AN EXAMINATION OF TEACHER ACCEPTANCE OF HANDHELD COMPUTERS

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As states and federal legislation have invested in integration of new technologies into education, the teacher's role as the user of such technologies in the classroom becomes more prominent (Telecommunications Act of 1996). However, relevant prior research suggests that teacher resistance to new technologies remains high. This study explores teachers' acceptance of handheld computer use, and identifies key intention determinants for using this technology based on a modified version of the technology acceptance model. The new model with five constructs—(1) perceived ease of use, (2) perceived usefulness, (3) subjective norms, (4) intention to use, and (5) dependability—was tested using the handheld computer acceptance survey responses from 45 special education teachers grouped into four groups by experience of using technology for data collection. The results showed that the direct effect of two constructs, perceived usefulness and perceived ease of use, on intention to use a handheld computer was statistically significant. The dependability factor, which was not included in any prior technology acceptance literature, had a statistically significant effect on perceived ease of use and usefulness, and intention to use a handheld computer, respectively. Groups of participants differed on only subjective norm. Theoretical and practical implications were also discussed.

This study carefully examines an emerging special educational technology, handheld computers. While this technology is not new, its emerging presence in special education classes merits careful review and examination for the salient factors relating to its viability for its intended purpose. As the job of special educators grows more laden with accountability for individualized education programs (IEP) that require direct observation of behavior in dynamic and interactive settings, administrators seek ways to streamline this job for special education teachers. Handheld computers are being considered as one of the ways by bringing the advantages of desktop and laptop computers to educators and researchers to be able to gather *just in time* (cf. Bruckner & Tjoa, 2001; McGhee & Kozma, 2003) data that can be used in support of learning and making sound educational decisions (Brown, Lovett, Bajzek, & Burnette, 2006). One serious concern is that lost, inappropriately stored, and poorly organized data can hinder the efficiency as well as issues related to teacher error in using the device. Therefore, it is paramount that the use of handheld devices for collecting and storing *just in time* educational data for accountability be studied and reported to facilitate school district decision making and to possibly influence legislator support for allocating funds to support the purchase of and training on handheld computers.

When new technologies are integrated into existing settings or processes there is a risk that these resources may be inadequately utilized or misused. Adaptation and adoption of such resources are dependent on factors such as willing acceptance by users, familiarity with the technology components, availability of appropriate resources, and design of the user interface and data entry formats (Legris, Ingham, & Collerette, 2003). Accordingly, users often resist an unplanned and inappropriately applied technology. Consequently, hardware, software and user satisfaction must be considered to help ensure the smooth implementation of any system.

Education stakeholders have invested significant time and financial resources introducing technology to schools and teachers. In their study, Booth, Wilkie, and Foster (1994) stated a common assumption that *if new technology is introduced, then it will be accepted and used* (p. 1). However, success is possible only when teachers agree to actually utilize the technology in instructional and administrative tasks (Paraskeva, Bouta, & Papagianna, 2008; Smarkola, 2007; Teo, Lee, & Chai, 2008). In their meta-analyses, Legris et al. (2003) concluded that teachers' attitudes toward technology and its perceived usefulness are significant determinants of behavior that may influence teachers' success in high-level use of technology in instruction. This idea originated in Davis' (1989) study that indicated the determinants of computer acceptance based on belief-attitude-intention-behavior relationship and resulted in the Technology Acceptance Model (TAM). However, TAM has been criticized, namely for being independent from the organizational context and having only two constructs. To address this constraint, many subsequent studies based on this model or extending it have been conducted related to educational contexts and have found that teacher acceptance is a key factor in the effective implementation of technology to support instruction (Gao, 2005; Kellenberger & Hendricks, 2003; Ma, Andersson, & Streith, 2005; Myers & Halpin, 2002; Ngai, Poon, & Chan, 2007; Pan, Sivo, Gunter, & Cornell, 2005; Pituch & Lee, 2006).

There are many studies in the literature stating that handheld computers are dependable tools and can be used as an alternative to traditional technologies, particularly in data collection (Adiguzel, Vannest, & Zellner, 2009; Crawford & Vahey, 2002; Trapl et al., 2005). Using reliable and dependable technology is critical for educators, because such factors determine a teacher's intention on a technology, the technology's usefulness, and the accuracy of the data collected. This documentation of reliability and effectiveness is a promising key factor for special education settings, where teachers need this type of technology to monitor progress on a student's IEP (Schaff, Jerome, Behrmann, & Sprague, 2005). Thus, handheld computers can be relevant tools for special education teachers, enabling them to walk around, monitor, and track student behavior where the actions take place, and to access student information and organize the details of daily teaching activities in one small, portable device that can be used anywhere and at any time (Adiguzel, Vannest, & Parker, 2009).

This study focuses on handheld computers that are particularly useful for special education applications. In order to increase the acceptance and use of handheld computers and to accelerate their integration in schools, it is necessary to study special education teachers' acceptance of this technology in school settings.

Theoretical Background

Technology acceptance is a complex construct, influenced not only by the type of technology and its purpose, but also by a cluster of variables that influence the adoption and application of technologies (Wolfe, Bjornstad, Russell, & Kerchner, 2002). Among these are the user's perceptions of social acceptability, confidence in his or her ability to use the device, and willingness to engage in training (Davis, Bagozzi, & Warshaw, 1989). Understanding what specific variables influence teachers' acceptance of technology and assessing the level of device acceptability among teachers can be measured by evaluating teachers' attitudes, intentions to use the device, perceived usefulness, and perceived ease of use (Davis et al., 1989).

There are two important factors that may mediate teacher's perceived usefulness and perceived ease of use when using computers for instructional and research purposes. The first factor was identified by Pavlou, Liang, and Xue (2007) who claimed that uncertainty can mitigate acceptance of a new technology. This is, given the high-stakes nature of the observations and grading of students with individual education plans may create a situation where they may find it difficult to adopt an untried technology. So regardless of perceived usefulness, the uncertainty related to dependability and data storage or security may negatively impact adoption of the technology. The second factor was identified by Ford, Duncan, Bedeian, Ginter, Rousculp, and Adams (2003) who claimed that regardless of other factors not fully understanding how the *back office* portion of the technology works creates mistrust of the technology and may lead to feeling out of control yet responsible for the ultimate outcome. This situation was described as feelings of culpability for the task at hand but not being in control of the mechanism on which they will depend. This condition may result in the tentative or superficial adoption of the technology but clearly suffers from perceptions of ease of use and usability because they are busy retaining their former practices and then duplicating their work in trying to learn and use the newer technology which accounts for lower scores on their perceptions.

In their study of teachers' acceptance and use of technology, Hu, Clark, and Ma (2003) concluded that teachers want to know that their adoption and utilization of technology will help them meet their school's goals and their own goals for the classroom. Thus, the ability of technological devices must be considered to help achieve both micro (classroom) and macro (school/district) level goals, and administrators and policy makers should determine how they can leverage existing empirical and anecdotal evidence to convince teachers that handheld computers are, in fact, acceptable for both types of goal achievement.

Handheld Computers

When compared to conventional desktop and laptop computers, handheld computers are generally perceived to offer greater portability at a more affordable cost generally between $100 and $400 (Bell, 2006). Handheld computers, which weigh on average less than half a pound, are smaller, lighter, and easier to maneuver than larger and heavier laptops, and offer portability that desktop computers cannot provide (Fletcher, Erickson, Toomey, & Wagenaar, 2003; Trapl et al., 2005). In addition, handheld computers with advanced multimedia capabilities and networking features are ideal for schools that require operating systems that have more power, are easier to use, and are more flexible in a wireless network setting. Although the documented benefits of handheld computers for school environments are substantial, the powerful uses of these computers are not yet widespread and the dynamics that influence the dependability and acceptability of these devices need to be understood.

Key Intention Determinants for Using Handheld Computers

Literature discusses many factors for adaptation and adoption of new technologies. Among these are: (a) perceptions regarding ease of use of handheld computers; (b) perceptions regarding the usefulness of handheld computers; (c) subjective norm; (d) the handheld computer's dependability; and (e) perceptions regarding the intention to use handheld computers. Each of these five variables must be considered regarding the use and efficacy of technology in general and of handheld computers in particular.

Perceptions regarding ease of use of handheld computers. Ease of use is a particularly important construct with respect to technology adoption and continued use (Davis et al., 1989). The phrase *ease of use* refers to the extent to which a person believes that using a technology will not require excessive mental and physical effort to implement (Davis et al., 1989). In particular, ease of use is the potential technology user's confidence that he or she will not be required to invest substantial amounts of time, energy, or effort learning to use the technology and maximize its functional capabilities. For example, teachers may feel compelled to learn about technology independently if they believe that its use will benefit teaching, classroom management, and student outcomes; however, expecting teachers to independently pursue learning opportunities in the field of technology use may be unrealistic on the part of administrators, because teachers are already overburdened and overextended with an array of responsibilities.

Perceptions regarding the ease of use of software and hardware technologies are influenced not only by concrete factors such as the teacher's actual ability to manipulate a technological device and use it for an intended purpose, but also by psychological factors, including the teacher' beliefs about the utility of a device and the role that it can play in classroom activities (Windschitl & Sahl, 2002). These authors point out that the degree to which school administrators believe in teachers' abilities to use technology effectively and the value they place on the technology itself are significant variables that influence teachers' perceptions regarding the devices' ease of use. The tone that is established and conveyed by the institutional culture, then, is a significant predictor of the perception that technology is easy to use and that learning how to use it effectively is possible.

Establishing an organizational culture that embraces technology plays a significant role in shaping teachers' perceptions of the utility of handheld computers. According to Zhao and Cziko (2001), teachers' perceptions of the utility of handheld computers and other computer technologies for classroom use are influenced by three principal beliefs: (a) that technology *can more effectively meet a higher-level goal than what [ever other means have] been used*; (b) that the use of such a computer will not disrupt classroom instruction and other *higher-level goals that he or she thinks are more important than the one being maintained*; and (c) that teachers will receive the training and ongoing support necessary to make the computer a useful tool (p. 5).

Perceptions regarding the usefulness of handheld computers. Whether policy makers present empirical or anecdotal evidence to teachers or administrators—or ideally, both—they must take a broad approach to the definition of usefulness. While one stakeholder group may consider the usefulness of handheld computers to be related primarily to the devices' portability, multiple functionalities, and the storage, access, and transfer of data, the teacher stakeholder group is likely to want to know how handheld computers will help them fulfill their classroom tasks and responsibilities. In addition, teachers want to know if the technology will enhance their overall job performance, as they assess it themselves, and also as assessed by their school administrators (Davis et al., 1989; Ma et al., 2005). Such evidence can be provided by empirical studies, but often has a profound influence when provided via the anecdotes and recommendations of other technology users. Thus, as administrators and policy makers attempt to convince teachers that handheld computers and other electronic technologies are useful in facilitating instruction, they should also consider the value of obtaining recommendations from other teachers familiar with these technologies.

Subjective norm. The term subjective norm refers to a broad category that includes a teacher's perceptions about, opinions regarding, or suggestions influencing his or her adoption and use of a handheld computer or other technology (Ajzen, 1988; Hu et al., 2003; Ma et al., 2005; Taylor & Todd, 1995). For the most part, as the term suggests, these norms are particular to each user, and are largely subjective, influenced not by empirical information about a technology's utility, ease of use, or functionality, but by anecdotal accounts of others' experiences with the technology and one's perceptions and projections about the technology based on one's own previous experiences (Marcinkiewicz & Regstad, 1996). The more negative experiences one has had with technology in the past, the more likely one is to be predisposed to resist, reject, or misuse the technology being introduced, even if it has been shown to have compelling benefits for both micro- and macro-level goals (Marcinkiewicz & Regstad, 1996). While subjective norms are available, the user also wants to know that the hardware and software are both dependable and reliable, with minimal intervention required from technical support staff or materials.

Dependability. Dependability refers to a technology's ability to perform consistently. It is also defined as *the system property that integrates [the] attributes [of] reliability, availability, safety, security, survivability, [and] maintainability* (Avizienis, Laprie, & Randell, 2001, p. 1). Dependability of both hardware and software is a *desirable property of all computer-based systems*, whether desktop, laptop, or handheld (Sterritt & Bustard, 2003, p. 247). Dependability and reliability are critical variables that, when taken into consideration, can help users predict the device's useful lifespan (Fitzgerald, 2002).

Dependability is measured by tabulating the incidents of *threats, faults, errors, and failures* that prevent the end user from being able to use the technology to fulfill its intended purpose (Avizienis et al., 2001, p. 1). Although dependability has improved considerably as technology has become more sophisticated, it remains a critical variable that determines both a user's interest in a technology and his or her ability to utilize it consistently, particularly because the same evolutionary process that has improved dependability has simultaneously increased the number of potential threats to dependability (Avizienis et al., 2001). In addition to discussing that teachers are influenced by the others to use handheld computer, and they believe it to be dependable, simple to use and useful for the realization of their own and the school's goals, it is crucial to elaborate how teachers intend to use handheld computers regarding four factors above.

Perceptions regarding the intention to use handheld computers. A teacher's decision to use a handheld computer may over time exert less of an influence than it does at present, particularly as both informal and formal elements of American culture demand the integration of technology in the country's classrooms (Cradler & Cradler, 2002). The No Child Left Behind (NCLB) Act in the beginning of this decade included provisions for the expanding role of technology in American schools (Cradler & Cradler, 2002). The NCLB Act emphasized the importance of technology's adoption and utilization in special education classrooms, making teachers in this area particularly compelled to address the question of whether and how they would incorporate technology into their classrooms, not only for instruction, but also for observation, monitoring, and evaluation purposes (NCLB, 2002).

As Hu, Chau, Liu, and Tam (1999) pointed out, however, mere adoption of a technology is not necessarily equivalent to a commitment to use the technology, much less to do so consistently and effectively. Teachers have varying beliefs about the value and utility of technology, and its ease of use.

Teachers also have varying levels of confidence in their own ability to master technology for basic and advanced purposes. Therefore, the teacher's intention and commitment to use a handheld computer or other technological resource in the classroom are dependent on a number of factors. Administrators and policy makers who realize that a conceptual and pragmatic gap often exists between a teacher's intention to use technology—which, in many cases, is mandated by the district and school—and his or her commitment to use it, will be better able to address these issues. A teacher may intend to use the handheld computer, and may actually do so to comply with administrators' expectations and demands. Intention and use however, should not be mistaken for indicators or confirmation that the technology is being used appropriately or optimally.

For these reasons, stakeholders responsible for determining the extent to which handheld computers will be implemented in classrooms need to attach some observable outcome criteria and measurements to the use of such technologies. Without making oversight punitive, administrators should ensure that technologies are being used correctly for the appropriate reasons, and that they are being leveraged to support the teacher's and school's overall instructional and achievement goals. Otherwise, the technology's potential benefits may be either undermined or underexploited.

Although the mobile technology has become a widespread in a range of organizational settings and user populations, empirical studies examining key factors affecting user behavior and its acceptance are limited. The TAM has been modified to measure individual's intention to use mobile wireless technology in several studies (Kim, 2008; Kwon & Chidambaram, 2000; Liang, Xue, & Bryd, 2003; Lu, Liu, Yu, & Yao, 2003; Pedersen, 2005). However, none of these studies were in education. The study reported here was intended to explore the handheld computer acceptance process and the differences between the groups of special education teachers in their educational settings, and to identify key intention determinants for using this technology based on a modified version of the technology acceptance model.

Method

Participants

Participants included two categories of special education teachers: those involved in a funded research project that investigated how special education teachers spend their time and those not involved. The project teachers came from two districts in a south-central U.S. state (n = 46). Teachers recorded their self-report of time-use data using a two-media (handheld- and Web-based data collection systems) instrument (Vannest, Hagan-Burke, & Parker, 2006) at three different times during 2005-2006. A data collection instrument developed on handheld computer was used for a total of ten weeks in the fall and winter terms (n = 18), and a web-based version of the same instrument was utilized for five weeks in the spring term (n = 28). The project teachers were grouped into three by experience of using these two media for their self-report of time-use data in the fall, winter, and spring terms: only handheld computer experience, only Web experience, and both.

Those in the comparison sample were special education teachers solicited within the same districts not involved or connected with the research project. They were selected based on demographics and their lack of previous experience using any type of data collection system, and was limited to those not already involved in the project (n = 91).

Table 1. Participants in the Study

N	Participants
8	Special education teachers who used only the handheld-based data collection system for self-report of their time-use.
8	Special education teachers who used both Web- and handheld-based data collection systems for self-report of their time-use.
12	Special education teachers who used only the Web-based version of the handheld data collection system for self-report of their time-use.
17	Special education teachers who did not involve in the project.

Forty-five special education teachers were included in the current study (see Table 1) to test the acceptance of handheld computers. Gender distribution showed an approximate 15:1 ratio in favor of female teachers. Their ages ranged from 22 to 31 (24.4%), from 32 to 41 (31.2%), from 42 to 51 (24.4%), and over 51 (20%). More than half of the participants (55.6%) owned a handheld computer.

They also reported they have used basic functions such as calendar, address book, to-do list, and notepad on handheld computers more often than other functions.

Model

As shown in Figure 1, the Technology Acceptance Model (TAM) was used as a theoretical basis, with its modified version (Hu et al., 2003; Ma et al., 2005) used in this study. In addition, a dependability construct was added to the model as a direct predictor of behavioral intention, ease of use, and usefulness. This was because teachers who experience difficulties regarding the dependability and reliability of their handheld computers are more likely than other users to use the device less frequently, to use it incorrectly, or even to abandon its use altogether (Edyburn, 2001). Teacher acceptance of handheld computers was measured using behavioral intention, which is theoretically and empirically supported in the TAM literature. Based on this expanded model, a teacher's intention to use handheld computer technology could be predicted and explained by his or her subjective perception of the technology's usefulness, ease of use, and dependability in conjunction with his or her subjective norm.

Perceived usefulness was defined in this study as *a teacher's subjective probability that using [handheld computer technology would] increase his or her job performance within [the school] context* (Davis et al., 1989, p. 985), while perceived ease of use was defined as *the degree to which [a teacher expected handheld computer technology] to be free of effort* (p. 985). Subjective norm refers to a teacher's perceptions about, opinions regarding, or suggestions influencing his or her adoption and use of handheld computer technology (Ajzen, 1988).

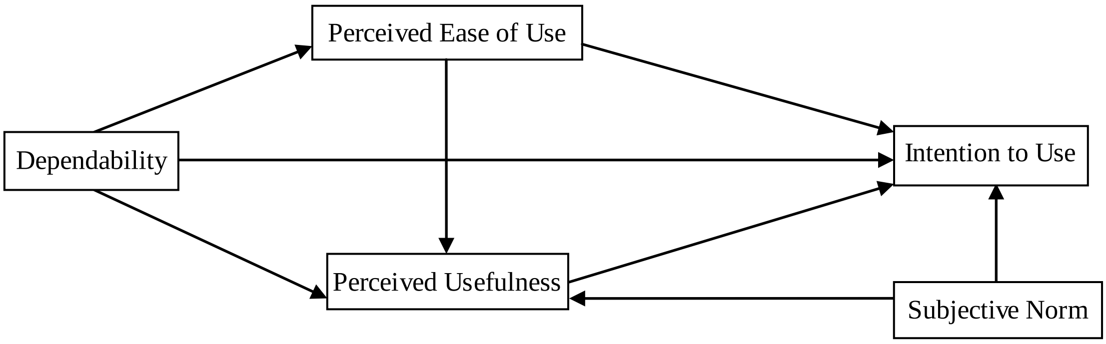

Figure 1. Theoretical model framework.

Dependability was defined as the degree to which the hardware and software of handheld computer were both dependable and reliable with minimal intervention from technical support staff or reference materials (Avizienis et al., 2001). Under this model, as informed by the reviewed literature, a teacher's perceptions of technology's usefulness and ease of use, as well as dependability and subjective norm, were investigated to test for significant effect on his or her decision to accept or reject handheld computer technology.

Instrumentation

One instrument—a modified version of the original TAM instrument—was used in this study. The handheld computer acceptability survey (HCAS) (Hu et al., 2003; Ma et al., 2005; Venkatesh & Davis, 2000) includes questions dealing with teachers' demographics, experiences with handheld computers, and finally, the acceptability items (see Appendix). The central construct of acceptability is composed of sub-constructs. The HCAS was developed based on five sub-constructs regarding the handheld computer: dependability (D), usefulness (PU), ease of use (PEU), teachers' intention to use (IU), and subjective norm (SN). TAM is a well-researched instrument with historical precedent in the validity and reliability of scores obtained from previous administrations. The instrument was designed for and used with a similar population, thereby increasing its content validity (Ma et al., 2005; Smarkola, 2007; Teo, 2009). HCAS includes items adapted from several variations of the TAM that were tailored to this study on handheld computer use in an education context. A total of 23 items were included within five domains of HCAS: intention to use (2 items), perceived usefulness (6 items), perceived ease of use (10 items), subjective norm (2 items), and dependability (3 items).

All HCAS items were randomly arranged based on a Likert-type five-point scale scored using the following key: 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree. HCAS also included a demographic section that asked participants to state their sex, age, experience using handheld computers, and frequency of handheld computer use for daily tasks (such as word processing, Internet access, and e-mail).

Data Collection and Analysis

To measure participants' acceptance of handheld computers, data were gathered from HCAS responses. The online version was administered to four different groups of special education teachers in mid-spring 2008. All participants (N = 137) were sent an e-mail that included a secure link and password to HCAS. A participation incentive was provided. Two respondents were randomly selected to win $50 gift certificates to Amazon.com. Forty-five (33%) completed surveys were collected with an assurance of confidentiality. The analyses used included linear regression, path analysis using structural equation modeling, and multivariate analysis of covariance (MANCOVA).

Model fit test. A five-variable path model was developed to examine causal relationships between three observed (measured) endogenous variables (PU, PEU, and IU) and two observed exogenous variables (D and SN). The AMOS 6.0 software (Arbuckle, 2005) with unweighted least squares (ULS) estimation was used to fit the path model in Figure 1 to the HCAS data. ULS was used given the small number of cases, as it provides reasonable estimators for small sample datasets. While we expected that power to detect effects was low, power was above 80% to detect a path value above about 0.3, a moderate effect that would indicate a meaningful direct effect between two variables. The model's overall fit with the HCAS data was evaluated using fit indexes different from Chi-square statistics, which provide only approximate indication of fit as they are very sensitive to sample size (N = 45) (Kline, 2005). The goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), and Bentler-Bonett normed fit index (NFI) were considered to test the model fit (Hair, Black, Babin, Anderson, & Tatham, 2006; Hoyle, 1995). Each causal path was evaluated in terms of statistical significance (t statistics, p = .05) and strength using standardized path coefficient (standardized betas) that range from -1 to +1. In addition, R^2 was used as an indicator of the model's overall predictive strength.

Group differences. Due to the nature of the data collected (survey data using Likert-scale items on five constructs measuring teacher acceptance of handheld computers), non-parametric inferential and descriptive statistics were also calculated on the scores of the dependent measures. To test differences among the groups of special education teachers based on their predetermined handheld computer experience, a non-parametric MANCOVA (Hair et al., 2006) with several planned contrasts was employed using SPSS 15.0 software. The five constructs of the HCAS served as dependent variables. Participants' ages and genders were entered as covariates to avoid bias due to project selection effects.

Results

Data from the HCAS instruments were analyzed to test the differences of four participant groups on five constructs (dependent variables) and the relations among observed and latent variables (constructs). With the exception of two items, the descriptive statistics of the HCAS items shown in Table 2 indicated that participants held generally positive (mean scores greater than three) perceptions towards handheld computer use in their classrooms. The mean scores ranged from 2.11 to 4.13, while the standard deviations ranged from 0.73 to 1.07. The internal consistency of the HCAS instrument was calculated using Cronbach's α-value. As shown in Table 2, Perceived Ease of Use, Perceived Usefulness, and Intention to Use exhibited α-values greater than 0.70, and Subjective Norm had a value of 0.62 while Dependability had a value of 0.31. However, item D3 was deleted and not included in the prospective analyses regarding item-total statistics results, which increased α-value for Dependability to 0.79.

Model Fit Testing

Because the study's sample size was small (N = 45) and the chi-square test of absolute model fit is sensitive to sample size and non-normality in the underlying distribution of the input variables, unweighted least squares estimates and the other common fit indexes—GFI, AGFI and NFI—were considered in AMOS to analyze the survey data and to evaluate the model's overall fit (D'Agostino & Stephens, 1986; Schumacker & Lomax, 2004). The most common index of fit, GFI = .992 (> .90) (Kline, 2005), AGFI = .939 (> .80) (Segars & Grover, 1993), and NFI = .974 (> .90) (Chin & Todd, 1995) exhibited an acceptable fit to the data based on the common acceptable values in the parentheses, which meant the overall model resulted in a very good fit.

Table 2. Summary of Descriptive Statistics and Reliability of HCAS Instrument

HCAS Items	*N*	Mean	SD	Cronbach' *α*
Intention to Use (IU)				.73
IU1	45	4.13	.726	
IU2	45	4.04	.976	
Perceived Usefulness (PU)				.86
PU1	45	3.87	.894	
PU2	45	3.58	.753	
PU3	45	3.78	.902	
PU4	45	3.87	.894	
PU5	45	3.58	.965	
PU6	45	3.69	.793	
Perceived Ease of Use (PEU)				.92
PEU1	45	3.09	.733	
PEU2	45	3.16	.999	
PEU3	45	3.38	.960	
PEU4	45	3.00	.905	
PEU5	45	3.67	.953	
PEU6	45	3.53	1.057	
PEU7	45	3.33	1.022	
PEU8	45	3.51	.757	
PEU9	45	3.51	.815	
PEU10	45	3.62	.936	
Subjective Norm (SN)				.62
SN1	45	2.84	.999	
SN2	45	3.02	1.011	
Dependability (D)				.31
D1	45	3.38	.834	
D2	45	3.80	.815	
D3	45	2.11	1.071	

Figure 2 shows the resulting path coefficients of the overall model. For the overall model, most of the standardized path coefficient represented a statistically significant relationship between the variables. Perceived usefulness and perceived ease of use had a statistically significant direct effect on participants' intention to use handheld computers, with standard path coefficients of .49 ($p < .01$) and .42 ($p < .05$), respectively.

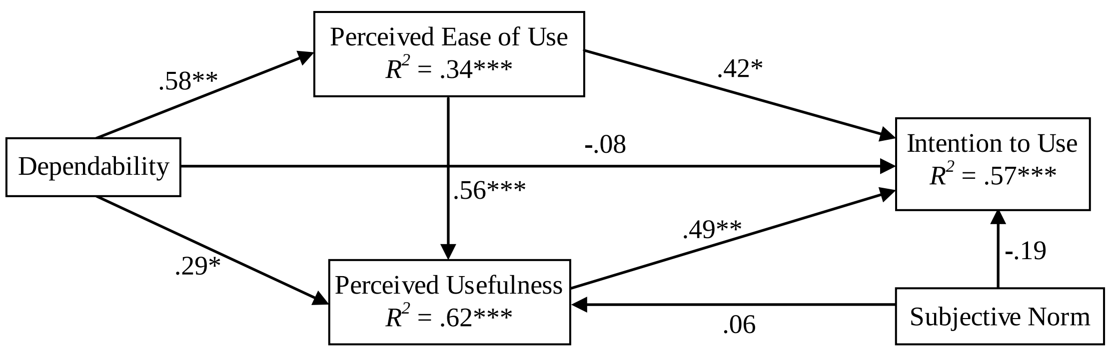

Figure 2. Theoretical model testing results.

In other words, intention to use handheld computers would positively improve by 0.49 standard deviations, given a change in perceived usefulness of one full standard deviation, when the other variables in the model were controlled. Direct effect of perceived ease of use on perceived usefulness was 0.56, statistically significant ($p < .01$). Dependability had the strongest and statistically significant effect in the model, which was on perceived ease of use, with a standardized path coefficient 0.58 ($p < .001$). Although dependability had a statistically non-significant direct effect on intention to use handheld computers, its total effect on intention to handheld computer use, through the mediating perceived usefulness and perceived ease of use, was a statistically significant and 0.44. Subjective norm had neither a statistically significant direct nor indirect effect on perceived usefulness or intention to handheld computer use.

The proportions of explained variance across dependent variables—perceived ease of use, perceived usefulness, and intention to use handheld computers—ranged from 34% ($p < .01$) to 59% ($p < .001$). Overall, the model accounted for a statistically significant portion of variance (57%, $p < .001$) in participants' acceptance of handheld computers. Perceived ease of use was predicted by the direct effect of dependability resulting in an R^2 of .34 ($p < .01$), while perceived ease of use, dependability and subjective norm together explained 62% of the variance in perceived usefulness (see Table 3). Based on the results from the model, perceived usefulness was the most important determinant of intention to use handheld computers, followed by ease of use, then dependability.

Table 3. Summary of Causal Path Testing Results

Causal Path	Standardized Path Coefficients	Standard Errors
D → PEU	.580 ***	.575
D → PU	.290 *	.320
SN → PU	.062	.241
PEU → PU	.562 ***	.073
PEU → IU	.416 *	.036
D → IU	-.079	.140
SN → IU	-.192	.099
PU → IU	.486 **	.064

Note. $R^2_{IU} = .57$ ***, $R^2_{PU} = .62$ ***, $R^2_{PE} = .34$ ***

* $p < .05$, ** $p < .01$, *** $p < .001$

Group Differences Results

A MANCOVA was performed contrasting the four groups listed in Table 1 on all five dependent variables. Levene's Test of Homogeneity of Variance and Box's M Test of Homogeneity of Covariance revealed no violation of assumptions. Bartlett's test was not considered because it is sensitive to even minor departures from normality or heteroscedasticity. Age and gender were tested separately within the overall MANCOVA to examine their relative contribution to any observed effects on the dependent variables.

Neither age (F (5, 35) = 1.514, $p > .05$) nor gender (F (5, 35) = .755, $p > .05$) accounted for a statistically significant proportion of the variance; therefore, they were not considered as covariates in the model. The overall group factor was statistically significant in the multivariate analysis (F (15, 102) = 1.809, $p < .05$), but examination of univariate ANOVAs yielded only one statistically significant dependent measure, subjective norm, among the four group levels (see Table 4). Certainly, power was not great to detect the small effects that were estimated here.

Table 4. Univariate Analysis Results for Group on Dependent Measures

Dependent Measures	MS	F(3, 41)	η^2	Power
Intention to Use	.801	.328	.023	.108
Perceived Usefulness	14.832	.908	.062	.231
Perceived Ease of Use	16.450	.327	.023	.108
Subjective Norm	7.660	2.957*	.178	.658
Dependability	.956	.288	.021	.100

*$p < .05$.

A summary of all planned contrasts is presented in Table 5. Of the eight planned contrasts within the MANOVA, only three—C1, C2, and C7—demonstrated statistically significant results, and these were on the same dependent measure of subjective norm. Specifically, contrasting group 1 against group 2 (C1) yielded that participants who used handheld- and Web-based data collection technology considered opinions or suggestions of others concerning their acceptance of handheld computers more than the ones who used only handheld computers ($p < .01$). A comparison of group 1 and group 3 (C2) revealed that participants who used only Web-based data collection technology cared more about the opinions or suggestions of others concerning their acceptance of handheld computers than those who used only a handheld-based version ($p < .05$). Contrasting group 1 with groups 2 and 3 (C7) showed that participants who used handheld- and Web-based data collection technology, and those who used only Web-based data collection technology, took into greater consideration the opinions or suggestions of others concerning their acceptance of handheld computer than those who used only a handheld-based version ($p < .01$). Based on participants' responses, the multivariate statistics with several contrasts demonstrated that four groups of participants differed only on subjective norm. Difference of the groups on the rest of the dependent measures was not statistically significant.

Table 5. Contrasts of Group Means by Hypothesis

	IU		PU		PEU		SN		D	
Contrasts	*F*	CD	*F*	CD	*F*	CD	*F*	CD	*F*	CD
C1 (1,-1,0,0)	.64	.63	.86	1.88	.10	1.13	7.82**	2.25	.03	.13
C2 (1,0,-1,0)	.22	.33	.29	1.00	.40	2.04	5.67*	1.75	.09	.21
C3 (1,0,0,-1)	.81	.60	.10	.56	.88	2.86	3.68	1.32	.44	.43
C4 (1,1,-1,-1)	.10	.31	1.84	3.43	.72	3.78	.67	.82	.64	.77
C5 (1,1,-2,0)	.00	.04	1.58	3.88	.30	2.96	1.03	1.25	.21	.54
C6 (1,1,1,-3)	.34	.85	.46	2.55	.67	5.41	.00	.03	.73	1.22
C7 (2,-1,-1,0)	.53	.96	.07	.88	.28	3.17	8.72**	4.00	.00	.08

Note. Simple contrasts were used. CD = Contrast Difference.
* $p < .05$, ** $p < .01$.

Discussion

This study was conducted to: (1) investigate special education teachers' acceptance of handheld computers, (2) determine the key factors that influence special education teachers' intention to use handheld computers, and (3) test the differences between groups of participants who had varying levels of handheld computer use on five constructs: IU, PU, PEU, SN, and D. The model structured with these constructs, consistent with the Technology Acceptance Model (TAM) literature, including the new dependability construct, was also tested. It was found that the special education teachers' overall average scores for each construct were all positive. Perceived usefulness and perceived ease of use were two direct determinants of special education teachers' intention to use handheld computers. Dependability was statistically confirmed to be an essential contributor for special education teachers' intention to use handheld computers, through perceived usefulness and perceived ease of use. Subjective norm was the only construct on which the four groups of special education teachers differed significantly.

Perceived usefulness was one of the most significant factors in determining the special education teachers' acceptance of handheld computers, a finding similar to previous studies such as those by Legris et al. (2003), Liang et al. (2003), Lu et al. (2003), and Ma et al. (2005). Accordingly, special education teachers perceive that handheld computers are useful because such computers improve their instructional performance, productivity and effectiveness. The usefulness of technology was also associated with its ease of use and dependability in the study either directly or indirectly. Therefore, having handheld computers that are not easy to use and dependable may cause special education teachers to perceive such computers in general as not useful. Special education teachers also considered handheld computers as useful regardless of the others' positive suggestions and opinions.

Perceived ease of use had both significant direct (Liang et al., 2003; Lu et al., 2003) and indirect effects on handheld computer acceptance, as mediated by perceived usefulness, just as Yuen and Ma (2002) found. In other words, special education teachers would adopt handheld computers when they are confident that using such computers would not require substantial investments of time, energy, or effort to learn and to maximize functional capabilities. A significant indirect effect of perceived ease of use on intention to use handheld computers (through perceived usefulness) also indicates that special education teachers' acceptance of handheld computers can be stronger and significant if they perceive handheld computers as easy to use and perceive that their use will benefit their teaching, classroom management, and student outcomes.

It was found that the average scores of subjective norm were low when compared with the other constructs. The model test results also showed that the effect of subjective norm on perceived usefulness and intention to use was not statistically significant. From a practical standpoint, special education teachers might not consider their colleagues' opinions or suggestions when making their initial decision to accept or reject the use of a handheld computer. This result is consistent with some previous studies (e.g., Davis, 1986; Ma et al., 2005), even though other studies (e.g., Ajzen, 1988; Mathieson, 1991; Pedersen, 2005; Taylor & Todd, 1995; Venkatesh & Davis, 2000) found either direct or indirect significance for these relationships. One reason for this discrepancy could be that the special education teachers in this study decided independently to accept handheld technology. On the other hand, more than half of the special education teachers in the study were required to use the handheld computers provided by the funded project. This argument was not consistent with the research study (Venkatesh & Davis, 2000) that found significant effect on intention to use in a mandatory-use context. Furthermore, the direct effect of subjective norm on intention to use handheld computers was adverse. The reason for this might be associated with special education teachers' own perspectives for accepting or rejecting handheld computers before they were informed of their colleagues' opinions.

The groups of special education teachers were significantly separated on only a subjective norm. A primary reason for this significant difference was the scores of the first group of special education teachers, who used only handheld computers in the funded research study. This difference resulted from the fact that these special education teachers did not need any norms from the other subjects as they become confident and experienced using handheld computers. Similarly, Hu et al. (2003) found that the effect of subjective norm on technology acceptance was not supported at the end of the training session, though this effect was supported at the beginning of the session. Therefore, this study contributes to the findings in the technology acceptance literature that one who has experience using this technology may resist the norms provided by other subjects.

This study is unique because it added dependability as a new construct. The overall average scores of dependability were greater than three, meaning that special education teachers found handheld computers dependable for use in their school settings. The model test results showed that the direct effect of dependability on intention to use handheld computers was not supported. However, dependability had a statistically significant direct effect on perceived ease of use and perceived usefulness. One interpretation of this finding could be that as long as the handheld computer hardware and software are both dependable and reliable with minimal technical support, special education teachers consistently perceive handheld computers as easy to use and useful for school-based tasks (Avizienis et al., 2001). In addition to direct effect, the indirect effect of dependability through the mediated effects of perceived usefulness and ease of use on intention to use handheld computers was also significant. This result is also plausible given that the dependability of handheld computers might not directly explain their acceptance by special education teachers who do not know that these computers are easy to use and useful. However, having dependable and useful, or dependable and easily used, technology makes a difference in special education teachers' acceptance of handheld computers.

Regarding the contrast results, all constructs except subjective norm did not differentiate the groups of special education teachers. One reason is associated with participants' differing levels of use and experience with handheld computers. Even if the 19 special education teachers experienced handheld computers in the funded project, there were still six more teachers who were not associated with the project and also used or owned handheld computers. It might be said that although the average scores of these 19 teachers showed positive intention to use handheld computers, this positivity was not sufficient to obtain significance among groups based on handheld computer experience. Another possible reason is that special education teachers in all four groups from the onset might have been disposed to be open to new technology and believe that technology is an indispensably assistive tool for their daily tasks.

There are several factors limiting this study. First, the sampling and assignment were not random, that is cluster sampling was used and only special education teachers were included. Second, the sample size of the study was small for testing the model and group differences. Small samples are generally underpowered and there is greater potential to erroneously fail to reject the null hypothesis and obtained results for small samples are less stable (Chou & Bentler, 1995; Kline, 2005). Thus, sampling and sample

size must be considered a prerequisite factor when generalizing these findings. In this case, testing the model with a larger number of both special education and general education teachers might give more stable results that could be generalized to a greater segment of the teaching field.
Third, the special education teachers in this study worked in different organizational contexts. Some were required to use handheld computers in the funded project in which they were involved. This participation brings the issue of context (Legris et al., 2003) into discussion and requires further research to test the models in mandatory and voluntary settings to bring different perspectives to the acceptance research. Fourth, the dependability factor on technology acceptance was tested and supported only with regard to handheld computers. The value of dependability should also be tested with other technologies to contribute a new model with several variations to the field. Finally, having lower reliability for dependability constructs when compared with satisfactory values may be a potential limitation, though this was improved by deleting the problematic item in the study. Therefore, caution should be taken regarding the reliability of each item in the instrument before conducting the main study. Specifically, having more than three items, as well as having alternately presented or negatively worded items, may alleviate the need for these caveats in further research (cf. Selwyn, 1997).

Implications and Conclusions
Although technology is evolving rapidly and has become increasingly common and accepted in school settings, just as it has in society at large, McDonald (2002) pointed out that *studies of score equivalence have largely ignored individual differences such as computer experience, computer anxiety and computer attitudes*, all of which have been substantiated by the literature as potential obstacles inhibiting the adoption and application of handheld computers (p. 299). Although teachers may rightly be viewed as likely to be open to learning new skills, technology adoption is a complicated area of learning, the success of which is often influenced by existing beliefs and perceptions. Those responsible for implementing and overseeing handheld computer use may not be able to effectively manage the wide range of beliefs and perceptions pertaining to technology, but knowing that they exist could be a minimum expectation.

The findings of the study support the influence of dependability on perceived ease of use and perceived usefulness as an asset that accelerates the process through which teachers come to accept handheld computers. Accordingly, it is crucial that school administrators and policy makers regularly check with teachers to ensure that they are not experiencing difficulties vis-à-vis dependability and reliability, in addition to ensuring that teachers are trained to use the computer appropriately, that they are satisfied with its performance, and that they believe it to be both simple to use and meaningful for the realization of their own and the school's goals (Edyburn, 2001).

While developing awareness and providing training for the introduction of handheld computer in the classroom are important strategies to prepare teachers for optimal leveraging of technology (Schulenberg & Yutrzenka, 2004), teachers are by no means the only, or even the most important, variables. The five areas discussed in this study must all be addressed to successfully and dependably prepare, plan, and implement the use of handheld computers into school- and classroom-based settings.

Overall, the study tested the model to explain the handheld technology acceptance decision process and the differences between the groups of special education teachers on five constructs of this model. Testing found that all the causal relationships among the constructs' latent variables (except the ones directed from subjective norm) were statistically significant; namely, special education teachers' intention to use handheld computers was successfully explained by their perceptions on the handheld computers' ease of use, usefulness, and dependability. Subjective norm was only factor for which the groups of special education teachers differed.

These findings are clearly an important addition to the literature pertaining to technology adoption in educational settings. A new tested dependability factor, blended with the factor of computer experience, will provide a new asset for technology acceptance models to be tested in diverse international contexts and with different technology applications.

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Appendix. Handheld Computers Acceptability Survey

Part I:

Directions: Please answer the following questions by putting a check mark with the appropriate response or filling in the information requested.

1. Gender ___ Male ___ Female
2. Age: _____
3. Have you owned or had access to a handheld computer? ___ Yes ___ No
4. I have been using handheld computers for _____ years.
5. During the last year, how often have you used a handheld computer for the following tasks (Check one answer per task)?

Task	**Never**	**Once or Twice**	**Monthly**	**Weekly**	**Daily**
Basic functions such as calendar, address book, to do list, and note pad					
Word processing					
Multimedia presentations					
Spreadsheet or database					
Drawing					
Internet access					
Email					
Games					
Playing music					
Taking pictures					
Stand-alone application to assist your activities					

Part II:

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	I intend to use handheld computers when they become available in my school settings. (IU)					
2.	To the extent possible, I would use handheld computers to do various Special Education tasks. (IU)					
3.	Using handheld computers improves Special Education teachers' school performance. (PU)					
4.	Handheld computers enable Special Education teachers to accomplish tasks more quickly. (PU)					
5.	Using handheld computers will make it easier for Special Education teachers to perform their daily activities. (PU)					
6.	Using handheld computers enhance Special Education teachers' effectiveness on Special Education services. (PU)					
7.	I find handheld computers to be useful for Special Education teachers. (PU)					
8.	The quality of the output from handheld computers is high. (PU)					
9.	Frequent errors are not common when using handheld computers. (PE)					
10.	I rarely need help when using handheld computers. (PE)					
11.	It is easy to get handheld computers to do what I need them to do. (PE)					
12.	It is easy to become skillful in using handheld computers. (PE)					
13.	Learning to operate handheld computers is easy. (PE)					
14.	Interactions with handheld computers are clear and understandable. (PE)					
15.	Interacting with handheld computers does not require a lot of mental effort. (PE)					
16.	Handheld computers are easy to use. (PE)					
17.	I rarely become confused when using handheld computers. (PE)					
18.	The results of using handheld computers are apparent. (PE)					
19.	People who influence my behavior think that I should use handheld computers. (SN)					
20.	People who are important to me think that I should use handheld computers in my instruction. (SN)					
21.	Handheld computers are reliable and trouble free for data collection. (D)					
22.	Handheld computers are dependable computers for data collection. (D)					
23.	Handheld computers are available for Special Education teachers to use for data collection any time. (D)					

(PU) = Perceived Usefulness; (PE) = Perceived Ease of Use; (IU) = Intention to Use;
(SN) = Subjective Norm; (D) Dependability