

RESEARCH ARTICLES

Doctor of Pharmacy Students' Use of Personal Digital Assistants

Mark V. Siracuse, PharmD, PhD,^a and John G. Sowell, PhD^b

^aSchool of Pharmacy and Health Professions, Creighton University

^bMcWhorter School of Pharmacy, Samford University

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Objectives. To describe the use of personal digital assistants (PDAs) by doctor of pharmacy (PharmD) students; determine the reliability of psychometric constructs that determine technology acceptance; and determine constructs that directly correlate with PDA use.

Methods. A survey instrument was developed containing descriptive and psychometric items and administered to PharmD students at 2 universities.

Results. Over half of new users (58.1%) and experienced users (51.3%) reported using their PDA at least weekly. Eighty-four percent of experienced users used their PDA at least weekly to look up drug information. The most reliable scales were perceived usefulness ($\alpha = 0.92$), perceived ease of use ($\alpha = 0.89$), and attitude towards behavior ($\alpha = 0.84$). Intention to use and self-reported use of PDAs were strongly correlated with perceived usefulness, attitude towards behavior, and compatibility.

Conclusions. The majority of pharmacy students used their PDAs at least weekly and find them most useful for looking up drug information.

Keywords: personal digital assistant, pharmacy student, technology

INTRODUCTION

In the last few years handheld technologies (eg, personal digital assistants or PDAs) have rapidly emerged as a clinical tool used by healthcare professionals. The use of PDAs by pharmacists for a variety of purposes has been documented in the professional literature.¹⁻¹⁰ Pharmacists report using PDAs at the point of care to obtain timely and up-to-date drug information, to conduct accurate and comprehensive drug interaction assessment for patients, and to provide clinical services such as pharmacist-directed warfarin dosing programs.¹⁻⁴ Some pharmacists also report using PDAs to track and document the provision of clinical pharmacy services in a variety of practices.⁴⁻¹⁰ Increased growth in the number and types of applications available for handheld technologies is likely to continue.

Colleges and schools of pharmacy around the country have recognized the early emergence of these technologies in the professional practice of pharmacy. Some schools have responded to this by providing pharmacy students with PDAs while others have not. Some examples of pharmacy programs that provide their students

with PDAs include Creighton University, the McWhorter School of Pharmacy (MSOP) at Samford University, and the University of Minnesota. For schools that have provided the PDA, the purposes for PDAs and the extent to which their use is incorporated into the curriculum varies. Students use these devices during simulated patient care laboratories, early learning practice experience courses, and advanced pharmacy practice experiences.

Even though significant efforts have been made by pharmacy programs to bring handheld technology to their students, some clinicians are reluctant to adopt these technologies. There is a wide range of adaptation and adoption behaviors by clinicians when PDA use is voluntary.¹¹ PharmD students are likely to exhibit similar behaviors. If students were given a choice between using technology and using printed media as a resource, there would likely be a range of responses. Pharmacy educators may expect their students to use these devices to enhance their educational experience by advancing their knowledge of how handheld technology can be utilized in patient care situations. However, many students may not understand how to optimize their use of this technology and may continue to use traditional printed sources for drug information. Additionally, pharmacy students may not understand how to use a PDA to document clinical interventions.

The theoretical framework for this study was provided by Unified Theory of Acceptance and Use of Technology (UTAUT).¹² UTAUT is a model formulated by

Corresponding Author: Mark V. Siracuse, PharmD, PhD, Assistant Professor, 2500 California Plaza, Boyne 143H, Creighton University School of Pharmacy and Health Professions, Creighton University, Omaha, Nebraska 68178. Tel: 402-280-3722. Fax: 402-280-4809. E-mail: msiracuse@creighton.edu

leading technology acceptance researchers based on conceptual and empirical similarities across 8 prominent competing technology acceptance models: (1) Theory of Reasoned Action (TRA); (2) Technology Acceptance Model (TAM); (3) Theory of Planned Behavior (TPB); (4) Motivational Model (MM); (5) Combined TAM-TPB; (6) Model of PC Utilization (MPCU); (7) Innovation Diffusion Theory (IDT); and (8) Social Cognitive Theory (SCT). Six of the 8 technology acceptance models were included in the current study. The combined TAM-TPB and SCT were not included due to constructs that overlapped and poorly developed constructs.

The TRA was originally formulated by Fishbein.¹³ Many subsequent technology acceptance theories are grounded in TRA. The TRA postulates that behavior is determined by behavioral intention, and that behavioral intention is jointly determined by a person's *attitude towards behavior* (an individual's positive or negative feelings about performing the target behavior) and *subjective norm* (the person's perception that most people who are important to him think he should or should not perform the behavior in question). The TAM developed by Davis builds off the TRA and is an intention-based model developed specifically for explaining and/or predicting user acceptance of computer technology.^{14,15} The TAM postulates that computer-acceptance behaviors are influenced by 2 particular beliefs: *perceived usefulness* (the prospective user's subjective probability that using a specific application system will increase his or her job performance) and *perceived ease of use* (the degree to which the prospective user expects the target system to be free of effort). The TPB builds off the TRA by adding the construct *perceived behavioral control* (the perceived ease or difficulty of performing the behavior) to the ideas of *attitude towards behavior* and *subjective norm*.¹⁶ A hybrid model identified as the *combined TAM-TPB* merges the predictors of TPB with the perceived usefulness measure from the TAM. Perceived ease of use and subjective norm are not included in the combined TAM-TPB.¹⁷ In the MM, the construct of extrinsic motivation is almost identical to perceived usefulness identified in the TAM.¹⁸ The MPCU presents a perspective that initially appears to compete with TAM and TBP.¹⁹ However, a closer look at the constructs that make up MPCU reveals a number of similarities.

Only the construct *affect towards use* (feelings of joy, elation, or pleasure; or feelings of depression, disgust, displeasure, or hate associated by an individual with a particular act) was used in this study. The remaining constructs from the MPCU had constructs identical in content to constructs previously mentioned. The IDT contains 7 constructs.²⁰ *Image* (degree to which use of an innovation

is perceived to enhance one's image or status in one's social system) and *compatibility* (the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters) are 2 constructs from IDT that are included in the survey items for this study.^{12,21,22} Finally, the SCT has been applied and extended to the context of information technology.^{23,24} The SCT contains 5 constructs: (1) *outcome expectations – performance* (performance expectations that deal with job-related outcomes); (2) *outcome expectations – personal* (personal expectations that deal with individual esteem and sense of accomplishment); (3) self-efficacy (judgment of one's ability to use a technology to accomplish a particular task); (4) affect (similar to attitude found in the TPB); and (5) anxiety (evoking anxious or emotional reactions when using a computer). Since the attitude construct from the TPB has been more widely studied, it will be included in the current study instead of the affect construct from SCT. Both performance and personal outcome expectations have not been well studied. Venkatesh initially included outcome expectations in the proposed UTAUT model.¹² However, after data analysis, outcome expectations did not form a factor that had discriminant validity in the UTAUT model. Therefore, outcome expectations (both performance and personal) will not be included in the current study.

The UTAUT has been tested empirically using data from 6 organizations.¹² This model posits 3 direct determinants of intention to use (perceived usefulness, ease of use, and social influences such as subjective norm) and 2 direct determinants of usage (compatibility and use intention). Nearly 70% of the variance in technology usage intention was explained by UTAUT, which is a substantial improvement over any of the original 8 models alone. This model provides a solid foundation for future research in the area of technology acceptance because it advances cumulative theory while retaining a parsimonious structure.

A high percentage of students and faculty members at one school of pharmacy used their PDA.²⁵ Applications used were mainly for school-related functions, although many students reported using these devices for functions that were not school-related. The objectives of the current study were to: (1) describe actual use of PDAs by PharmD students; (2) determine reliability of scales forming the UTAUT model of technology acceptance; and (3) determine predictor variables that had a direct effect on either intention to use PDAs or self-reported use of PDAs.

METHODS

In August 2005 and August 2006, Creighton University issued PDAs to all third- professional year pharmacy students. PDA hardware and required software (Clinical

Pharmacology, Lexi-Comp, Windows Mobile 2003, Microsoft Excel Pocket, and Adobe for PDA) funding for Creighton students was included in tuition costs. In September 2005, McWorter School of Pharmacy issued PDAs to their first-professional year (P1) PharmD students, as they had done each year for the 3 previous entering classes of pharmacy students; thus, the second-, third-, and fourth-professional year students (P2, P3, and P4, respectively) at MSOP already had 1, 2, and 3 years of experience, respectively, using their University-issued PDA. PDA hardware funding for MSOP students was provided through grant dollars from a private individual. MSOP students purchased the required software (Lexi-Comp and HandBase products) using their own resources.

A 67-item survey instrument was developed to collect descriptive information from the students about themselves (2 items), their general use of technology (2 items), and their PDA use (9 items). The second part of the survey instrument contained psychometric items based on the UTAUT defined earlier in this paper. Items covered the constructs of perceived usefulness (7 items), perceived ease of use (10 items), subjective norm (2 items), image (3 items), perceived behavioral control (5 items), compatibility (3 items), attitude toward behavior (5 items), affect toward use (3 items), intention to use/self-reported use (8 items), computer self-efficacy (4 items) and computer anxiety (4 items). (A copy of the survey instrument is available from the first author by request.)

This study used a cross-sectional design and was approved by Institutional Review Boards at Creighton University and Samford University. In August 2005 and August 2006, an e-mail was sent to 330 third-professional

year PharmD students at Creighton University (campus-based and web-based) inviting them to participate in the survey. The e-mail contained an informed consent document with a web link to the survey instrument, which was stored on a secure web site. Also, in September 2005, an e-mail was sent to all PharmD students (n = 480) at the McWhorter School of Pharmacy inviting them to complete the same survey instrument via WebCT.

Survey data were coded and entered into an *Excel* spreadsheet. All analyses were done using SPSS version 14.0.²⁶ Means were calculated for all descriptive items. Cronbach's alpha was used to determine the reliability of each construct. Data were stratified based on experience. All students from both schools who just received a PDA for the first time (new PDA user) were analyzed together. Students from MSOP who had used their PDA for at least 1 year and were considered experienced users were analyzed together.

RESULTS

At Creighton, 222 third-professional year students (141 campus-based and 81 web-based) completed the survey instrument. At MSOP, 265 students (P1 = 107, P2 = 67, P3 = 53, P4 = 38) completed the survey instrument. At Creighton and MSOP combined, there were 329 PharmD students who had just been issued a PDA for the first time (new users) and 158 students (all from MSOP) who had used their School-issued PDA for at least 1 year and were considered experienced users in this study. Sample demographics are reported in Table 1. The majority of MSOP respondents and Creighton campus-based respondents were female and between the ages of 19 and 29 years. However, the majority of Creighton

Table 1. Demographics of Doctor of Pharmacy Students Who Participated in a Survey to Determine Acceptance and Use of Personal Digital Assistant (PDA) Devices (N = 487)

Characteristic	Creighton ^a (n = 222)		MSOP ^b (n = 265)			
	Campus (%)	Web (%)	P1 (%)	P2 (%)	P3 (%)	P4 (%)
Gender						
Female	68.8	65.4	72.9	68.7	71.7	68.4
Male	31.2	34.6	27.1	31.3	28.3	31.6
Age (years)						
19-23	54.1	2.8	83.1	74.2	39.6	23.7
24-29	42.1	38.9	13.1	24.2	47.2	68.4
30-35	3.0	25.0	1.9	1.6	5.7	7.9
36+	0.8	33.3	1.9	0	7.5	0

Abbreviations: Creighton = Creighton University School of Pharmacy; MSOP = McWorter School of Pharmacy

P1 = first-year pharmacy student (n = 107); P2 = second-year pharmacy student (n = 67); P3 = third-year pharmacy student (n = 53); P4 = fourth-year pharmacy student (n = 38)

^aCreighton students receive a PDA at the beginning of their P3 year

^bMSOP student receive a PDA at the beginning of their P1 year

web-based respondents were female and over the age of 30 years. This is representative of student body statistics at both Creighton and MSOP.

Among students who had just been issued a PDA, 25 students (7.6%) reported being extremely experienced or having above average previous experience with PDAs, 82 (24.9%) reported moderate experience with PDAs, and 221 students (67.1%) reported little or no experience with PDAs. Among experienced PDA users, 45 (28.5%) reported being extremely experienced or having above average experience with PDAs, 71 (44.9%) reported having moderate experience with PDAs, and 42 (26.5%) reported having little or no experience with PDAs (Figure 1).

When asked how frequently they used their PDA, 29.7% of both new users and experienced users reported using their PDA at least daily. Interestingly, at least weekly use of a PDA was more likely among new users (58.1%) compared to experienced users (51.3%). Also of interest is that a much greater percentage of experienced users (8.2%) reported never using their PDA compared to new users (4.2%) (Table 2).

Experienced PDA users were asked how they used their PDAs for both pharmacy and non-pharmacy applications (Table 2). Nearly 84% of experienced users reported using their PDA to look up drug information at least weekly (about 25% used their PDA at least daily for this application). Just under half (43%) reported using their PDA at least weekly for schoolwork other than looking up drug information (about 12% used their PDA at least daily for this application). Data on student use of various non-pharmacy applications for the PDA were also collected. At least monthly use of the PDA was reported for the following applications: calculator (55.7%); games (57.6%); looking up addresses (42.4%); looking up telephone numbers (45.6%); and scheduling (41.2%).

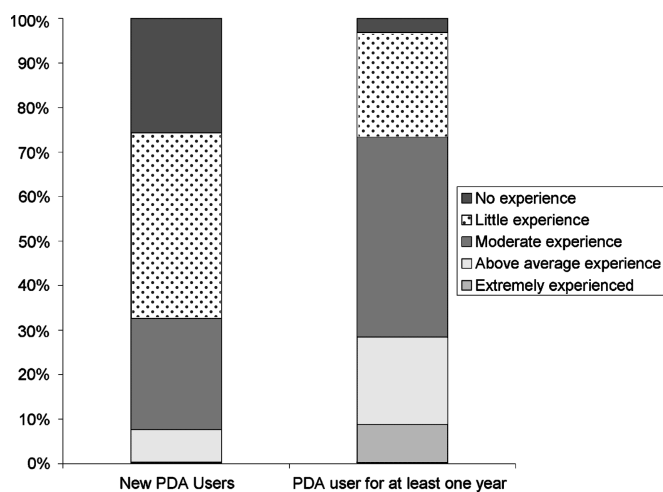


Figure 1. How Much Experience do you have with PDAs?

Data reduction using factor analysis of each scale, followed by reliability determination, resulted in the following scales (Table 3): perceived usefulness, 7 items ($\alpha = 0.92-0.93$); perceived ease of use, 6 items ($\alpha = 0.89-0.90$); attitude towards behavior, 5 items ($\alpha = 0.84-0.85$); intention to use (new users only), 8 items ($\alpha = 0.85$); self-reported use behavior (experienced users only), 4 items ($\alpha = 0.81$), image, 3 items ($\alpha = 0.78-0.82$); compatibility, 3 items ($\alpha = 0.79$); perceived behavioral control, 5 items ($\alpha = 0.75-0.77$); affect towards use, 3 items ($\alpha = 0.66-0.69$); subjective norm, 2 items ($\alpha = 0.68-0.70$).

Two separate multiple linear regressions were performed (one for new PDA users and one for experienced PDA users) to determine predictor variables that had direct effect. First, predictor variables associated with new PDA users' intention to use was determined. All 8 predictor variables identified above were regressed against the intention to use dependent variable. Stepwise regression using backwards elimination of predictor variables dropped all variables except (1) perceived usefulness, (2) attitude towards behavior, (3), compatibility, and (4) affect towards use (Table 4). A second multiple linear regression was performed to determine variables associated with experienced PDA users and self-reported use behavior. Again, all 8 predictor variables identified above were regressed against the self-reported use dependent variable. Stepwise regression using backwards elimination of predictor variables dropped all variables except (1) perceived usefulness, (2) attitude towards behavior, and (3) compatibility (Table 4).

DISCUSSION

This study documents PharmD students' attitudes and opinions about the use of PDAs, as well as their current level of PDA use. This research will have implications for educators, pharmacists and pharmacy students, patients, healthcare administrators and managers, information systems professionals, and information systems researchers.

This study could help pharmacy school educators determine whether investing in handheld technology for their students would be worth it. Since it is likely that these costs are passed along to students in the form of higher tuition and fees, pharmacy educators have a responsibility to their students to determine how students ultimately end up using these devices. Pharmacy students should be using handheld technology devices to improve the quality of patient care and enhance learning. Are pharmacy students using these devices as they were intended, if they use them at all? The results of this study show that most pharmacy students are using PDAs as they were intended, although a small percentage (less than 10%)

Table 2. PDA Use Among Pharmacy Students

Survey Item	Never, %	Quarterly, %	At Least Monthly, %	At Least Weekly, %	At Least Daily, %
How frequently do you use a PDA?					
New PDA users (n = 329)	4.3	3.0	4.9	58.1	29.8
PDA user for at least 1 year (n = 158)	8.2	3.2	7.6	51.3	29.7
How frequently do you use your PDA as a drug information source? (PDA users for at least 1 year, n = 158)	1.9	3.8	10.8	58.2	25.3
How frequently do you use your PDA for school work other than looking up drug information? (PDA users for at least 1 year, n = 158)	17.1	13.3	26.6	31.0	12.0
For PDA users for at least 1 year (n = 158), how frequently do you use your PDA:					
as a calculator	24.7	19.6	31.0	20.3	4.4
to play games	21.5	20.9	23.4	27.2	7.0
to look up addresses	36.1	21.5	26.6	13.3	2.5
to look up telephone numbers	31.6	22.8	27.2	14.6	3.8
for scheduling	41.1	17.1	8.9	18.4	14.6

have not effectively integrated this technology into their learning or patient care activities.

Measures designed to enhance the patient care capacity of pharmacists and pharmacy students through adaptation and adoption of existing and developing technologies is in the interest of the profession. Pharmacists and pharmacy students will increasingly find themselves needing to utilize PDAs in their patient care activities.²⁷ In a recent study, healthcare professional's (pharmacists, physicians, and nurses) use of PDAs at various institutions ranged from 45% to 85%.²⁸ Other researchers have concluded

that PDAs complement textbook references for pharmacy students in a clinical simulation environment.²⁹ Therefore, it is essential to ensure that user acceptance of technology issues do not hamper the continual growth and advancement of the pharmacy profession. This study seems to indicate that well over 80% of students are able to use this technology for the primary purpose of looking up drug information.

Pharmacists and pharmacy students enter a therapeutic relationship with their patients. This is characterized by trust and a reciprocal agreement to work together to identify, resolve, and prevent drug-therapy problems. The basic responsibilities of pharmacists and pharmacy students are to identify a patient's drug-related needs and commit to meeting those needs.³⁰ This means that pharmacists and pharmacy students must ensure that the drug therapy chosen for a patient is indicated, the safest and most effective available, and able to be taken by the patient. The ultimate goal of pharmacists and pharmacy students is to maximize patient care specific to the patient's drug therapy needs. Effective utilization of handheld technology by pharmacists and pharmacy students will be an essential element in future patient-centered pharmacy practice because patient care is enhanced when access and management of information occurs at the point of care.

Information on how technology acceptance and utilization of handheld devices could be influenced and improved provides a useful tool for healthcare administrators and managers to assess the likelihood of success for new

Table 3. Scale Reliabilities

Scale	No. of Items	Cronbach's Alpha	
		New User ^a (n = 329)	Experienced User ^b (n = 158)
Perceived usefulness	7	0.915	0.933
Perceived ease of use	6	0.892	0.903
Attitude towards behavior	5	0.839	0.853
Intention to use	8	0.847	N/A
Self-reported use	4	N/A	0.810
Image	3	0.815	0.776
Compatibility	3	0.785	0.794
Perceived behavioral control	5	0.751	0.771
Affect towards use	3	0.688	0.661
Subjective norm	2	0.697	0.679

^aNew users include all Creighton respondents (campus and web) and P1 MSOP students

^bExperienced users include P2, P3, and P4 MSOP students

Table 4. Best Fit Regression Models for Direct Effects Only Regarding PDA Use

Model and Variables	Standardized Beta	p
Model 1. New User Intention to Use PDA (R ² = 0.751; F(4,324) = 244.54; p < 0.001)		
Perceived Usefulness	0.206	<0.001
Attitude Towards Behavior	0.308	<0.001
Compatibility	0.282	<0.001
Affect Towards Use	0.172	0.001
Model 2. Self-reported Use of PDA (experienced users) (R ² = 0.708; F(3,154) = 124.30; p < 0.001)		
Perceived Usefulness	0.379	<0.001
Attitude Towards Behavior	0.354	<0.001
Compatibility	0.178	0.035

technologies such as handheld devices. It also allows healthcare administrators and managers to proactively design and target interventions to increase the success of innovations such as handheld devices in patient care settings.

The information systems community will be interested in the results of this study as it will provide information to improve the acceptance and use of handheld technology and improve understanding of the marketability of their handheld products.

This study addressed the need for technology acceptance research specifically with PDAs in the healthcare sector. Many previous studies have focused on determining factors associated with the use of new technologies, both hardware and software. While some of these studies have tried to explain physician use of technology and many have looked at non-healthcare professionals, there are no studies on factors that influence pharmacists or pharmacy student use of PDAs.^{12,31-35} Recurring factors that are prominent in determining intention to use and actual use of technology are *perceived usefulness*, *ease of use*, and *attitude towards use*. The current study is the first attempt to correlate factors with intention to use and actual use of PDAs by pharmacy students. Theoretical validity in technology acceptance was extended in the current study to further understand how it applies to user acceptance of handheld technology. Results of the current study were consistent with previous work showing that *perceived usefulness* and *attitude towards use* had the most significant influence on intention to use and actual PDA use. No significant relationship was found between ease of use and intention to use on the actual use of PDAs. However, the factor compatibility emerged as a significant correlate to the intention to use and actual use of PDAs by pharmacy students.

The message for pharmacy schools and colleges contemplating the adoption of PDAs by their students is that

these devices should be viewed by students as useful and compatible with the student experience. Students' attitudes also have a significant impact on PDA use. Ultimately, PDA use by pharmacy students and pharmacists should be tested to determine if it improves patient care; however, this was beyond the scope of the current study.

CONCLUSIONS

Pharmacists and pharmacy students will need to use handheld technology in their patient care activities. Nearly 30% of all students surveyed used their PDA at least daily. Over 80% of students use their PDA at least weekly to look up drug information. Perceived usefulness, attitude towards behavior, compatibility, and affect towards use explain about 75% of new user intent to use PDAs. Perceived usefulness, attitudes towards behavior, and compatibility explain about 71% of PDA use by experienced users.

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American Journal of Pharmaceutical Education 2008; 72 (1) Article 07.

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