



Exploring Factors of Mobile Device Adoption in Nursing Education

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The world has seen an explosion in mobile device technology over the past decade, in addition to the impact that COVID-19 has placed on nursing education programs. More specifically, mobile devices have afforded users with endless possibilities. This upsurge in mobile technology has altered the way people use and interact with their device. One such example is how these devices are being utilized for the purposes of learning due to social distancing guidelines. Thus, it becomes important to explore and understand those factors that will influence the use of mobile devices for learning. The purpose of this study was to explore variables that might influence the adoption of mobile devices among nursing faculty. The Unified Theory of Acceptance and Use of Technology served as the theoretical basis for this study and guiding framework. An exploratory quantitative survey research design was utilized to explore specific variables and their impact on mobile device adoption among participants. It was found that 85%, six of the seven research variables were statistically significant predictors of mobile device adoption. Mobile devices have the potential to leverage a wealth of resources for both users and faculty. Therefore, recommendations for developing increased use of mobile device technology for teaching and learning will be suggested.

KEY WORDS: Mobile devices, Mobile learning, Mobile technology, Nursing education

Evolving technology has changed, and will continue to change, the way people communicate and interact with one another.¹ Mobile devices have fundamentally transformed how individuals go about their daily lives including how they communicate, collect information, and potentially how they learn.² Ninety-five percent of the global population lives within range of a

mobile-cellular network.³ Mobile technology is expected to become more popular, and the use of devices will continue to increase.^{2,4} The mobile nature of these portable devices affords individuals with endless opportunities and benefits like affordability, availability, applications, portability, improved functions, and instant access, just to name a few.

One opportunity provided by mobile devices is the ability to learn in a new way. The term *mobile learning*, or m-learning, refers to the idea of using mobile and handheld technology devices for the purpose of training, learning, and teaching.⁵ M-learning aims to create an environment that is learner-centered to allow the individual to learn, experience, investigate, and interact with real-world and digital-world resources using mobile technology.⁶ Research indicates that the majority of college-age students own or have access to a mobile device, that is, smartphones, and use these devices for accessing the Internet.⁷ Since students already engage in informal use of m-learning, it would be beneficial to incorporate this learning style within education. Faculty need to be willing to push the boundaries of learning environments and teach beyond traditional methods in order to engage contemporary learners.⁸

BACKGROUND

Nursing Education and Mobile Devices

Didactic and clinical experiences are the core to preparing nursing students with the needed level of competence and confidence to practice as a professional nurse.^{9,10} Novice nurses and inexperienced nursing students tend to struggle with applying and transferring knowledge that is critical for the professional work environment.^{6,11} McDonald et al⁹ found that one-third of experienced nurses feel that new graduate RNs are not prepared, have poor execution of clinical skills, and lack confidence in interprofessional collaboration. For student nurses to gain the needed skills to practice as a professional nurse, they must obtain the necessary theoretical knowledge, be able to follow policies and procedures, and have experience through hands-on learning.⁹

In undergraduate education, nursing faculty are frequently searching for ways to improve student engagement in the classroom. Gallegos et al¹² discovered that purposeful use of m-learning encouraged student engagement in a research and evidence-based practice course. By utilizing m-learning

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activities, nursing faculty enhanced teaching strategies in theoretical courses where clinical or simulation activities were not available.¹² Although seen as a way to enhance student engagement and participation, it is important that faculty have a plan that will lead to the attainment of student learning outcomes. Mobile devices can easily lead to a distraction in the class if not implemented appropriately.¹²

M-learning is essential for the future of higher education.¹³ Crompton and Burke³ reported that 70% of studies demonstrated a positive outcome in student learning by use of m-learning. M-learning allows students to engage in learning in a real setting, to support learning with resources pertinent to the environment, to incorporate learning flexibility to access resources from anywhere, to participate in active learning, to develop critical thinking and problem-solving skills, to enhance their knowledge in the subject material, and to collect, analyze, and disseminate data.^{2,4,6,10,13–16} Furthermore, m-learning has been found to successfully improve nursing students' professional knowledge, clinical efficiency, and communication with faculty.^{7,15,17} M-learning can be used to enable nursing students to link textbook knowledge to problem solving in real-life situations, to allow the students increased opportunities with skills training, to link theories to practice, and to receive feedback.^{7,13,15} M-learning can likewise allow students to have more hands-on learning that can be incorporated with the traditional course material or could be the sole way the students learn course information.^{8,9} Researchers additionally found that students who used m-learning stated that it assisted them with being more engaged, added value to their courses, and aided the students to obtain better examination scores when using mobile study tools.¹⁶

M-learning can also be incorporated within the clinical setting to allow students to have access to supplementary material, which can increase their clinical knowledge and experience. The use of m-learning in the clinical setting allows students to have the most up-to-date and accurate information that can assist with enhancing the student's competence and self-confidence in clinical decision making and enhance patient safety.¹⁷ O'Connor and Andrews¹⁸ reported that 98% of nursing students surveyed used a smartphone, but only 47% used the device within the clinical setting. Students reported that the use of smartphones within the clinical setting would allow for easier access to educational resources during clinical practice.¹⁸ Willemse et al¹³ found that students experienced m-learning as an affordable and innovative way of learning communication skills and testing their knowledge and clinical abilities. M-learning should be implemented to improve student learning in and outside of the classroom.⁶

Barriers to Mobile Devices

Although students use their mobile devices in their everyday life, they do not tend to use them for meaningful learning

experiences.² The use of m-learning in an educational environment is also rarely used due to multiple factors. One of the biggest barriers to m-learning is that institutions and faculty typically ban these devices from their classrooms, due to these devices being viewed as a distraction and m-learning being difficult to implement.² Institutions that use a "Bring Your Own Device"⁸ policy for faculty and students to use on-site tend to face more infrastructure challenges than those institutions that require or provide uniform devices for all faculty and students. Chen et al² recommend that institutions create m-learning policies, provide devices, and have accessible technological and pedagogical support for all faculty and students. Loans, leases, stipends, and including the cost to the student in their tuition could all be used as ways to combat the cost of institutions using uniform devices and applications.² Faculty may find themselves reluctant to use mobile devices due to multiple reasons including financial constraints on users, data privacy concerns, technical issues, and unwillingness of faculty to change their teaching style to accommodate m-learning.^{2,14} Other barriers to m-learning include lack of resources, knowledge and experience with technology, and support by institution leadership; educator attitudes and beliefs; and reluctance to adopt technology that is not typically used to teach subject matter.² Faculty who are willing to implement mobile technology in the classroom tend to face multiple setbacks including problems with the infrastructure of applications, inadequate resources and training, and little to no access to technical support.^{2,8}

Buabeng-Andoh⁷ found that in addition to barriers faculty face, students likewise have issues with employing m-learning due to too little or no training. Other variables that can impact how much students learn through m-learning include how much knowledge the student has about the device being used, how long the device is used for learning, faculty experience with using the device, and the accessibility of the learning resources that are available.^{3,13} Other challenges that students face are m-learning devices and applications not being compatible with their particular device and the cost of these devices and applications.⁸ Willemse et al¹³ noted that students' attitudes toward m-learning can negatively affect m-learning being implemented. O'Connor and Andrews¹⁸ received multiple statements from nursing students for how nursing faculty could assist with enhancing m-learning including providing education to staff nurses and patients about the benefits of mobile devices for learning within the clinical setting, offering students a list of the best applications to use for learning resources, and that nursing faculty should contribute to the content and design of the mobile applications used. For m-learning to be successful in education, administration within these institutions must be willing to provide faculty and students with the proper training and resources needed to implement this technology within the classroom.^{2,8}

METHODS

Theoretical Framework

The Unified Theory of Acceptance and Use of Technology (UTAUT2) served as the theoretical basis for this study and guiding framework. Developed by Venkatesh et al,¹⁹ the UTAUT2 aims to predict behaviors of technology adoption. Consisting of eight models, the UTAUT2 draws from the Theory of Reasoned Action, Technology Acceptance Model (TAM), Motivational Model, Theory of Planned Behavior (TPB), Combined TAM and TPB, Model of PC Utilization, Innovation Diffusion Theory, and Social Cognitive Theory. The UTAUT2 describes an individual's intention to use technology and his/her usage behavior using seven key constructs—performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FCs), hedonic motivation (HM), price value (PV), and habit (HB)—that influence behavioral intention (BI) related to the use of a technology¹⁹ (see Supplemental Digital Content 1, <http://links.lww.com/CIN/A89>).

Design and Sample

An exploratory quantitative survey research design was utilized in order to understand variables for the adoption of mobile devices among undergraduate nursing faculty in a southeastern state. Institutional review board approval was granted for the study.

Nursing faculty teaching in undergraduate nursing programs in a single southeastern state were invited via email to participate in an electronic survey. Twenty-three different nationally accredited nursing programs across the state were contacted with an electronic research invitation. Only faculty members teaching in undergraduate nursing programs were considered eligible to participate. Undergraduate nursing programs included associate, baccalaureate (traditional and accelerated programs), and mobility (RN-BSN) programs. According to Grove and Ciper,²⁰ for an eight-predictor scenario with an estimated treatment effect of $R^2 = 0.13$ ($f^2 = 0.15$), the minimum sample size for the overall model required at least 110 participants. One hundred twenty participants participated in the study. Approximately 550 eligible faculty members across the state received the invitation to participate. Therefore, the response rate was calculated as 21%.

Survey Instrument

An adapted version of the UTAUT2 instrument, with author permission, was utilized. The 36-item survey was deployed electronically to obtain feedback. The UTAUT2 instrument has been adopted and modified by many researchers prior to this study.^{21–23} Researchers who have used the UTAUT2 instrument have altered the subject of the questions to make the context of the survey more relevant to the phenomena under investigation. The instrument's validity has been well established by prior research.^{21–23} In this study, the survey was adapted to explore the variable of mobile device adoption. Thus, it was important and essential to

assess the content validity of the modified instrument in order to verify whether the items adequately represented the construct of interest. Content experts in the fields of nursing education and instructional technology reviewed the survey and determined it to be a valid assessment. A Cronbach's α was calculated for the survey. The total Cronbach's α score was found to be .953, indicating a high level of internal consistency, thus validating the survey as a reliable assessment.

Data Analysis

SPSS version 24 (IBM, Armonk, NY) was used for statistical analysis. The independent variables were PE, EE, SI, FCs, HM, PV, and HB. BI served as the dependent variable. Descriptive analysis was used to explore how nursing faculty use mobile device technology. Hierarchical regression analysis was used to understand how each of the independent variables impacted nursing faculty's BI to adopt mobile devices. Both one-way analysis of variance (ANOVA) and three-way ANOVA were performed to examine differences between sex, age, education level, type of nursing program, and BI to adopt mobile devices.

RESULTS

One hundred twenty undergraduate nursing faculty in a single southeastern state participated in this study. Table 1 presents the descriptive statistic results of those individuals surveyed.

Mobile Device Ownership and Use

The first step was focused on understanding mobile device ownership among nursing faculty and how mobile device technology is being utilized. In terms of mobile device ownership and use, 100% ($n = 120$) reported that they currently owned a mobile device (ie, smartphone). In terms of other types of mobile device ownership, 20.8% ($n = 25$) reported owning an MP3/MP4 player, 77.5% ($n = 93$) indicated that they owned a tablet, and 4.2% ($n = 5$) indicated that they owned a netbook. More than 95% ($n = 116$) of those surveyed noted that they owned a laptop. Participants were also asked about their use of mobile devices. When participants were asked about the kind of activities they perform on their mobile devices, activities varied among participants.

Participants were surveyed about their level of experience in using mobile devices. Categories for selection included *none* (no experience), *novice* (use of mobile devices one to three times per week), *intermediate* (use mobile devices daily), and *advanced* (use of mobile devices many times throughout a day). Eight participants (6.6%) identified as an intermediate mobile device user, while 111 participants (92.5%) identified as an advanced mobile device user, and one participant (0.9%) did not respond to the question. Lastly, participants were asked about the number of hours spent on a mobile device per day. Table 3 presents the number of hours per day that nursing faculty used a mobile device.

Predictors of Adoption

The second step explored the impact that the independent variables, PE, EE, SI, FCs, HM, PV, and HB, had on nursing faculty's BI to adopt mobile devices. A hierarchical linear regression analysis was conducted to examine if and how variables impacted BI of nursing faculty toward adoption. Hierarchical regression is a statistical method to show if variables of interest can explain statistically significant amounts of variance on a dependent variable after accounting for all other variables.²⁰ The ranking of the seven variables was based on a consensus of relevance to the population of interest, nursing faculty, and degree of importance developed from the literature (Table 2).

The seven linear regression models were calculated to predict BI based on participants' reported EE, FCs, PE, SI, HM, HB, and PV in their respected order. Regression analysis results revealed that the independent variables of EE, FCs, PE, SI, HM, and HB did have a statistically significant impact on BI of undergraduate nursing faculty. The only independent variable found to have no statistically significant impact on BI was PV (Table 3).

Exploring Differences

The third step of the research effort focused on examining differences between age, education level, and type of nursing program among undergraduate nursing faculty's BI to adopt mobile devices. Both one-way ANOVA and three-way ANOVA were performed. Results revealed that age ($F_{3,111} = 0.20$, $P = .89$), education level ($F_{2,113} = 0.08$, $P = .92$), and type

of nursing program ($F_{3,113} = 0.08$, $P = .77$) did not have a statistically significant impact on participants' BI to adopt. A three-way ANOVA was performed to explore if any interactions existed between age, level of education, and type of nursing program to BI responses. Results revealed that there were no statistically significant interactions between groups (Table 4).

DISCUSSION

Four major conclusions resulted from this study. First, it was discovered that nursing faculty currently own and use mobile technology on a routine basis. Participants noted that mobile device ownership was high for smartphones. Other types of mobile device ownership included tablets, netbooks, laptops, and MP3/MP4 players. Undergraduate nursing faculty are using mobile devices regularly. More than 90% of those surveyed identified their level of device use as advanced, meaning that participants are experienced mobile device users and feel they are well prepared to use mobile devices.

Nursing faculty are also using their devices for multiple activities. Results revealed that faculty used their devices on a regular basis throughout the day for information seeking, business-related activities, and entertainment purposes. Information seeking may be directly or indirectly related to educational uses. For example, devices may be used to research a telephone number needed or employ a medication app to locate specific drug information in the clinical environment. Examples of business activities include checking emails, responding to students via text or phone call, and/or accessing a learning management system. Finally, entertainment activities include game applications, social media access, and viewing of information for pleasure.

It was found that six of the seven variables, EE, FCs, PE, SI, HM, and HB, were significantly related to participants' BI to adopt mobile devices. This means that nursing faculty are more likely to adopt mobile devices if they feel it is easy to use, if they feel they have the necessary resources and organizational support in place, if they believe it will assist them in improving their job performance, if people whose opinions they value think it is important to use, if they feel it is fun to use, and if they develop a routine using it. The only variable that was found to not be a significant predictor of BI was PV, meaning nursing faculty did not find the cost of mobile technology to be a factor in their decision.

Of those surveyed, age, education level, and type of nursing program did not significantly impact BI. These findings suggest that undergraduate nursing education faculty age, education level, and type of program in which they teach are not influencing factors.

LIMITATIONS

Geographical limitations imposed by using a single state limit the generalizability of these results to nursing faculty

Table 1. Sample Demographic Statistics

Selections	n	%
Gender		
Female	115	95.8
Male	5	4.2
Age (y)		
<25	1	0.9
25–35	19	15.8
36–45	37	30.8
46–55	34	28.3
56–65	25	20.8
≥66	3	2.5
Did not respond	1	0.9
Level of education		
Baccalaureate (BSN)	5	4.1
Master's degree (MSN)	65	54.2
Clinical doctorate (DNP)	26	21.7
Research doctorate (DNS, EdD, PhD)	24	20.0
Type of nursing program		
Associate degree (ADN or ASN)	67	55.8
Baccalaureate (BSN)	48	40.0
RN mobility (RN-BSN)	4	3.3
Did not respond	1	0.9

Table 2. Ranked Constructs by Expert Consensus

Construct	Definition	Ranking
EE	Amount of ease associated with use of a system or technology	1
FCs	Degree to which an individual perceives that organizational and technical infrastructure exists to support use of the system or technology	2
PE	Degree to which an individual believes that using the system, or in this case the technology, will help him/her attain gains in job performance	3
SI	Degree to which an individual perceives or believes that others influence him/her to use the new technology	4
HM	Pleasure or fun resulting from the use of a technology	5
HB	Perceptual construct that reflects the results of previous experiences	6
PV	Learner's cognitive tradeoff between the perceived benefits of the applications and the monetary cost for using mobile technology	7

more broadly. There were several reasons as to why the study aimed at a single geographical location. Primarily, the decision to limit the geographical location was due to time and resource constraints. Also, only undergraduate nursing faculty were recruited; as a result, this imposes unique limits toward the ability to generalize these results to other faculty groups. While the sample size did meet the requirements set by the power analysis, a larger sample size could impact the study further. There was low sample variability related to three of the demographic variables: age, sex, and level of education. As a result of the low sample size in each of the three categories, the data required additional manipulation. Differences based on sex were not explored due to lack of male participants. In terms of age, groups were compressed into larger spans of time. For educational preparation, data were grouped based on nondoctoral and doctoral participants. While both one-way ANOVA and three-way ANOVA demonstrated no significant relationship on BI, this could be a result of the demographic makeup of this study. Potentially having a greater sample variability could yield different statistical results. There was a potential for response bias due to the fact that those who had and used mobile devices were more likely to participate in the survey compared to those who had little experience with mobile devices.

Lastly, the novel coronavirus (COVID-19) may or may not have impacted this research. Due to the virtual nature of the study using an electronic research invitation and participation via an electronic survey, participants were not at risk of additional exposure. Nonetheless, as the nation and nursing programs across the country battle the virus, the availability and willingness of faculty to participate may have been limited.

CONCLUSION

Study findings contribute to the understanding of mobile device ownership and use of mobile devices among nursing faculty. This study also provides insight related to predictors of mobile device adoption among nursing faculty; however,

further research is needed to expand understanding. It is important that nurse administrators, education technology specialists, and nursing education curriculum developers be informed regarding the predictors that help to promote mobile device adoption among nursing faculty. Given that the majority of those surveyed used their mobile devices frequently and feel comfortable engaging with mobile devices, it is plausible that the use of m-learning methodologies could be beneficial for nursing faculty in the process of teaching and learning.

As a result of the findings from this study, the researchers suggest some practical approaches to promoting mobile device adoption. Importantly, further research is recommended to explore the impact that each variable has on mobile device adoption. Universities, colleges, and nursing programs might consider how to provide additional training for nursing faculty in order to incorporate the use of mobile devices in their teaching and learning practices. When examining ways to promote mobile technology adoption among faculty, individuals would benefit from understanding how each predictor impacts the BI. It is important to consider mobile devices, programs, and applications that are easy to use. It is equally beneficial to reflect on how resources and organizational support are provided for technology integration. By providing case studies, activities, and examples, nursing faculty can engage in experiencing how mobile devices can

Table 3. Linear Regression Model Coefficients

	B	SE	t	P	95% LCL	95% UCL
EE	0.597	0.42	8.62	.000	1.49	3.15
FCs	0.428	0.13	3.41	.001	0.18	0.68
PE	0.510	0.09	6.03	.000	0.34	0.68
SI	0.155	0.05	3.02	.003	0.05	0.26
HM	0.196	0.07	2.82	.006	0.06	0.33
HB	0.149	0.05	2.80	.006	0.04	0.26
PV	0.040	0.06	0.69	.493	0.07	0.04

Abbreviations: LCL, lower confidence limit; UCL, upper confidence limit.

Table 4. Three-Way ANOVA Table for Age, Level of Education, and Behavioral Intention

	SS	df	MS	F	P
Age	0.33	3	0.11	0.15	.931
Level of education	0.75	2	0.37	0.49	.612
Type of nursing program	0.11	1	0.11	0.15	.700
Age * level of education * type of nursing program	3.31	5	0.66	0.88	.499
Total	4095.78	115			

Abbreviations: SS, sum-of-squares; MS, mean-square.

be incorporated into the learning process and therefore into their job performance. Another recommendation is that mobile device champions be established in order to serve as role models and to provide guidance, as well as examples as to how colleagues might incorporate mobile devices. It is equally important to create an environment that promotes the use of mobile technology and encourages device use in a fun manner. Lastly, helping to support faculty in using mobile devices on a regular basis and thus establishing a regular routine in using them in the teaching and learning process will help faculty to embrace this technology.

Mobile device technology and m-learning have the potential to leverage a wealth of resources in regard to current teaching and learning modalities, such as flipped classrooms and online courses. This is certainly more important than ever due to the constantly evolving COVID-19 situation. As nursing programs across the nation struggle to look for ways to engage students and offer educational content remotely, the use of mobile technology is a critical component. Additionally, the cost-effectiveness of mobile devices helps to reduce the digital divide and, in some circumstances, may close it. Mobile devices are offering both the educator and student new tools to communicate and engage with learning content from virtually any location.

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