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THE EFFECTS OF MOBILE DEVICES AND WIRELESS TECHNOLOGY ON E-LEARNING

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ABSTRACT

This paper examines factors influencing e-learning. A survey-based methodology was used to obtain data from respondents, namely, students in three higher educational institutions. The dependent variable in this study was effectiveness of e-learning and the independent variables were the impact of wireless technology and mobile devices, and demographic factors such as gender, age and course of study. Multiple regression analysis, correlation analysis, and chi-square test for independence were employed to analyze the data. Wireless technology and mobile devices were found to be the most important determinants of effectiveness of e-learning. There was no significant effect of course of study, age and gender on effectiveness of e-learning.

Key words: E-learning, mobile devices, wireless technology, effectiveness, performance, availability.

INTRODUCTION

Wireless computing is currently the cream filling in the technology applications in e-learning (Sbihli, 2002**)**. Mobility is the most important feature of a wireless communication system. Currently wireless communication is one of the fastest growing segments in industry (Rogers and Edwards, 2003). Wireless networks are the pathways along which e-learning travels. Without a network it would not be possible to read a file from a server, share documents with remote customers, or send and receive e-mails (Jamlipour, 2003). Wireless communication offers the flexibility for users to access the geographical coverage of wireless systems. Nevertheless, it is limited: wireless networks use a fixed infrastructure for central administration (Mark and Zhuang, 2003).

Wireless communication systems, such as cellular, PDAs (Personal Digital Assistant), satellite phones as well as wireless local area networks, have widespread use and have become an essential tool in many people's everyday life, both professional and personal (Sbihli, 2002). PDAs and cellular systems are omnidirectional in design, permitting service for many different users within a specified area. Microwaves involve unidirectional or point-to-point technology; unidirectional wireless technologies transmit only in one direction at one time (Rogers and Edwards, 2003). In multiple-access communication systems, which refer to mobile devices, the goals are universal coverage, quality of service similar to that of traditional service, low equipment cost for providers and end users, and lower number of cell

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sites required to achieve maximum penetration while maintaining quality of service (Dubendorf, 2003). Wireless computing technology benefits e-learning by increased customer strength, decreased cost and improved customer service. Wireless data networks must be able to overcome challenges like coverage, reliability, standards, speed and cost (Vacca, 2002).

ISSUES IN WIRELESS TECHNOLOGY

The availability, mobility, and performance of wireless technology depend on five major areas.

Platform

The majority of PDAs and cellular phones being produced have embedded in them some type of Web browsing technology (Sbihli, 2002). There are four major platforms worth considering for handheld and wireless computing. The Palm OS, RIM (Research in Motion), Windows CE (Pocket PC) and wireless Internet are becoming the dominant players. Two others with good visibility are Symbian and Zaurus (Rogers and Edwards, 2003).

Connectivity

The true wireless connectivity is wireless RF (Radio Frequency). The wireless communication categories are WLAN (Wireless Local Area Network) and WWAN (Wireless Wide Area Network) (Sbihli, 2002). The IEEE 802.11 Standards for WLANs have gone a long way toward standardizing WLAN development and ensuring a certain level of interoperability, which is absolutely critical for enterprise adoption of WLAN. 8.5.12 802.11a is a high speed WLAN standard that provides speeds of up to 54 Mbps in the relatively uncrowded and unlicensed 5-GHz band. 802.11g is the high speed extension of 802.11b. Training sites at corporations and students at universities use wireless connectivity to facilitate access to information, information exchanges and learning (Rogers and Edwards, 2003).

Wireless Middleware

Wireless middleware provides services specific to the world of wireless and handheld computing. A good middleware package handles user authentication, device management, encryption and protocol conversion. Wireless middleware services are secure communication management, synchronization, message processing and management tools (Sbihli, 2002).

Back-End System

Handheld and wireless computing extends the reach of corporate data and corporate transaction engines. The data are stored on a Web site, mainframe, UNIX server, or an Oracle database. Although a PC application might use all of the data, handheld applications will likely only transfer or synchronize a subset of that data (Sbihli, 2002).

Security

The key security requirements are confidentiality, authentication, integrity and nonrepudiation. In a wireless world, security includes communication links, integrity of the channel, and accuracy of transactions (Schwarz, 2002).

ATTRIBUTES OF MOBILE DEVICES

The main attributes are Operating System, large graphical display, touch screens, connectivity, memory, programmability, and PIM (Personal Information Manager) functionality (Sbihli, 2002). Wireless network appliances include network-attached disks, cameras and displays; set-top boxes and Web browsers; handheld and portable devices; and application, gateway, and special-purpose servers, such as Web and file servers.

OBJECTIVE

The objective of the study is to establish the effect of wireless technology and mobile devices on e-learning. Further, the study looks at the effect of demographic factors such as course of study, age and gender on effectiveness of e-learning.

METHODOLOGY

The effect of wireless technology and mobile devices (the independent variables) on e-learning (the dependent variable) was evaluated by carrying out a survey among students majoring in different areas. A questionnaire on the perception of wireless technology and mobile devices in e-learning was given to the sample consisting of 300 degree students from three different universities: Monash University Malaysia (100 students), Sunway University College (150 students), and UNITAR (50 students).

Likert-scale questions were used to measure the perceptions. A five-point score ranging from “strongly disagree” (1) to “strongly agree” (5) was used to analyze the responses. The lower scores indicated perceived deficiencies of the properties. Twenty-five perception-based questions were asked regarding the effect of wireless technology, and 16 questions were asked regarding the effect of mobile devices. Four questions measured the effectiveness of e-learning.

Descriptive statistics in the form of frequencies for each of the scores, the mean and the standard deviation for all the variables of wireless-technology properties and mobile-device properties were computed. Tests of hypothesis were carried out using 1-tailed test, at 5% level of significance, to determine whether the mean perception of the students differs significantly from the neutral perception score of 3.0. Analysis was carried out using MINITAB.

Tests of hypotheses were also carried out to analyze the correlation between the independent variables and the dependent variable. Regression analysis was done to predict the effectiveness of e-learning based on the above two factors (wireless technology and mobile devices). Further, chi-square tests were used to evaluate whether perception differs based on course, age, and gender. The following hypotheses were tested:

H1: The student perception of effectiveness of e-learning depends on the course of study.
H2: The student perception of effectiveness of e-learning depends on age.
H3: The student perception of effectiveness of e-learning depends on gender.
H4: There is significant positive correlation between the wireless-technology properties and effectiveness of e-learning.
H5: There is significant positive correlation between the mobile-device properties and effectiveness of e-learning.

RESULTS

This section examines the role of each property in wireless technology. Table 1 shows descriptive statistics of wireless-technology properties. The *p*-values indicate that all the properties except Internet access have a mean value significantly below the neutral value 3.0.

Table 2 gives descriptive statistics and results of tests of hypotheses for mobile-device properties. The tests of hypotheses revealed that all the properties related to mobile devices have a significant positive effect on e-learning, with the mean perception scores for all the properties except Health problems significantly above the neutral value.

The overall statistics of sumwt (sum of wireless technology), sume (sum of e-learning) summd (sum of mobile devices) are shown in Table 3.

The summated scores for the properties of WT (wireless technology), MD (mobile device), and E (e-learning) were analyzed for normality. The histograms and normal probability plots in Figures 1, 2, and 3 confirm that the distributions of the three variables follow the normal distribution.

The frequencies of respondents based on course, age, and gender are given in Table 4. Pearson chi-square tests were carried out to determine the dependence of e-learning on the course, age, and gender of the respondents. Table 5 shows the results, which reveal that the course taken by the students, their age, and their gender have no significant effect on e-learning at 5% level of significance.

Table 1. Descriptive Statistics of Wireless-Technology Properties

Property	1	2	3	4	5	Mean	Std. Dev.	*p*-Value
Coverage	49	52	86	109	4	2.89	0.962	0.024*
Quality of service	33	71	113	75	8	2.84	0.898	0.002*
Internet access	26	90	49	120	15	3.03	0.984	0.362
Storage methods	22	113	120	22	23	2.71	0.883	0.000*
Current middleware	11	82	158	37	12	2.86	0.777	0.001*
Protocols are sophisticated	11	71	162	45	11	2.92	0.757	0.021*
Location calculation	30	60	154	56	0	2.79	0.820	0.000*
Tracking accuracy	18	67	165	45	5	2.84	0.772	0.000*
Power facility	37	64	143	41	15	2.78	0.877	0.000*
Availability	30	90	101	67	12	2.81	0.918	0.000*
Accuracy	15	82	143	56	4	2.84	0.802	0.000*
Reliability	18	64	147	56	15	2.95	0.801	0.139
VPN connectivity	26	86	120	60	8	2.79	0.875	0.000*
Interference	18	75	158	37	12	2.83	0.798	0.000*
Health issues	23	113	90	50	24	2.80	0.936	0.000*
11Mbs shared bandwidth	37	109	116	35	3	2.53	0.871	0.000*
802.11b suitability	26	101	124	37	12	2.70	0.872	0.000*
802.11g suitability	33	82	135	33	17	2.73	0.883	0.000*
Security	22	79	131	56	12	2.86	0.851	0.001*
Devices quality	18	116	124	39	3	2.65	0.833	0.000*
Turnaround time	22	98	135	34	11	2.72	0.847	0.000*
Interoperability	18	79	158	42	3	2.78	0.789	0.000*
Operating system compatibility	33	101	90	71	5	2.72	0.926	0.000*
Wi-Fi card support	33	116	94	45	12	2.63	0.916	0.000*
Router specifications	33	90	101	49	27	2.83	0.946	0.001*

* Significant at the 0.05 level (1-tailed).

Table 2. Descriptive Statistics of Mobile-Device Properties

Property	1	2	3	4	5	Mean	Std. Dev.	*p*-Value
Hardware problems	32	40	86	109	33	3.60	0.79	0.00*
Software problems	22	54	78	110	36	3.65	0.78	0.00*
User friendly interface	20	65	49	132	34	3.76	0.83	0.00*
Wasting time	15	78	135	45	27	3.12	0.80	0.04*
Middleware problems	26	56	78	123	17	3.57	0.79	0.00*
Protocols are sophisticated	9	34	75	154	28	4.04	0.36	0.00*
Compatibility	19	45	75	148	13	3.80	0.63	0.00*
Useful for e-learning	12	43	83	152	10	3.86	0.50	0.00*
Battery problems	18	34	53	42	153	4.07	0.83	0.00*
Data availability	25	46	34	126	69	3.98	0.83	0.00*
Data accuracy	7	52	138	56	47	3.47	0.66	0.00*
Data reliability	21	56	132	68	23	3.28	0.76	0.00*
Access rate	22	41	136	53	48	3.39	0.74	0.00*

Table 2 (continued)

Property	1	2	3	4	5	Mean	Std. Dev.	*p*-Value
Performance	17	75	34	136	38	3.80	0.87	0.00*
Health problems	32	134	83	33	18	2.68	0.93	0.00*
Affordable	25	67	126	78	4	3.16	0.78	0.00*

* Significant at the 0.05 level (1-tailed).

Table 3. Statistics of Sumwt, Sume, and Summd

		Sumwt	Sume	Summd
N	Valid	300	300	300
	Missing	0	0	0
Mean		79.40	14.66	62.35
Std. Deviation		11.59	2.96	8.87
Minimum		43.00	6.00	37.00
Maximum		117.00	20.00	92.00

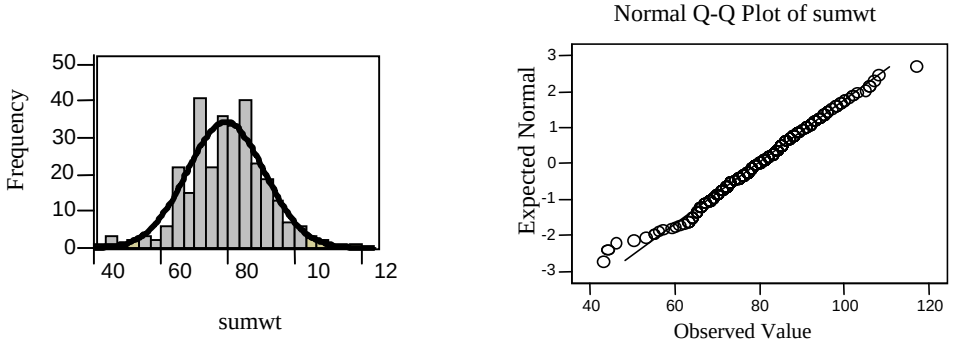

Figure 1. Sumwt (sum of wireless technology score)

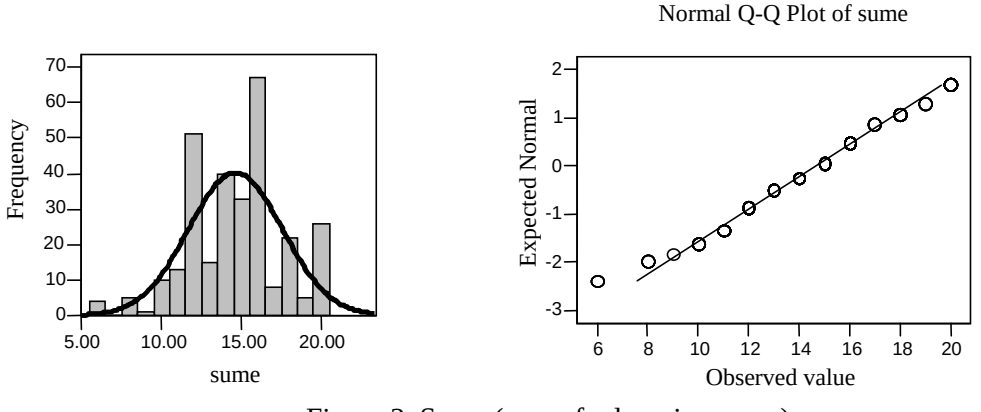

Figure 2. Sume (sum of e-learning score)

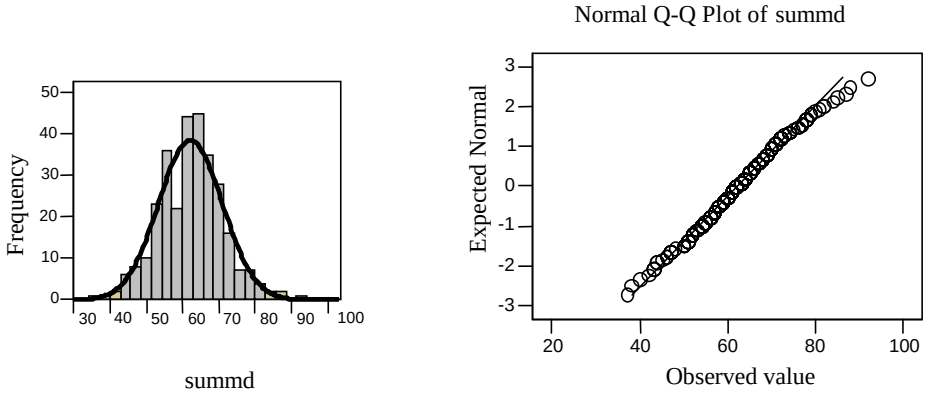

Figure 3. Summd (sum of mobile devices score)

Table 4. Frequencies of Respondents based on Course, Age, and Gender

Variable		Frequency	Percent
Course	Business	38	12.7
	Computer	168	56.0
	Engineering	36	12.0
	Accounting	28	9.3
	Others	30	10.0
Age	18 and below	15	5.0
	Between 19 to 21	169	56.3
	Between 22 to 24	108	36.0
	Between 25 to 27	8	2.7
Gender	Male	155	51.7
	Female	145	48.3

Table 5. Results of Chi-Square Test by Courses, Age, and Gender

Variable	Type	Value	df	Asymp.Sig. (2-sided)
Course*ecat	Pearson Chi-Square	13.359	12	0.343
Age*ecat	Pearson Chi-Square	9.084	9	0.430
Gender*ecat	Pearson Chi-Square	7.787	3	0.051

Table 6 shows the results of tests of correlation. We conclude that there is significant positive correlation between WT and E and between MD and E at 1% level of significance.

The output of regression analysis is summarized below in Tables 7, 8, 9 and 10. It can be seen that the regression model of WT and MD on E is significant and that the two independent variables explain about 11% of changes in E. The regression equation is represented by: E = 6.918 + 0.057*WT + 0.052*MD.

Table 6. Results of Correlation Test for Sume, Sumwt, and Summd

Variable	Sume	Sumwt	Summd
Sume Pearson Correlation	1	0.310**	0.280**
Sig. (2-tailed)		0.000	0.000
N		300	300

** Correlation is significant at the 0.01 level.

Table 7. Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	summd, sumwt[b]		Enter

[a]Dependent variable: sume. [b]All requested variables entered.

Table 8. Model Summary

Model	*R*	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
1	0.335[a]	0.113	0.107	2.79463

[a]Predictors: (constant), summd, sumwt.

Table 9. ANOVA[a]

Model		Sum of Squares	df	Mean Square	*F*	Sig.
1	Regression	294.085	2	147.042	18.828	0.000[b]
	Residual	2319.552	297	7.810		
	Total	2613.637	299			

[a]Dependent variable: sume. [b]Predictors: (constant), summd, sumwt.

Table 10. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.918	1.280		5.403	0.000
	sumwt	0.057	0.017	0.223	3.372	0.001
	summd	0.052	0.022	0.155	2.351	0.019

[a]Dependent variable: sume.

CONCLUSION

This research is basically a pilot study that can be used as a platform for conducting further detailed research. The results of the study, however, do offer some insights into the important determinants of e-learning effectiveness. Wireless technology and mobile devices are found to be positively correlated with e-learning effectiveness. However the two variables, wireless technology and mobile devices, explain only about 11 percent of the changes in e-learning effectiveness. It may not be appropriate to provide any generalization of the findings due to the small sample size. However, the study confirms that wireless technology and mobile devices are two important factors affecting e-learning.

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