zero (CR = 59.67; $p < 0.001$). One approach to handle the presence of non-normal observed variables in structural equation modeling suggests the use of a bootstrapping procedure, which yields more accurate ML estimates of parameters [33]. Therefore, estimates for the hypothetical measurement model of the MTQ ($k = 500$ samples) were obtained by applying the bootstrapping procedure (method based on bias-corrected confidence intervals), which is available in AMOS and corrects for biases in parameter estimates. Assessment of the goodness-of-fit was carried out using the following criteria [33]: the χ^2/df statistic (chi-squared/degree of freedom), CFI (comparative fit index), NFI (normed fit index), IFI (incremental fit index), SRMR (standardized root mean square residual) and RMSEA (root mean square error of approximation) with its confidence interval (CI) at 90%. The conventional overall test for goodness of fit of a hypothesized model is evaluated by chi-square (χ^2). However, χ^2 statistics are sensitive to sample size. Therefore, it is recommended to use this index along with other measures of fit. Thus, χ^2/df is used as an indicator of model fit in confirmatory factor analysis where values ≤ 5.00 are indicative of acceptable model fit. The CFI is among the most widely used goodness-of-fit indexes. This index compares the fit of a hypothetical model to the fit of an independent model, i.e., a model in which the variables are assumed to be uncorrelated. The NFI is used to analyze the discrepancy between the χ^2 value of the hypothesized model and the χ^2 value of the null model. The IFI adjusts the NFI for sample size and degrees of freedom. RMSEA is considered to be one of the most important indicators that show the degree to which the estimated parameters are representative of the population. A non-significant value for χ^2, a value lower than 2 for the χ^2/df statistic, values higher than 0.95 for CFI, NFI and IFI in conjunction with values below 0.05 for SRMR and RMSEA are thought to indicate an excellent model fit [33,34]. Research practice suggests that values above 0.90 for CFI, NFI and IFI accompanied by values as high as 0.08 for SRMR and 0.10 for RMSEA are representative of a reasonable fit when analyzing real data sets (33). Standardized estimates are shown to be suitable with values over 0.40 [32].

The internal consistency of the MTQ scales was estimated by computing the Cronbach's alpha coefficient. Cronbach's alpha reliability coefficient is suitable with values equal to 0.70 or higher [32]. Comparisons by gender, age, year of study, place of residence, academic status and study program were performed using the two-independent-sample *t*-test and One-Way ANOVA. For One-Way ANOVA, post hoc comparisons with Bonferroni correction were performed. A difference was considered as being statistically significant when $p < 0.05$ (two-tailed). The effect size was reported for all significant differences. The significance of the effect size was established taking into account the critical values recommended by Cohen [35]: 0.20—small effect, 0.50—moderate effect, 0.80—large effect. In the case of One-Way ANOVA, Cohen [35] recommended the following standards for the qualitative interpretation of the effect size: 0.10—small effect, 0.25—moderate effect, 0.40—large effect.

3. Results

3.1. Factorial Validity of the MTQ

3.1.1. Exploratory Factor Analysis

The 10 items were subjected to an exploratory factor analysis to examine the factorial validity of the MTQ. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was equal to 0.901, and Bartlett's test of sphericity reached statistical significance (χ^2 = 2210.70; $p < 0.001$). Values of KMO index and Bartlett's test indicated the suitability of the raw data set for the exploratory factor analysis. For all MTQ items, the mean inter-item correlation was 0.40 (range: 0.24–0.61). The communalities ranged from 0.488 to 0.773. The analysis yielded two factors with eigenvalues of 3.13 and 2.67. The first factor (which is identified as MT facilities for study resources and communication) accounted for 31.34% of the total item variance. The second factor (which is identified as MT facilities for learning) accounted for 26.72% of the total item variance. Table 2 summarizes the standardized loadings of the MTQ items in the two latent factors.

Table 2. Rotated factor loadings of the MTQ items.

Items	Components	
	F1	**F2**
Factor 1: MT facilities for study resources and communication		
I5. Accessing course materials anytime and anywhere	0.74	
I7. Facilitating the exchange of course materials with friends	0.71	
I3. Facilitating the finding of resources for study	0.70	
I2. Opportunities for communication and teamwork	0.68	
I1. MT utility for study	0.61	
I6. Obtaining feedback and notifications from teachers	0.52	
Factor 2: MT facilities for learning		
I10. Developing learning skills		0.86
I9. Carrying out homework/projects		0.80
I8. Study management		0.73
I4. Providing opportunities for learning		0.56

As expected, all MTQ items showed loadings greater than 0.40 in one or the other of the two latent factors. No item cross-loading on non-targeted factors was found. For each of the scales corresponding to the extracted factors, an overall score was computed by averaging the score across all corresponding items (possible range: 1–5). The correlation between the two scales was moderate (r = 0.65; $p < 0.001$).

3.1.2. Confirmatory Factor Analysis

The initial two-factor model showed an acceptable fit to data: χ^2 (N = 535, df = 34) = 198.49, $p< 0.001$, χ^2/df = 5.83; CFI = 0.925; NFI = 0.911; IFI = 0.925; SRMR = 0.051; RMSEA = 0.092 (90% CI = 0.080–0.104). The inspection of modification indices suggested the need to correlate a pair of measurement errors, i.e., item 6 (obtaining feedback and notifications from teachers) and item 8 (study management). Therefore, a modified two-factor model allowing the residual variance for items 6 and 8 to correlate showed a slight improvement in the statistical fitting: χ^2 (N = 535, df = 33) = 163.52, $p< 0.001$, χ^2/df = 4.95; CFI = 0.940; NFI = 0.927; IFI = 0.941; SRMR = 0.047; RMSEA = 0.083 (90% CI = 0.071–0.096). Bootstrapped standardized estimates of factor loadings (Figure 2) ranged from 0.56 to 0.75. All estimates were statistically significant ($p < 0.001$). The two latent factors accounted for 31.2%–57.3% of the variance in the MTQ items. Absolute biases (i.e., difference between bootstrapped mean estimates and estimates for the original data set) ranged from 0.0001 to 0.003, which is negligible. The correlation between the two latent factors was equal to 0.79 ($p < 0.001$), thus providing an acceptable level of conceptual distinctiveness.

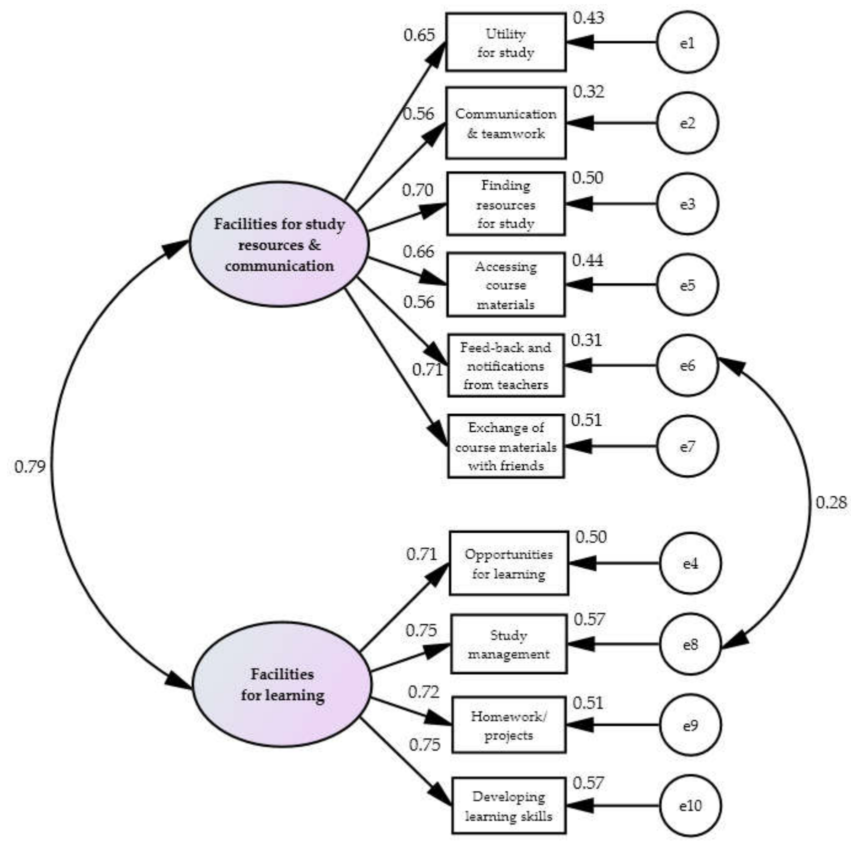

Figure 2. Bootstrapped standardized estimates of the retained factorial model of the MTQ Internal consistency reliability.

The Cronbach's alpha coefficient for facilities for study resources and communication was 0.80. For facilities for learning, the internal consistency was 0.82. These values indicate a suitable reliability of the MTQ scales.

3.2. Descriptive and Comparative Data on Students' Attitude towards MT Use in the Academic Activities

The means, medians and standard deviations for the distribution of scores for the two scales were computed. The results of the descriptive statistical analysis indicate a positive attitude students have towards MT use in their own academic activities (e.g., individual study, learning process, exchange of course materials and communication with teachers and colleagues) (Table 3).

Table 3. Descriptive data on students' attitude towards MT.

Variables	***M***	**Median**	***SD***
I1. MT utility for study	4.28	4.00	0.84
I2. Opportunities for communication and teamwork	4.38	5.00	0.83
I3. Facilitating the finding of resources for study	4.41	5.00	0.75
I4. Providing opportunities for learning	4.14	4.00	0.84
I5. Accessing course materials anytime and anywhere	4.46	5.00	0.81
I6. Obtaining feedback and notifications from teachers	4.02	4.00	0.97
I7. Facilitating the exchange of course materials with friends	4.46	5.00	0.81
I8. Study management	3.80	4.00	1.02

I9. Carrying out homework/projects	3.98	4.00	0.97
I10. Developing learning skills	3.69	4.00	1.09
MT facilities for study resources and communication (overall score)	4.33	4.50	0.59
MT facilities for learning (overall score)	3.90	4.00	0.79

Table 4 shows the means and standard deviations for the two scales according to participants' gender, age, year of study, place of residence, academic status and study program.

Table 4. Comparative data on students' attitude towards MT.

Independent Variables	**MT Facilities for Study Resources and Communication**		**MT Facilities for Learning**	
	M	*SD*	*M*	*SD*
Gender				
Male (N = 152)	4.34	0.56	3.91	0.80
Female (N = 423)	4.32	0.60	3.89	0.79
Age				
19-34 years old (N= 471)	4.32	0.60	3.86	0.79
≥ 35 years old (N = 104)	4.38	0.58	4.10	0.75
Year of study				
1st year (N = 305)	4.35	0.54	3.95	0.76
2nd year (N = 210)	4.25	0.67	3.77	0.85
3rd year (N = 60)	4.47	0.52	4.11	0.69
Place of residence				
Urban (N = 359)	4.38	0.56	3.93	0.82
Rural (N = 216)	4.25	0.64	3.85	0.75
Academic status				
First-level study programme (N = 376)	4.27	0.60	3.82	0.78
Master's student (N = 199)	4.44	0.56	4.05	0.80
Study programme				
Philology (N = 99)	4.28	0.72	3.80	0.90
Education Sciences (N = 115)	4.40	0.49	3.99	0.80
Engineering (N = 62)	4.36	0.63	3.93	0.84
Physical education and Physical therapy (N = 117)	4.44	0.48	4.01	0.65
Sciences (N = 137)	4.20	0.62	3.75	0.80
Economics (N = 45)	4.34	0.61	4.04	0.72

The participants' gender did not reveal a significant effect on either the score for MT facilities for study resources and communication (t = 0.31; $p > 0.05$) or the score for MT facilities for learning (t = 0.24; $p > 0.05$). The age of the participants did not have a significant effect on the score for MT facilities for study resources and communication (t = –1.03; $p > 0.05$). In contrast, the difference for the facilities that MT offers in the learning process was statistically significant (t = –2.79; $p < 0.01$), compared to participants aged 19 to 34, those older than or equal to 35 scored higher. However, the effect size was modest ($d = 0.31$).

The place of residence showed a significant effect only on the score for facilities that affect MT for study and communication (t = 2.52; $p < 0.05$), although the effect size was small ($d = 0.22$). Compared to participants living in rural areas, those living in urban areas scored higher on facilities that offer MT for study and communication. For facilities that offer MT for learning, the difference according to the place of residence was not statistically significant (t = 1.09; $p > 0.05$).

The year of study had significant overall effects on both the score for MT facilities for study resources and communication (F = 3.64; $p < 0.05$) and the score for MT facilities for learning (F = 5.30; $p < 0.01$). For both differences, the effect size was small ($f = 0.11$ and $f = 0.13$, respectively). However, for the facilities that offers MT for study and communication, the participants who were in the third year of their academic studies revealed a significantly higher mean score (t = 2.50; $p < 0.05$) than those who were in the second year. As for the facilities that offer MT for learning, the participants who were in the first year of study scored higher (t = 2.47; $p < 0.05$) than participants who were in the second year. Furthermore, the participants who were in the third year of study scored higher (t = 2.91; $p < 0.01$) than those who were in the second year of their academic studies.

The participants' academic status revealed significant effects on both the score for facilities that offer MT for study and communication (t = –3.14; $p < 0.01$) and the score for facilities that offer MT for the learning process (t = –3.37; $p < 0.01$). However, for both differences, the effect size was modest ($d = 0.29$). Compared to participants who were enrolled in a first-level study program (bachelor's degree), those who attended a master's program scored higher for both MTQ scales.

As for the study program, the comparative data revealed significant overall effects on both MTQ scales (F = 2.64, $p < 0.05$ for facilities that offer MT for study and communication; F = 2.33, $p < 0.05$ for facilities that offer MT for the learning process). For both dimensions, the effect size was small ($f = 0.15$ and $f = 0.14$, respectively). The post hoc analysis yielded only one statistically significant difference (t = 3.21; $p < 0.01$), namely for facilities that offer MT for study and communication. Compared to participants who were enrolled in a science study program (e.g., mathematics, informatics, biology), those who were enrolled in physical education and physical therapy programs showed a higher score on facilities that MT offer to study and communication.

4. Discussion

Exploratory factor analysis revealed two latent factors, i.e., MT facilities for study resources and communication and MT facilities for learning. Together, the two factors accounted for 58.06% of the total item variance. Confirmatory factor analysis strengthened the evidence on the construct validity of the MTQ. The correlation between the two factors (as well as between the corresponding scales) justifies their separate use for assessing the attitude students have towards the use of MT in the academic learning process. Scales corresponding to the latent factors revealed good internal consistency and reliability. The current study provides additional statistical support for the construct validity of the MTQ. However, the data we obtained are not consistent with the factorial structure that the authors of the MTQ reported in their original work [2]. The exploratory factor analysis authors performed revealed only one latent factor with a high internal-consistency. Therefore, we consider that new psychometric investigations are needed to clarify the underlying dimensions that MTQ captures. If a researcher is not interested in refining the dimensions of the attitude students express towards the use of MT in an academic setting, an overall MTQ score can be derived. Due to its shortness and intelligibility of items, the MTQ can be useful in research projects where a large number of variables are used.

In our study, we also analyzed the relationships between the use of MT in the learning process and socio-demographic variables. Several studies have focused on the relationships between different socio-demographic variables and the use of MT by university students. Thus, the gender [36], age [37,38] or place of residence [39] came to the attention of researchers. Furthermore, studies correlate the use of MT with other variables, such as learning outcomes [40], performance expectation, effort that learners spend, social influence, facilitating conditions [41], academic discipline or educational environment [38]. Other studies were interested in students' perception of mobile-based learning, but did not consider the relationships between attitude towards the use of MT and socio-demographic variables such as gender, age, residence, level of education or academic major.

No significant difference has been noticed between female and male students in terms of their attitude towards the use of MT in higher education. Our findings are convergent with those reported in other studies [1,38,40,42–45]. A possible explanation for these convergent findings must take into account that, regardless of the users' gender, the information, communication and learning technologies are key components of adjustment and performance in different learning and professional settings. Other studies found that female students were more prone to use MT in their learning/social activities than male students [36,46,47]. One study points out that "gender had a significant impact on the rate of educational use of mobile phone among the university students. Female students have more educational use of mobile phone in comparison to male students" [36] (p. 1106). Furthermore, a comprehensive synthesis of several studies indicates that "…women engaged in group learning with video spend more time in the application, women in group learning with video have higher peer-influenced learning scores" [46] (p. 61). B. Skog [48] argues that preferences regarding the use of the mobile phone differ as males focus on technical functions while females give importance to social aspects. Some researchers [49] appreciate that there is a high predisposition for the use of mobile devices in the learning process that can be influenced to a moderate extent by socio-demographic variables (e.g., age or gender). Therefore, the relationship between the use of MT in the academic setting and students' gender requires more research.

The place of residence revealed a significant effect only on the facilities that offer MT for study and communication. Compared to students living in rural areas, urban residents scored higher on facilities for study resources and communication. However, the effect size was small. It is possible that the difference we obtained was accidental. However, we should note that other studies [38,49] reported variations depending on the indicators targeted. For example, with respect to the attitude towards usability and preferability of using MT, the university students residing in rural areas did not differ from those residing in urban areas. Instead, in terms of attitude towards barriers of using MT for educational purpose, rural undergraduate students expressed a less favorable attitude compared to urban students. In very poor countries, there is a well-known discrepancy between the resources held by rural residents and those in urban areas. In addition, people living in rural areas throughout their lives might find it difficult to cope with the new advanced information and communication technology [38]. In some predominantly rural countries (e.g., India or Romania), MT may facilitate working at home for young people living in rural areas. However, the relationship between the students' place of residence and the use of MT for academic preparation and learning should be contextualized depending on the global socio-cultural context, the students' economic status and the indicators used to measure attitudes towards the use of MT for educational purpose.

For the facilities that MT offers to study and communication, undergraduate students who were in the third year of their academic education scored significantly higher than those who were in the second year. As for the facilities that MT offers for learning, students who were in the first year of study scored higher than those who were in the second year, while students who were in the third year of study scored significantly higher than students who were in the second year. Furthermore, compared to undergraduate students, those who attended a master's program scored higher for both MTQ scales. These findings may reflect the different educational needs of students in the two successive stages of higher education. In addition, master's students may face an increasing need for individual study, which is why MT can be a valued resource.

One-way analysis of variance was conducted in order to examine whether there is a significant difference among undergraduate/ master's students regarding attitude towards use of MT in terms of the study program. The results of ANOVA revealed a significant difference among students' attitude in terms of academic major both for facilities that MT offer to study and communication and the impact of MT on the learning process. However, the strength of relationship between the study program and the attitude towards use of MT for educational purposes, as assessed by *f*-Cohen, was low. Compared to students who were enrolled in a science study program, those who were enrolled in the physical education and physical therapy program scored significantly higher on facilities that MT offers to study and communication. This difference can be explained by the nature of the curricular contents and academic tasks used by students enrolled in different study programs. Thus, for students who follow a science study program (e.g., mathematics or informatics), the applications and options that a smartphone offers may prove insufficient, given the complexity of knowledge and the academic tasks. However, it should be noted that while some studies did not identify significant differences among students' attitudes toward mobile-based learning in terms of their academic majors [2,24], other investigations showed that students' attitude towards the sustainable use of MT in the learning process is impacted by the academic major [50]. Regardless of the academic status and major, it must be emphasized that given the current pandemic context that favors online teaching, learning and evaluation, the use of MT is a means of making the time and digital resources more flexible in the students' academic activity.

5. Conclusions

Advances in mobile and wireless technologies have influenced the dynamics of human society including how education can be designed and implemented. Presently, mobile devices are used for various purposes to meet different needs. Since lifelong learning and development are core requirements for human beings, smartphones have become increasingly used in all sectors of education.

The systematic integration of MT in the instructional process that takes place in higher education provides students with new instrumental resources that can support learning and facilitate creative work. Successful implementation of MT in higher education can be facilitated by the favorable attitude that students have towards technological innovations. The first objective of the current study was to investigate the construct validity of the Romanian version of a brief instrument (MTQ). It was designed to measure the attitude that university students have towards the use of MT in their own instruction. The metric model with two intercorrelated latent factors proved an acceptable statistical fit with the input data. These factors showed good reliability. The correlation between the two latent factors (as well as between the corresponding scales) provides support for their conceptual separateness. The factors we have identified (i.e., MT facilities for study resources and communication and MT facilities for learning) can be used simultaneously or independently to evaluate the components of the attitude that university students have towards the use of MT in their academic instruction.

The second objective of our study was to explore the differences between university students regarding their attitude towards the use of MT in terms of gender, age, residence, year of study, academic status and study program. Through this approach, we aimed to identify the profile of socio-demographic characteristics that differentiate the attitude that university students have towards the integration of MT in the instructional process. Based on possible differences, we can better target educational interventions aimed at expanding the use of MT by university students in their academic work. Comparative data revealed some differences depending on residence, year of study, academic status and study program. However, the effect sizes were small or modest. Our findings suggest that, regardless of socio-demographic and academic background, university students may be open to using MT in their learning and to more easily achieve their academic goals. Another explanation is that almost all students are highly aware of the benefits that MT can bring to their own academic work. In addition, most students have strong skills in the use of MT for various educational purposes.

The new generation of wireless technologies and mobile devices makes it possible for students to learn interactively, collaborate and share ideas with each other. It has become an important educational technology component in higher education all over the world. The use of MT can contribute to improving the teaching–learning and assessment process in higher education. This is the main reason why investigating the attitude that university students have towards the use of MT in their academic activity acquires practical importance. Future studies should also focus on the ethical aspects of using these technologies for educational purposes.

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Informed Consent Statement: Participants expressed their consent to complete the questionnaire, stating that they had read all relevant information and agreed to continue. They were also informed of their right to withdraw from the survey at any time.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Survey structure of students' attitude towards mobile technologies.

No.	Items	SD (1)	D (2)	Un (3)	A (4)	SA (5)
1	Mobile technology is a useful tool for my study.					
2	Mobile technology can offer opportunities for communication and team-working.					
3	Mobile technology can help me in finding resources related to my study.					
4	Mobile technology can bring many opportunities to the learning process.					
5	Mobile technology can help me to access the course-material anytime anywhere.					
6	Mobile technology can be an easy way to get feedback and notifications from my instructors.					
7	Mobile technology can help me to exchange the course-material with my friends.					
8	Mobile Apps can help me to manage my study.					
9	Mobile technology can help me to do my coursework.					
10	Mobile technology can help me to develop my learning skills.					

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