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Mobile learning usage and acceptance: perceptions of secondary school students

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Abstract The use of mobile devices among secondary school students is increasingly more common; however, mobile learning and mobile technology acceptance research in secondary education is still limited. This study investigated secondary school students' perceptions regarding mobile device usage and mobile learning acceptance. A questionnaire was administered to 530 students aged 12–18 years old, in Greece. The study revealed that mobile phone was the predominant device which is used daily by almost all students. 83% of the sample goes online via a mobile device several times per day. 65% of the sample described themselves as advanced mobile device users, and 11% perceived themselves as experts. Students expressed positive perceptions indicating mobile learning acceptance. The higher the grade (or age group), the higher the frequency of going online via a mobile device, and the more the years of using a mobile device, the more positive were students' perceptions. Implications for educational policy makers, teachers, and students are discussed.

Keywords Mobile learning acceptance · Mobile devices · Performance expectancy · Effort expectancy · Secondary schools

Introduction

Innovations in smart phones and other mobile/portable devices allow students to have mobile access to email, library staff, videos, internet information resources, course documents, and collaboration on projects. Researchers have called the

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learning mode that employs mobile technology/devices to facilitate or support learning, mobile learning (m-learning). Mobile learning has been defined as the process of learning mediated by handheld devices such as smart phones and tablet computers (Schuler et al. 2012), or as the learning context in which learners, for example, access a mobile network to conduct their learning, anytime and anywhere, whether in or out of the classroom (Song 2014). For the purpose of this paper, it is adopted that mobile learning can be defined as facilitating and enhancing the learning process via mobile devices anytime and anywhere, while the use of mobile devices in education (known as m-learning) is considered along with its potential pedagogical benefits such as enhancement of students' motivation, achievement and communication (Baydas and Yilmaz 2018).

Evidence reports on the high penetration rate of mobile devices and their high popularity among the school-age population, particularly in the teenage years (Rau et al. 2008; Chee et al. 2017). The rapid development of mobile technology together with secondary school students' increased ownership of mobile devices with internet access, have the potential to expand communication methods, collaborative learning (Fu and Hwang 2018; Heflin et al. 2017), access to traditional learning, and access to information resources (Donaldson 2011). Recent reviews regarding mobile learning research reported on the promotion of students' learning performances and motivation (Chang and Hwang 2019; Crompton et al. 2017), as well as on students' learning/perceptions of specific subjects such as language (Hwang and Fu 2018; Kukulska-Hulme and Viberg 2018), science (Bano et al. 2018; Bellou et al. 2018) and mathematics (Bano et al. 2018; Fabian et al. 2016). The use of mobile devices among secondary school students is increasingly more common (Christensen and Knezek 2018), while mobile learning and mobile technology acceptance research in secondary education is still limited (Hwang et al. 2018). The purpose of this study was to investigate Greek secondary school students' perceptions regarding mobile device usage and mobile learning acceptance.

Regarding the Greek context, the ITU report (2017) ranked Greece among a higher scoring European nation in the information and communication technologies development index (IDI); ranking 38th (IDI = 7.23) out of 40 global economies. Within the Greek formal educational context, mobile learning is in its infancy. For example, mobile phone use is officially banned, but during the school intervals (despite the ban), several students "switch on" their mobile phones in order to take photos/videos, send messages or enter social networking sites (Nikolopoulou and Gialamas 2017), while within semi-formal settings/contexts pre-determined by a teacher (such as school projects, museums and field trips), students are allowed/encouraged to use their mobile devices. Significant causes of restricting mobile phone use in schools are the protection of privacy (e.g., pupils taking photos of their peers/teachers in the classroom) and the possibility of sending messages that can lead to cheating. There are very few studies regarding teachers' or students' attitudes. Kousloglou and Syrpi (2018) investigated Greek secondary school teachers' perceptions on the use of mobile phones for educational purposes; around 38% of the sample said they often use mobile phones/tablets for educational purposes, while 75% of respondents expressed willingness to integrate mobile devices in the learning process (they said, it is likely to increase students' interest/motivation), if the

law allows it. When teachers allow their students to use mobile phones, this happens under supervision (e.g., in clubs, during school projects, physics experiments or extra-curricular activities). Regarding Greek secondary school students, recent studies indicated positive attitudes and high self-efficacy toward mobile devices' usage (Nikolopoulou and Gialamas 2017), little self-perceived mobile phone dependence (Nikolopoulou and Gialamas 2018), and positive perceptions with reference to the iPad being an excellent tool that helps them organize and understand the course (Retalis et al. 2018). Nikou and Economides (2018) proposed a series of mobile-based micro-learning and assessment activities for secondary school students of science, and indicated improvement of student learning performance and enhancement of motivation. The topic of mobile learning is not covered in the literature in the Greek context and the findings of this study are expected to have implications for the broader school community (policymakers, teachers and students).

Literature review

Secondary school students' mobile device ownership and usage

Information access and usage have been significantly influenced by the ownership/adoption of mobile devices. Mobile devices enhanced with social media and wireless connectivity enable highly personalized learning opportunities for students, while there are opportunities for interaction, collaboration and content creation (Gikas and Grant 2013). A recent review demonstrated that smartphones and tablet computers were the devices with new technology which were used widely in the last years (Fu and Hwang 2018). Biloš et al. (2017) investigated mobile learning usage and preferences of vocational secondary school students in three countries; Austria, the Czech Republic, and Germany. Their research confirmed a high level of mobile device usage among secondary school students on a daily basis; smartphones and laptops were the most commonly used devices. The majority of respondents (90.8%) were categorized as extensive internet users, while 68% perceived themselves to be advanced mobile device users.

Grimus and Ebner (2014) examined the ownership and usage of mobile phones of students aged 10-14 years old, in lower secondary schools in Austria. 52% of students owned a mobile phone with internet access, and there was a slight increase on internet surfing throughout the years (between 2009 and 2013). A recently published report in the USA (Anderson and Jiang 2018) revealed that 95% of teenagers (ages 13–17 years old) reported going online daily via their smartphone, while 45% said they are online almost constantly. Bartholomew and Reeve (2018) surveyed middle-school students regarding their perceptions of how they would use mobile devices, if given the opportunity, during school (an under-researched area). Students were allowed to use mobile devices during a 2-week engineering design unit and were asked to report their actual use of mobile devices. Several gaps between perceptions of how mobile devices would be used and the actual use by students emerged (students did not use mobile devices as often as they planned).

Secondary school students' perceptions regarding mobile learning acceptance

Previous studies revealed that the attitude toward a new technology plays an important role in its acceptance and usage (Peng et al. 2006). In view of its educational potential, the acceptance of mobile learning in education is important (Baydas and Yilmaz 2018). Prior studies highlighted students' perceptions toward mobile devices and mobile learning; however, despite the significant growth and capabilities of mobile technology, wireless mobile learning still remains in its infancy stage (Wang et al. 2009), in particular in secondary education sector. Poll (2014) examined elementary and high school students' perceptions toward mobile devices. Across all grade levels, about one-third of the sample reported they were "early adopters," among the first to try a new electronic device or gadget, while over 50% of the sample would like to use mobile devices more often in the classroom. Pupils at all grade levels felt that tablets make learning more fun, help them to do better in class, and to learn in a way that is best for them. Three quarters of high school students said they know more about technology than their teachers, and also boys and girls shared similar attitudes.

Positive perceptions toward mobile learning were indicated among teenagers in different countries, such as Greece, China, Italy, Northern Cyprus, Canada, Malaysia and Taiwan. A recent study carried out by the author (Nikolopoulou and Gialamas 2017) investigated Greek junior high school students' attitudes and self-efficacy of using mobile devices. Pupils' attitudes were positive, and most of the students (over 87%) expressed high self-efficacy in using mobile devices; higher self-efficacy was linked to positive perspectives, to greater willingness to use mobile devices, and to favorable perceptions toward their independent control. Cheng and Haagen (2015) reported from a high school in China, where students in two 11th grade classes were given a tablet to try out: 90% of students stated that the mobile devices had proven useful particularly in learning English. Ozdamli and Uzunboylu (2015) reported positive perceptions toward mobile learning among secondary school students (12–18 years old) in Northern Cyprus. Students were using their mobile phones and laptops at their best level, although their competence level was not yet sufficient. Teenagers aged 13–17 years old, in Malaysia, expressed positive perceptions toward the use of mobile devices for gaming, entertainment, and learning purposes, although they had little experience in using mobile devices for learning related activities (Kee and Samsudin 2014). Using mobile devices to perform ubiquitous learning was much dependent on the individual's preference, interest and self-motivation. Other characteristics, such as age group (Wang et al. 2012), gender and frequency of devices' use (Villani et al. 2018) were found to impact students' perceptions and attitudes toward the use of mobile technologies.

Villani et al. (2018) explored Italian high school (14–18 years old) students' acceptance of tablet PC in order to outline the typical students' profiles and to compare the acceptance conveyed in two types of use (learning and communicative activities at school). Their results indicated high, moderate, and low acceptance, and significant differences in gender, grade level, and usage frequency. The acceptance of tablets and the recognition of opportunities for learning were stronger for middle grade students, and moderate in younger and older students, while the higher the

frequency of use the stronger were students' perceptions. Parmigiani et al. (2015) carried out a case study with upper secondary school students, aiming to analyze the role of mobile devices for the development of students' motivation and concentration. Pupils' views revealed that the mobile devices improved and fostered their motivation to study. A large scale survey (Karsenti and Fievez 2013) of over 6000 secondary school students using iPads in Canada, found students divided over key benefits with a quarter to a half of them mentioning access to information, quality of student presentations, creativity and motivation. Hwang et al. (2018), in Taiwan, investigated the relationships between high school students' perceptions of mobile learning and their tendencies of peer interaction and higher-order thinking in issue-based mobile learning activities. Their study revealed that the provision of adaptive content in the mobile learning had positive impacts on the students' tendency to interact with peers (i.e., collaboration and communication), which further affected their tendency to engage in higher-order thinking (i.e., problem-solving, critical thinking).

Mobile learning acceptance and constructs from the UTAUT model

In researching mobile learning acceptance, some researchers (see Al-Shihi et al. 2018; Baydas and Yilmaz 2018) used constructs from the UTAUT (Unified Theory of Acceptance and Use of Technology) model, as proposed by Venkatesh et al. (2003). Two salient variables/constructs of this model are "performance expectancy" and "effort expectancy"; "performance expectancy" is the degree to which an individual believes that using the system will help him/her to attain gains in job performance, while "effort expectancy" is the degree of ease associated with the use of the information system. The study of Wang et al. (2009), based on the UTAUT, with elementary and secondary school students and young adults in Taiwan, found that performance expectancy, effort expectancy, social influence, perceived playfulness, and self-management of learning were all significant determinants of behavioral intention to use mobile learning. They also found that age differences moderate the effects of effort expectancy and social influence on mobile learning use intention, and that gender differences moderate the effects of social influence and self-management of learning on m-learning use intention. Osakwe et al. (2017) used the UTAUT as a guiding model to analyze learner perceptions toward mobile learning; their findings were that the majority of students in Namibian high schools own handheld mobile devices and were positive that mobile technology would enhance their learning capabilities, assist in improving their grades and accomplish learning activities quickly. Recently, Cacciamani et al. (2018) with reference to the UTAUT, analyzed the factors influencing high school students' acceptance of tablets in schools; their results showed that empowerment in learning, perceived usefulness, and support conditions affected learning use.

Taken into account the above-mentioned research and the widespread use of mobile devices among students aged 12–18 years old, it is important to investigate secondary school students' mobile devices' usage and mobile learning acceptance. The results may be useful for researchers, educational policymakers, as well as

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teachers. Investigating adolescents' perceptions is important, since the acceptance of mobile learning is critical to the successful implementation of mobile learning in both formal and informal contexts.

Research questions of the study

The following research questions were addressed:

1. Which types of mobile device do students own—use and how do students perceive themselves as mobile device users?
2. What are the students' perceptions regarding mobile learning acceptance?
3. Is there a significant difference in students' perceptions with regard to specific characteristics? (gender, age group or grade, years of using a mobile device with internet access, frequency of going online via a mobile device).

Method

Sample

The sample consisted of 530 secondary school students of two public (state) schools in Piraeus, in Greece. Demographic and individual characteristics of the sample (age group—grade, gender, years of using a mobile device with internet access, frequency of going online via a mobile device) are shown in Table 1. The age of students ranged from 12 to 18 years old. Around 52% of the students have 3-5 years experience in using a mobile device with internet access, and 31% have more than 5 years of experience. Over 83% reported they go online via their mobile device several times per day. The questionnaire was administered in the middle of

Table 1 Characteristics of the sample (530 students)

Age group	Gender
12–13 years old (or year 7) (18.9%)	Male (56.8%)
13–14 years old (or year 8) (13.2%)	Female (43.2%)
14–15 years old (or year 9) (17%)	
15–16 years old (or year 10) (19.8%)	
16–17 years old (or year 11) (16%)	
17–18 years old (or year 12) (15.1%)	
Ownership of a mobile device with internet access: yes (99.2%)	

Years of using a mobile device with internet access	Frequency of going online via a mobile device
More than 5 years (31.3%)	Several times per day (83.4%)
3–5 years (51.9%)	Around once per day (12.8%)
1–2 years (13.6%)	2–4 times per week (2.3%)
Less than a year (2.8%)	2–4 times per month (0.9%)

the academic year 2017–2018, during class time, with the teacher present and all students completed the survey ($n = 530$, response rate 100%). The responses were anonymous, and the students were assured that there was no right or wrong answer. Official permission was obtained from the Greek Ministry of Education since this study constituted part of a larger project carried out by the author-researcher (number 104989/D2, 28-06-2016).

The research instrument

Data were collected by the use of a questionnaire, which consisted of two sections. Section A involved statements regarding students' characteristics (age group and grade, gender, ownership and frequency of usage of different types of mobile devices, ownership of a mobile device with internet access, years of using a mobile device with internet access, and frequency of going online via a mobile device). This section also aimed to identify students' perceptions as mobile device users. Regarding the perceived mobile device user type, category descriptions were provided to describe and clarify the differences between categories (taken from Biloš et al. 2017):

- *Novice* I have been using a mobile device for less than 6 months and have only a few apps installed. I use my mobile device for calls, texting, and e-mail.
- *Intermediate* I have been using a mobile device for more than 6 months. I occasionally download apps when I have a need or when my friends recommend something new.
- *Advanced* I have been using a mobile device for 2+ years and have installed and used a variety of different apps. I often install many of the same types of apps to evaluate differences and make recommendations to my friends about the best ones.
- *Expert* I have developed my own mobile apps.

Section B involved 13 statements/items aiming to investigate students' perceptions regarding mobile learning acceptance, and were all taken from the relevant literature. Four items regarded the construct "performance expectancy" (PE), four items the construct "effort expectancy" (EE), and five items the construct "perceived playfulness" (PP). The first two constructs were taken and explained by the Unified Theory of Acceptance and Use of Technology (UTAUT) model. The UTAUT, as proposed by Venkatesh et al. (2003), integrated components across eight prominent models of technology acceptance in information technology research; the researchers validated the questionnaire instrument with performance expectancy, effort expectancy, social influence, and facilitating conditions, as the four core determinants of intention. Venkatesh et al. (2003) confirmed the considerable enhancement in explaining information technology usage behavior by the UTAUT, and also encouraged other scholars to validate and test the model with different technologies, contexts, and users. UTAUT is applicable in the context of m-learning and it can be a useful tool to explore the implementation challenges of m-learning. "Performance

expectancy" is the degree to which an individual believes that using the system will help him/her to attain gains in job performance, while "effort expectancy" is the degree of ease associated with the use of the system. The construct "perceived playfulness" is an additional one added to the UTAUT model by Wang et al. (2009); perceived playfulness was a predictor variable for the behavioral intention to use mobile learning. The dimensions of perceived playfulness, as defined by Wang et al. (2009), and used in this study are: the extent to which individuals perceive their attention is focused on the interaction with the mobile learning (i.e., concentration), are curious during the interaction (i.e., curiosity), and find the interaction intrinsically interesting or enjoyable (i.e., enjoyment). The above three constructs were chosen so as to also be relevant to Greek context. All items were initially translated into the Greek language by the author-researcher with the help of a linguistic expert. Then, the instrument was piloted with 15 students (who did not participate in the main survey) in order to check that there were no difficulties or ambiguities in interpreting the statements. The 13 items were presented in mixed order, and the students were asked to rate their views on a 4-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree).

Data analysis

The statistical software SPSS version 20.0 (2011) was used for managing the data and conducting the statistical analyses (descriptive statistics, factor analysis, and correlation analysis). Monte Carlo PCA for Parallel analysis (Watkins 2000) was used to conduct a Parallel analysis.

Results

Mobile device ownership: usage and students' perceptions as mobile device users

Table 2 displays students' ownership—usage of mobile devices and their perceptions as mobile device users (530 students). The study revealed that the mobile phone was the primary/predominant device which is used daily by almost all students. The mobile phone was followed by the laptop which was reported to be used daily by 27.9% and weekly by 30% of the sample. The tablet was the device owned and used by fewer students; 36.4% of the students do not possess a tablet. Students aged older than 14 years possess a tablet in a significant smaller percent in comparison to students aged 12–14 years old [$\chi^2(5) = 24.8$, $p < 0.001$, see Table 3]. Since over 83% of the students go online via their mobile device several times per day (Table 1), the majority of them can be categorized as extensive internet users. Using an elaborated 4-level experience scale (novice, intermediate, advanced, and expert), almost 65% described themselves as advanced mobile device users, and 11% perceived themselves as expert mobile device users (Table 2).

Table 2 Students' ownership—usage of mobile devices and their perceptions as mobile device users (530 students)

	Mobile phone	Tablet	Laptop
Daily	96.4%	10.9%	27.9%
Weekly (2–4 times per week)	1.3%	14.7%	30.4%
Monthly (2–4 times per month)	1.1%	11.9%	15.5%
Less than once per month	0.2%	26%	11.3%
Does not own the device	0.9%	36.4%	14.9%
Perceptions on mobile device user type			
Novice (0.9%)			
Intermediate (22.8%)			
Advanced (65.1%)			
Expert (11.1%)			

Descriptive measures for students' perceptions regarding mobile learning acceptance

To explore students' perceptions regarding mobile learning acceptance, a descriptive analysis was performed. Table 4 shows students' response percentage frequencies on the 13 items of the questionnaire ($n = 530$ students). The last column of the Table has added together the percentages of those who "agree" and "strongly agree." Several students expressed positive perceptions indicating mobile learning acceptance; in particular, strong "effort expectancy" and "performance expectancy" perceptions. More specifically, over 80% of the sample, "agree and strongly agree" with the items EE4, EE3, PE1, PE2, and EE2. The items "Learning to operate mobile learning is easy for me" (for EE4: 85.9%), "I would find mobile learning easy to use" (for EE3: 85.4%) and "It would be easy for me to become skilful at using mobile learning" (for EE2: 81.3%) belong to the construct "effort expectancy," while the items "I would find mobile learning useful in my learning" (for PE1: 84.3%) and "Using mobile learning enables me to accomplish learning activities more quickly" (for PE2: 82%) belong to the construct "performance expectancy."

An exploratory factor analysis was performed, using Principal Axis Factoring method accompanied by the Promax rotation method with Kaiser Normalization, in order to investigate the factorial validity of the 13-item perceptions questionnaire. KMO coefficient of sampling adequacy, 0.85, was satisfactory. The scree plot (Fig. 1) and the parallel analysis results supported a three factor solution which was retained for interpretation. The first factor (F1), labeled "performance expectancy," was associated with eight items: Using mobile learning increases my learning productivity, Using mobile learning will stimulate my curiosity, Using mobile learning will give enjoyment to me for my learning, I would find mobile learning useful in my learning, Using mobile learning enables me to accomplish learning activities more quickly, Using mobile learning will lead to my exploration, If I use mobile learning, I will increase my chances of getting a better grade, and My interaction with mobile learning would be clear and understandable. The second factor (F2), labeled "effort expectancy," was associated with three items: I would find mobile learning easy to use, Learning to operate mobile learning is easy for me, and It

Table 3 Ownership of tablet by grade (or age group) (530 students)

		Grade (age group)						Total (%)
		12–13 (%)	13–14 (%)	14–15 (%)	15–16 (%)	16–17 (%)	17–18 (%)	
Owns a tablet	% within grade	76	80	57.8	60	60	48.8	63.6
Does not own a tablet		24	20	42.2	40	40	51.2	36.4
Total		100	100	100	100	100	100	100

$\chi^2(5) = 24.8$, $p < 0.001$

Table 4 Students' response percentage frequencies on the 13 items (*n* = 530 students)

|	Strongly disagree	Disagree	Agree	Strongly agree	Agree and strongly agree
EE4: learning to operate mobile learning is easy for me	5.5	8.7	37.2	48.7	85.9
EE3: I would find mobile learning easy to use	3.2	11.3	42.6	42.8	85.4
PE1: I would find mobile learning useful in my learning	2.8	12.8	59.8	24.5	84.3
PE2: using mobile learning enables me to accomplish learning activities more quickly	4.2	13.8	44.3	37.7	82
EE2: it would be easy for me to become skilful at using mobile learning	3.6	15.1	44.3	37	81.3
PP5: using mobile learning will lead to my exploration	5.8	21.5	50.6	22.1	72.7
EE1: my interaction with mobile learning would be clear and understandable	5.7	25	49.4	19.6	69
PP4: using mobile learning will stimulate my curiosity	5.5	28.9	44	21.7	65.7
PP1: when using mobile learning, I will not realize the time elapsed	6.2	28.5	32.8	32.5	65.3
PE3: using mobile learning increases my learning productivity	5.1	35.1	42.6	17.2	59.8
PP3: using mobile learning will give enjoyment to me for my learning	9.8	32.3	39	18.5	57.5
PE4: if I use mobile learning, I will increase my chances of getting a better grade	7.2	37.9	36.6	18.3	54.9
PP2: when using mobile learning, I will forget the work I must do	16	40.8	27.7	15.5	43.2
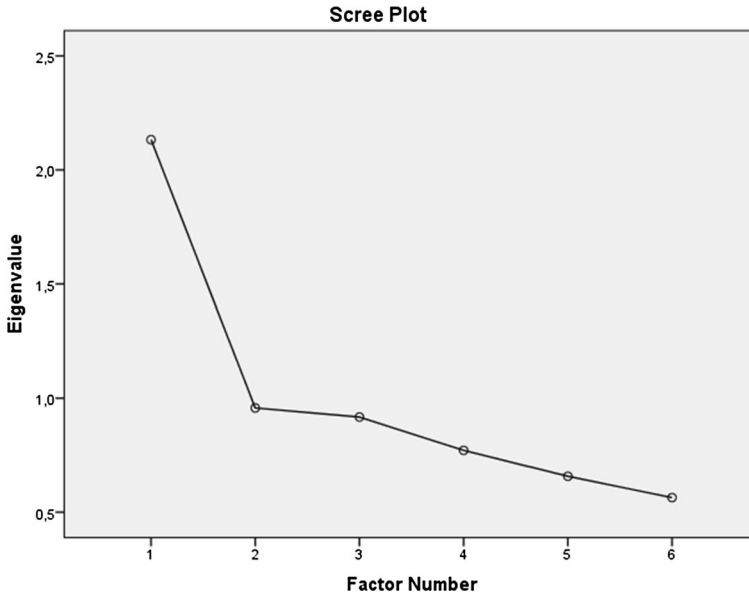
Fig. 1 Scree plot of eigenvalues extracted by factor analysis on the 13 perception items

would be easy for me to become skilful at using mobile learning. The third factor (F3), labeled "perceived playfulness," was associated with two items: When using mobile learning, I will forget the work I must do, and using mobile learning, I will not realize the time elapsed. Table 5 displays the loadings and the Chronbach-a coefficient for internal consistency for each factor (F1–F3), as well as the means and standard deviations for each item. The factors "performance expectancy" and "effort expectancy" showed an acceptable internal consistency (Chronbach-a coefficients were 0.82 and 0.78, respectively), while the third factor "perceived playfulness" had low reliability (Chronbach-a = 0.49). It is noteworthy that the last factor had only two items, which could be linked to some sort of dependence to mobile devices. The remaining three items of the original "perceived playfulness" construct (i.e., PP4, PP3, PP5, in Wang et al. 2009) load on the factor Mediocre positive correlations were found among the factors (Table 6). The factor "performance expectancy" (factor F1) was significantly correlated to "effort expectancy" (factor F2) ($r = 0.459$, $p < 0.01$) and "perceived playfulness" (factor F3) ($r = 0.113$, $p < 0.01$).

Impact of students' characteristics on the perceptions factors

Given the significant correlations among the factors, the unique relations between each factor and students' characteristics were then explored. Correlations between factors and the specific characteristics (gender, grade or age group, years of using a mobile device with internet access, frequency of going online via a mobile device) are shown in Table 7. Each of the factors "performance expectancy" and

Table 5 Factor loadings, mean, and standard deviation per item (13 items)

	F1	F2	F3	Mean	S.D
PE3: Using mobile learning increases my learning productivity	0.786			2.72	0.805
PP4: Using mobile learning will stimulate my curiosity	0.652			2.82	0.832
PP3: Using mobile learning will give enjoyment to me for my learning	0.637			2.67	0.889
PE1: I would find mobile learning useful in my learning	0.586			3.06	0.696
PE2: Using mobile learning enables me to accomplish learning activities more quickly	0.551			3.16	0.811
PP5: Using mobile learning will lead to my exploration	0.530			2.89	0.812
PE4: If I use mobile learning, I will increase my chances of getting a better grade	0.506			2.66	0.857
EE1: My interaction with mobile learning would be clear and understandable	0.360			2.83	0.805
EE3: I would find mobile learning easy to use		0.869		3.25	0.780
EE4: Learning to operate mobile learning is easy for me		0.728		3.29	0.842
EE2: It would be easy for me to become skilful at using mobile learning		0.629		3.15	0.802
PP2: When using mobile learning, I will forget the work I must do			0.573	2.43	0.936
PP1: When using mobile learning, I will not realize the time elapsed			0.568	2.92	0.924
Total variance explained is 55%					
Cronbach-a	0.82	0.78	0.49		

All responses ranged from 1 (strongly disagree) to 4 (strongly agree)

Factor 1 (F1): "performance expectancy," Factor 2 (F2): "effort expectancy," Factor 3 (F3): "perceived playfulness"

Extraction method: principal axis factoring. rotation method: Promax with Kaiser normalization

Rotation converged in four iterations

Table 6 Pearson correlations among factors

	Performance expectancy (F1)	Effort expectancy (F2)
Performance expectancy (F1)		
Effort expectancy (F2)	0.459**	
Perceived playfulness (F3)	0.113**	0.064

*Significant at the 0.05 level

**Significant at the 0.01 level

** higher significance than *

"effort expectancy" was significantly and positively related to grade, years of using a mobile device with internet access, and frequency of going online via a mobile device. Indicatively, Fig. 2 displays the mean values of the factors "perceived expectancy" and "effort expectancy" (factors F1 and F2, respectively) by the characteristic years of using a mobile device with internet access. Gender had no effect on any factor.

Discussion and conclusions

The aim of this study was to explore the perceptions of Greek secondary school students regarding mobile devices' usage and mobile learning acceptance. The study adds to the body of empirical evidence regarding mobile devices' ownership—usage and perceptions of 12–18 year old students, particularly within the Greek context. This investigation is important because the acceptance of mobile learning by students is a prerequisite to the successful implementation of mobile learning in both formal and informal contexts. Woodcock et al. (2012) pointed out that successful implementation of mobile learning significantly depends on students' willingness to adopt/accept a new technology that is different from what they used in the past. In order to successfully implement mobile learning in secondary education, investigations of students' perceptions of mobile learning acceptance, as well as the factors that influence these perceptions are needed.

With regard to the first research question (Which types of mobile device do students own—use and how do students perceive themselves as mobile device users?), the mobile phone was the primary/predominant device which is used daily by almost all students. The laptop was the secondary owned—used device, and the tablet was the device owned and used by fewer students (36.4% of the students do not possess a tablet). Students older than 14 years old possess a tablet in a significant smaller percent in comparison to students aged 12–14 years old. The tablet tends to be the major device for young children (Nikolopoulou 2018) and this trend seems to continue for students aged 12–14 years old; while when adolescence begins (14 years and older) students become eager and timely adopters of the mobile phones (Matimbwa and Anney 2016). More than 83% of the students reported they go online via their mobile device several times per day; thus they could be categorized as

Table 7 Correlations among factors and characteristics (gender, grade, years of using a mobile device with internet access, and frequency of going online via a mobile device)

Correlation coefficient	Factors	Gender	Grade (age group)	Years of mobile device use	Frequency of going online via a device
Spearman's rho	Performance expectancy (F1)	0.014	0.087*	0.096*	0.130**
	Effort expectancy (F2)	0.019	0.109*	0.133**	0.177**
	Perceived playfulness (F3)	0.042	0.042	0.014	0.041

*Correlation is significant at the 0.05 level (2-tailed)

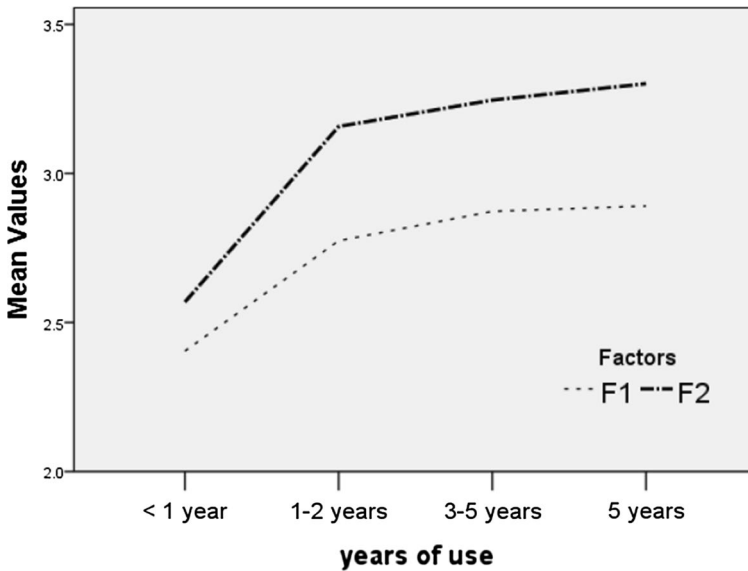**Correlation is significant at the 0.01 level (2-tailed)

Fig. 2 Mean values of the factors "performance expectancy" (F1) and "effort expectancy" (F2) by years of mobile device use

extensive internet users. Indeed, using an elaborated 4-level experience scale (novice, intermediate, advanced, and expert), almost 65% described themselves as advanced mobile device users, and 11% perceived themselves as expert mobile device users. It is noted that there could be a difference between perceived user type (measured as a self-reporting item) and actual mobile device experience; the latter one is revealed as an issue for further research. There is an agreement with Fu and Hwang (2018) in that the smartphones are used widely, and, in particular, with Biloš et al. (2017) who found a high level of mobile device usage among secondary school students on a daily basis; in Austria, the Czech Republic, and Germany. In their study, the smart phones were the primary mobile device; more than 90% of students went online several times per day, while most participants (68%) perceived themselves to be advanced mobile device users. There is also an agreement with a recent study involving upper secondary school students in Sweden (Ott et al. 2018); around 61% of the sample described themselves as habitual users (they can do most things, and what they cannot do, they can learn on their own), and 22% as expert users (they know most things and a little extra). The fact that the mobile/smart phone tends to be the predominant mobile device for teenagers has implications for future research, and it is discussed at the end of the section.

In terms of the second research question/objective (to investigate students' perceptions regarding mobile learning acceptance), students expressed positive perceptions indicating mobile learning acceptance; in particular, over 80% of the sampled students agree and strongly agree with the items of the constructs "performance expectancy" and "effort expectancy." Students' perceived "performance expectancy" and "effort expectancy" were found to be significant determinants with regard to

mobile learning acceptance. In the context of mobile learning, "performance expectancy" suggests that individuals will find mobile learning useful because it enables them to access information quickly, at a time and place of their convenience, and on the device of their choice. However, with limited research in this area for secondary school students, further studies are needed to determine this construct's effect on mobile learning. In the context of "effort expectancy" in the use of mobile learning, effort expectancy may affect students' behavior. There is an agreement with earlier studies with secondary school students, which revealed positive mobile learning perceptions (Osakwe et al. 2017; Ozdamli and Uzunboylu 2015; Kee and Samsudin 2014). The analysis revealed that the two factors/constructs "performance expectancy" (factor 1 or F1) and "effort expectancy" (factor 2 or F2) had acceptable internal consistency and they were significantly correlated. There was an agreement with the factors/constructs proposed by Venkatesh et al. (2003), in the UTAUT model, and by Wang et al. (2009). The original "performance expectancy" factor (proposed by Venkatesh et al. 2003) and the original "perceived playfulness" construct (as proposed by Wang et al. 2009), in the present study, were (in general terms) perceived as a unique factor, probably because mobile learning and enjoyment/exploration are closely linked in students' minds.

With regard to the third research question/objective, to investigate any significant difference in students' perceptions with regard to specific characteristics, it was found that (a) each of the factors "performance expectancy" and "effort expectancy" was significantly and positively related to grade (or age group), years of using a mobile device with internet access, and frequency of going online via a mobile device, and (b) gender had no effect on any factor. The higher the grade (i.e., older secondary school students), the higher the frequency and the more the years of using a mobile device, the more positive were students' perceptions. These findings are, in part, consistent with earlier research (Villani et al. 2018; Wang et al. 2009). The research findings regarding the relationship between gender and mobile leaning acceptance are inconclusive; some studies found no gender differences (e.g., Poll 2014), while others (e.g., Villani et al. 2018) indicated some gender differences.

The findings of this study have implications for educational policy developers, researchers, secondary school teachers, and students. Taking into account that (a) over 83% of students go online via their mobile phone (it is their primary mobile device) several times per day, and (b) students' positive perceptions toward mobile learning acceptance (and specifically, performance expectancy and effort expectancy), educational policy makers may incorporate basic guidelines for mobile phone use into the official program of studies; effective educational policies are needed. Although there is currently a ban on mobile phones in Greek schools, a growing body of international research (Wishart 2018) has noted the potential of mobile phones for pedagogical uses, and some teachers are taking initiatives to allow students to use them in the classroom under their supervision. In parallel, upper secondary school students seem to be aware and concerned of the implications of mobile phone presence in school (Ott et al. 2018), describing mobile phones as both a tool which facilitates school work and as a distraction. Curriculum planners should incorporate the use of mobile phones as tools for learning in secondary schools (e.g., under the umbrella of ICT guidelines), while appropriate rules and regulations should be put into place to guide

the use of mobile phones within the school environment (Nikolopoulou and Gialamas 2018). Teachers have also an important role in encouraging more efficient acceptance by becoming active mediators in the educational process. Although mobile technology is a recognized tool for the learning process, there is a lack of practical strategies for teachers supporting the students through the mobile technology (Suárez et al. 2018). For example, an earlier study with elementary school students (Hwang and Chang 2011) explored the effect of employing online learning strategies in a mobile learning environment that combined digital learning resources and real-world learning contexts; the results showed that the proposed approach promoted students' learning interest and attitude, and also improved their learning achievement. It is important that schools provide a context supporting appropriate approaches/practices of mobile devices in classrooms, for example, by organizing/developing suitable learning activities. Teachers need to have supportive professional development fostering enthusiasm and willingness for integrating mobile devices successfully in the classroom (Christensen and Knezek 2018).

Limitations of this study include the origin of the sample (from only one city) and the fact that the data came from a self-reported questionnaire. In future studies, interviews or observations could be combined with questionnaires in order to have more robust evidence. Students' perceptions can be further explored with different adolescent and other target populations (e.g., young University students), in other countries, in order to reveal possible similarities and differences. Another limitation of this study is that the questionnaire items derived from three constructs, "performance expectancy," "effort expectancy" and "perceived playfulness" of the mobile learning acceptance UTAUT model. There is a need to research and other factors/constructs that affect user intention to use mobile learning; apart from performance expectancy, effort expectancy and perceived playfulness, there is a need to investigate, for example, social influence and self-management of learning. Investigating students' perceptions is a first step, because research related to mobile learning acceptance and the implications of mobile technology use in schools, is gradually growing.

Mobile learning in secondary education contexts is still in its infancy in many countries, including Greece. The fact that the mobile/smart phone (with its new advanced features/attributes and functions) is the predominant mobile device for teenagers, provides a challenge for the implementation of mobile learning in formal educational contexts. Since the neutrality of technology varies from one culture to another, future directions of research need to include participants from schools in different areas and different countries; this is necessary because contextual aspects can have a different influence on students' perceptions. Future research is suggested to consider the various types of learning activities being practiced inside and also outside the classrooms; for example, in semi-formal settings/contexts pre-determined by the teachers such as school playgrounds, museums, and field trips. New mobile technologies could affect learners' perceptions and behaviors in the learning environment. The extensive use of the internet via mobile phones and the development of new features and functions make it crucial for students' perceptions regarding mobile learning acceptance to be examined throughout the years.

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