

Measuring wireless network success: An analysis of a University in Ohio

Jason Rakers, D.Sc.

3/11/2009

Summary of findings

Contents

- Introduction
- Literature Review
- Methodology
- Results
- Discussion

Introduction

- Wireless network growth: flexible networks, scalable designs, user mobility (Drew, 2003)
 - Universities and mobile users (Beasley, Dobda, & Wang, 2005)
 - Network accessibility (Chang, Yu, & Tsai, 2006)

Universities and wireless

- Wireless networks attract students, “because its [*sic*] cool and everyone else is doing it” (Bartel & DiLorenzo, 2003, p.1)
- Campus Computing Project of 2006, wireless projects target common areas on campus (CCP, 2006)
- “fosters access, mobility, and collaborative work among students and faculty” (CCP, 2006, p.1)

Universities and wireless

- 2006 survey from University of South Carolina
 - 80.4% of students bring wireless laptops
(Crews, Brown, Bray, & Pringle, 2007)

Introduction

- Evaluating wireless success is vital
- This research:
 - Wireless network success is identified as student acceptance
 - Measured in terms of student usage and intention to adopt
- Demonstrating success can determine investment strategies

Problem

- Insufficient literature available focused on wireless acceptance
- Literature focuses on technical challenges
- University of South Carolina
 - “residential students prefer a wired connection due to its reliability and bandwidth” (Crews et al., 2007, p. 32)
- This research expanded the literature available on wireless acceptance

Research goals

- Examine usage patterns among students
 - How do students use the wireless network at YSU?
- Examine the factors of facilitating conditions, wireless trust, and intention to use wireless among students (Lu, Yu, & Liu, 2005)
- Develop a measurement system for continued analysis of wireless acceptance

Research methodology

- Analyzed a single university in Northeast Ohio
 - Student population 13,100
 - Target sample, undergraduate resident students: 1,275
- Survey used for data collection
 - Based on instrument used for wireless acceptance among MBA students (Lu et al., 2005)

Summary of findings – Usage

- Sample – 77% had wireless experience
- Less than half of participants had used the wireless network – 48.8%
- Usage priorities: 1. Internet, 2. campus resources, 3. personal resources
- YSUWIRELESS network identified as most frequently used – 41.5%
- Over one-third did not know which wireless network they used – 35%
- On-campus wireless usage differed from home wireless usage

Summary of findings – Lu et al. (2005) replication

- **Confirmatory Factor Analysis**
 - Three strong factors identified among constructs of wireless trust, facilitating conditions, and intention to use wireless
 - Similar to Lu et al. (2005) analysis
- **Cronbach's Alpha**
 - High reliability among the factor loading scores
 - Similar to Lu et al. (2005) analysis

Significance

- Assisted YSU in analyzing its own wireless network project
- Provided the university with a system for continued measuring of wireless acceptance among students
- Replicated the study of Lu et al. (2005) on facilitating conditions, wireless trust, and intention to use wireless
- May serve other universities analyzing student acceptance

Literature Review

Lack of Literature

- Bina & Giaglis (2005) literature review categorized wireless network issues
 - Technical (52): performance, security, etc.
 - Managerial (36): development, policies, etc.
 - Community (11): adoption, motivation, etc.
- Majority of literature addresses technical issues

Traditional wireless success

- EDUCAUSE
 - Design, supportability, and security (Bartel & Meertz, 2002)
 - Technological challenges: overcoming security, roaming, and wireless radio strength (Bartel & DiLorenzo, 2003)

Traditional wireless success

- Western Michigan University
 - \$3.9 million wireless project for 29,000 students
 - President defines success, on Feb. 7, 2002
 - WMU will be a wireless campus in 12 months (Western Michigan, 2002)

Traditional wireless success

- Dartmouth College
 - Usage analysis of wireless network by bandwidth
 - 1,706 unique users, student population of nearly 6,000 students
 - Insight reveals that devices without end-users consume network bandwidth (Kotz, 2003)

New wireless success

- Wireless networks must provide a desired service for end-users (Balachandran, Voelker, & Bahl, 2003)

New wireless success

- EDUCAUSE

- Wireless network success dependent on the applications they provide (St. George, 2006)
 - Interactive learning (Barak, Lipson, & Lerman, 2006)
 - University resources (Owen & Farsaii, 2006)

Technology Acceptance

- Mobile computing research at universities
 - Finn & Inman (2004)
 - Savery & Boon (2006)
- Davis Technology Acceptance Model
 - Unproven in acceptance of wireless (Lu, Yu, Liu, & Yao, 2003)
- Wireless Trust, Facilitating Conditions, and Intention to use Wireless (Lu et al., 2005)

Intention to use wireless

- **Wireless Trust**
 - Confidence in privacy and data security
 - Access to personal information
 - Security of the wireless network
- **Facilitating Conditions**
 - Governmental regulation and legal issues
 - Training, support, and education

Methodology

Survey instrument

- Based on instrument developed by Lu et al. (2005)
 - 7-point Likert scale from strongly disagree (1) to strongly agree (7)
- Included anecdotal perceptions of wireless adoption
- Other studies referenced
 - Finn & Inman (2004)
 - Savery & Reed (2006)

Survey instrument

- Consisted of 64 questions
 - General wireless experience: 3
 - WT/FC/Intention to use: 14
 - On-campus wireless experience: 18
 - Reasons for using/not using wireless: 9
 - Security awareness: 6
 - Future direction of wireless: 6
 - Off-campus wireless experience: 3
 - Demographic information: 5

Survey administration

- Announcement letter sent to registered housing students (794) during July 2007
- Survey distributed primarily through campus mail beginning August 27
 - 802 housing students
 - 473 non-university housing students
- E-mail reminders sent to students
- On-site visits on September 26 and 28
- E-mail reminders sent to students in October
- Data collection stops, November 9
 - 258 surveys returned

Results

Sample description

- 258 out of 1,275 students – 20%
- Demographic data on non-university housing not available
- Analysis of college enrollment, year of study, and gender
 - College enrollment: similar to university housing within 3%
 - Year of study: disparity 75% to 56% for university population of freshmen/sophomores
 - Gender: 67% female compared to 55% for university population and 48% for university housing

College enrollment

College	Student size		
	<u>Sample</u>	<u>University Housing</u>	<u>University Population</u>
Business Administration	11%	12%	13%
Education	12%	9%	12%
Fine & Performing Arts	10%	14%	7%
Health & Human Services	24%	22%	26%
Liberal Arts & Social Sciences	14%	14%	16%
Science, Technology, Engineering, & Math	26%	28%	17%
Graduate Studies or Other	3%	1%	9%
Total	100%		

Year of study

Year of Study	Student size		
	<u>Sample</u>	<u>University Housing</u>	<u>University Population</u>
Freshmen	51%	68%	40%
Sophomore	24%	14%	16%
Junior	10%	8%	14%
Senior	14%	9%	21%
Graduate	1%	1%	9%
Total	100%		

General wireless experience

- 77% indicated they had used a wireless network
 - 19.1% began using wireless in 2007
 - 27.3% began using wireless in 2006
 - 13.7% began using wireless in 2005
 - 16.8% began using wireless in 2004 or earlier
- 76.6% indicated they had a wireless laptop

Intention to use wireless

- Assume access – 6.23
- Given access – 6.27

Wireless Trust

- Notified information collected – 5.21
- Access data collected – 5.39
- Choice sharing information – 5.43
- Secure data transmitted – 5.59
- Protect information – 5.69
- Wireless reliable – 4.10

Facilitating Conditions

- Policies encourage use – 4.35
- Training available – 4.55
- Legal protections – 4.88
- Instruction available – 5.13
- Assistance using wireless – 5.55
- Overall use supportive – 5.55

Lu et al. (2005) replication

- Confirmatory Factor Analysis
 - Three factors identified
 - First accounted for 43% of variance, closely resembling the wireless trust construct
 - Second accounted for 12% of variance, closely resembling the facilitating conditions construct
 - Third accounted for 9% for variance, closely resembling the intention to use wireless construct

Factor Loading Scores

Table 4.3

Wireless results reported from resident student sample

Constructs	M	SD	Cronbach's Alpha	Factor Loading		
				1	2	3
Intention to Use			.96			
Assume access	6.23	1.29				-.926
Given access	6.27	1.30				-.925
Wireless Trust			.86			
Wireless reliable	4.10	1.67		.574		
Notified info collected	5.21	1.49		.866		
Access data collected	5.39	1.49		.874		
Choice sharing info	5.43	1.59		.757		
Secure data transmitted	5.59	1.39		.783		
Protect info	5.69	1.39		.686		
Facilitating Conditions			.82			
Policies encourage use	4.35	1.32		.347	.454	
Training Available	4.55	1.44			.886	
Legal protections using	4.87	1.30		.499	.410	
Instruction available	5.13	1.34			.829	
Assistance using wireless	5.55	1.29			.577	
Overall use supportive	5.55	1.33			.397	-.402

Other Factor Loading Scores

- Confirmatory Factor Analysis
 - Removed intention to use wireless from consideration
 - See Table 4.6
 - Possibility of additional influence related among legal and regulatory protections and wireless reliability (Cronbach's Alpha = .69)

Other Factor Loading

Table 4.6

Intention to Use not considered

Constructs	Factor Loading		
	1	2	3
Wireless Trust			
Notified info collected	.670		
Access data collected	.772		
Choice sharing info	.818		
Secure data transmitted	.832		
Protect info	.755		
Wireless reliable			.765
Facilitating Conditions			
Policies encourage use			.749
Legal protections using			.575
Assistance using wireless	.693		
Instruction available	.866		
Training Available	.788		
Overall use supportive	.502		

Reliability testing

- Cronbach's Alpha
 - Performed on each construct to identify reliability of each set of scaled responses
 - Alpha values of .70 or higher are acceptable fits for constructs (UCLA, 2007)
 - Intention to use wireless: .96
 - Wireless Trust: .86
 - Facilitating Conditions: .82

Correlation Significance

- Constructs demonstrated significance at the 0.01 level
 - Facilitating Conditions had a coefficient of .593 with Wireless Trust and .464 with Intention to use wireless
 - Wireless Trust had a coefficient of .386 with Intention to use wireless
- Correlations may explain factor loading of items across the constructs

On-campus wireless experience

- 48.8% of participants indicated they had used the wireless network at YSU
- 87.2% of participants indicated they had access to a wireless device while on campus
- Of identified wireless users:
 - 64.8% agreed they were able to access all the systems they needed, such as e-mail, Internet, and classroom resources

How do students use the wireless network at YSU?

- Wireless network priorities
 - Internet access: 6.28
 - Campus resources: 5.97
 - Personal resources: 5.87
- Wireless network used most frequently
 - YSUWIRELESS: 41.5%
 - Didn't Know: 35.0%
 - YSUOPENNETWORK: 22.8%
 - Other: 0.8%

On-campus wireless experience

- Login with username/password
 - Yes: 72.4%
 - Didn't Know: 17.1%
 - No: 10.6%
- Yesterday or the last time you used wireless:
 - Frequency of use
 - 76.5% used a wireless network twice or less per day
 - Duration of use
 - 31.0% used a wireless network for less than 30 minutes

Off-campus wireless experience

- Yesterday's or the last time you used wireless:
 - Frequency of use
 - 56.8% used a wireless network three or more times
 - Duration of use
 - 73.3% used a wireless network for more than two hours

On-campus wireless experience

- 76.7% indicated they had not used wireless in the classroom
- Wireless performance perceptions
 - Analysis of Variance between gender and overall wireless performance
 - $F(1, 123) = 4.966, p = .028$
 - Females: 4.95
 - Males: 4.27

Future direction of wireless

- Participants emphasized more wireless coverage, over educational and learning opportunities
 - Comparison of means between users and non-users

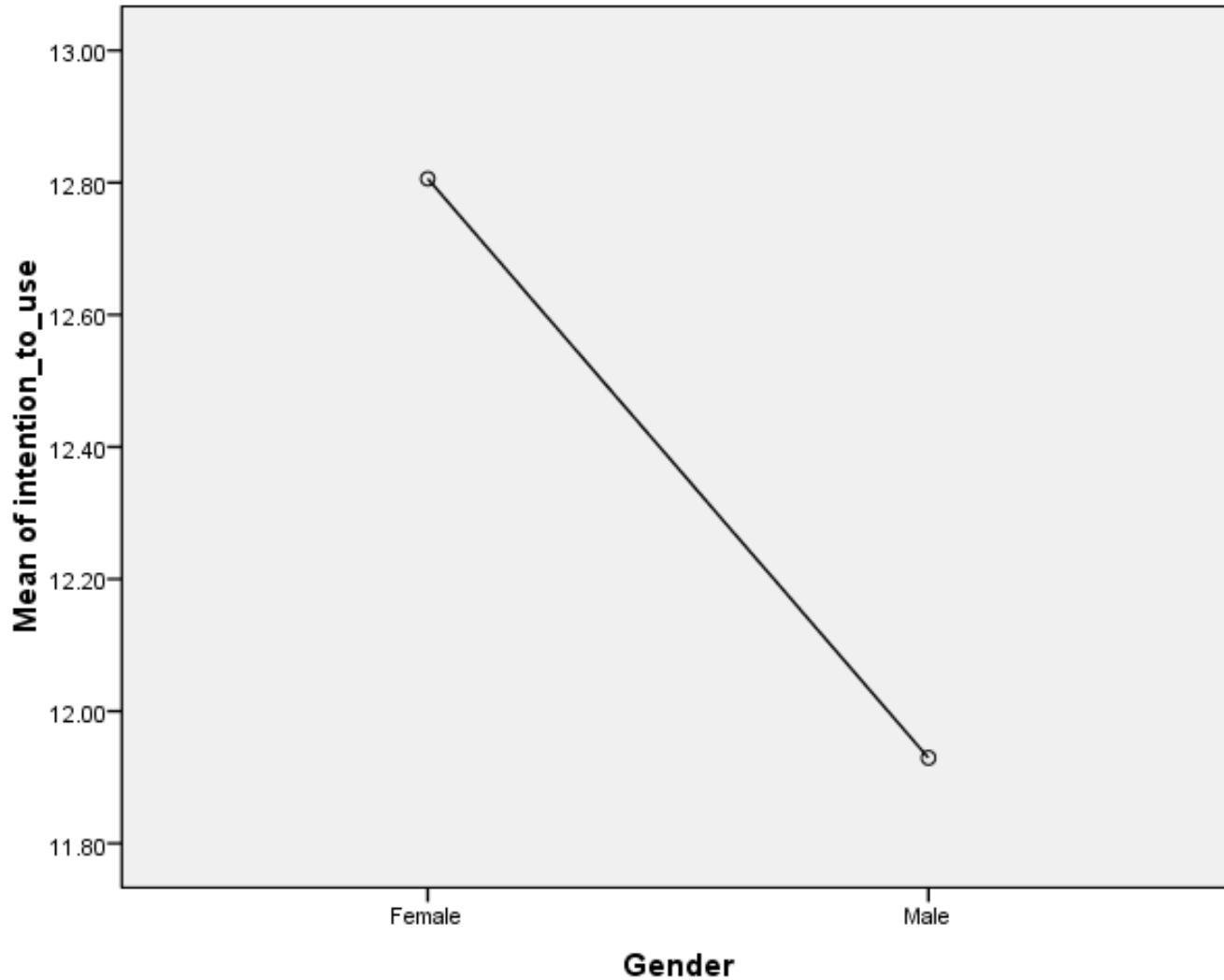
Future direction of wireless

Investments	Users N = 125	Non-users N = 129	<i>df</i>	<i>MS</i>	<i>F</i>	<i>p</i>
More Hotspots	6.29	6.02	1, 252	4.714	3.398	.066
Battery Recharging Stations	5.93	5.85	1, 252	.360	.206	.650
Access to wireless devices	5.79	5.73	1, 252	.255	.145	.704
Technical Assistance	5.50	5.67	1, 252	1.685	1.045	.308
Wireless in Classroom	5.39	5.33	1, 252	.218	.123	.726
Training Opportunities	4.52	4.78	1, 252	4.134	2.020	.156

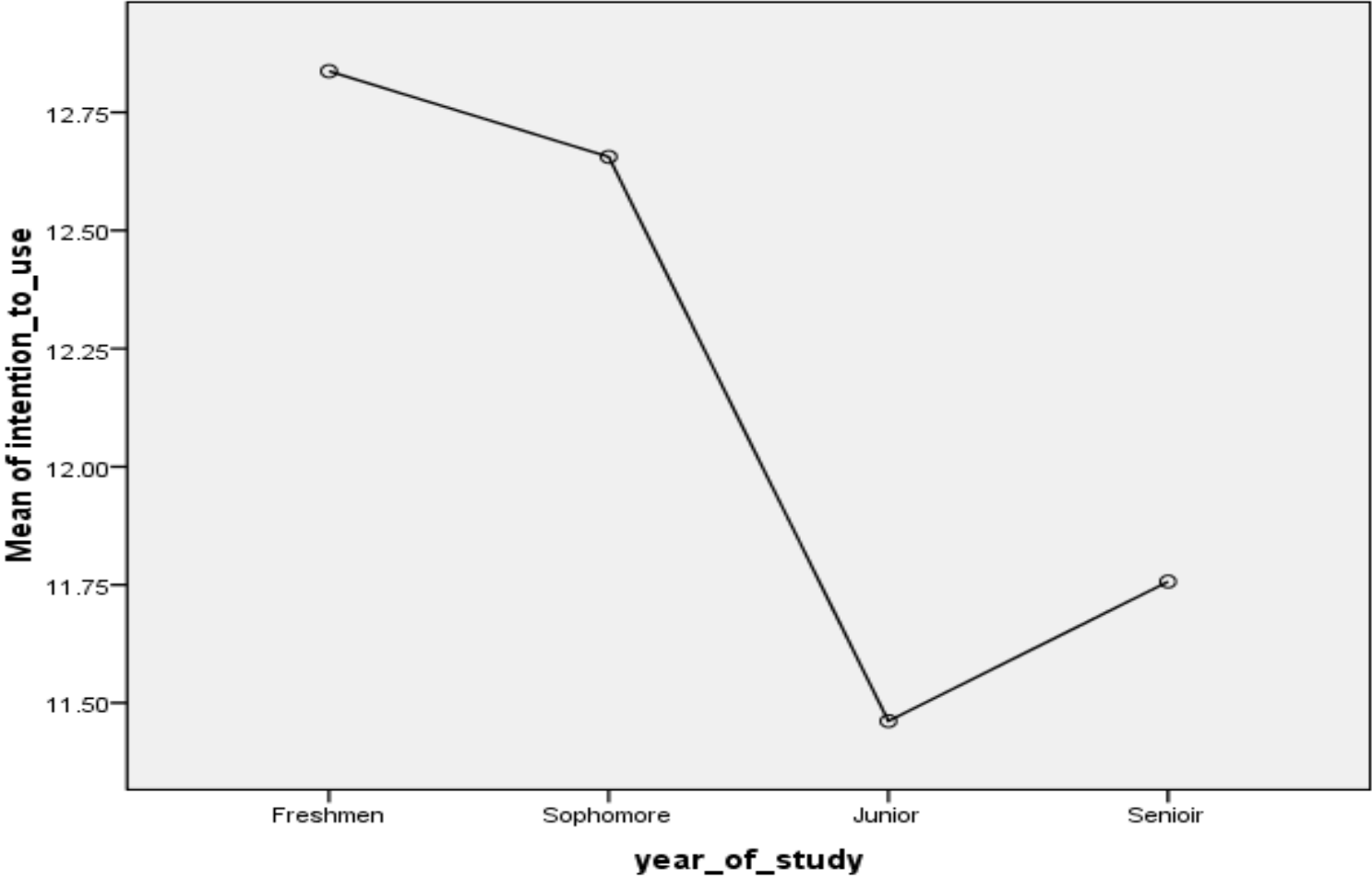
Analysis of Variance

- Small sample sizes may account for ANOVA results, despite suggestion of difference
 - One-way ANOVA of gender on intention to use wireless: $F(1, 253) = 6.935, p = .009$
 - One-way ANOVA of year of study on intention to use wireless: $F(4, 250) = 2.592, p = .037$
- Two-way ANOVA interactivity between gender and year of study on intention to use wireless
 - Difference in intention to use between males and females is likely the same for participants' despite year of study. $F(4, 250) = .637, p = .637$

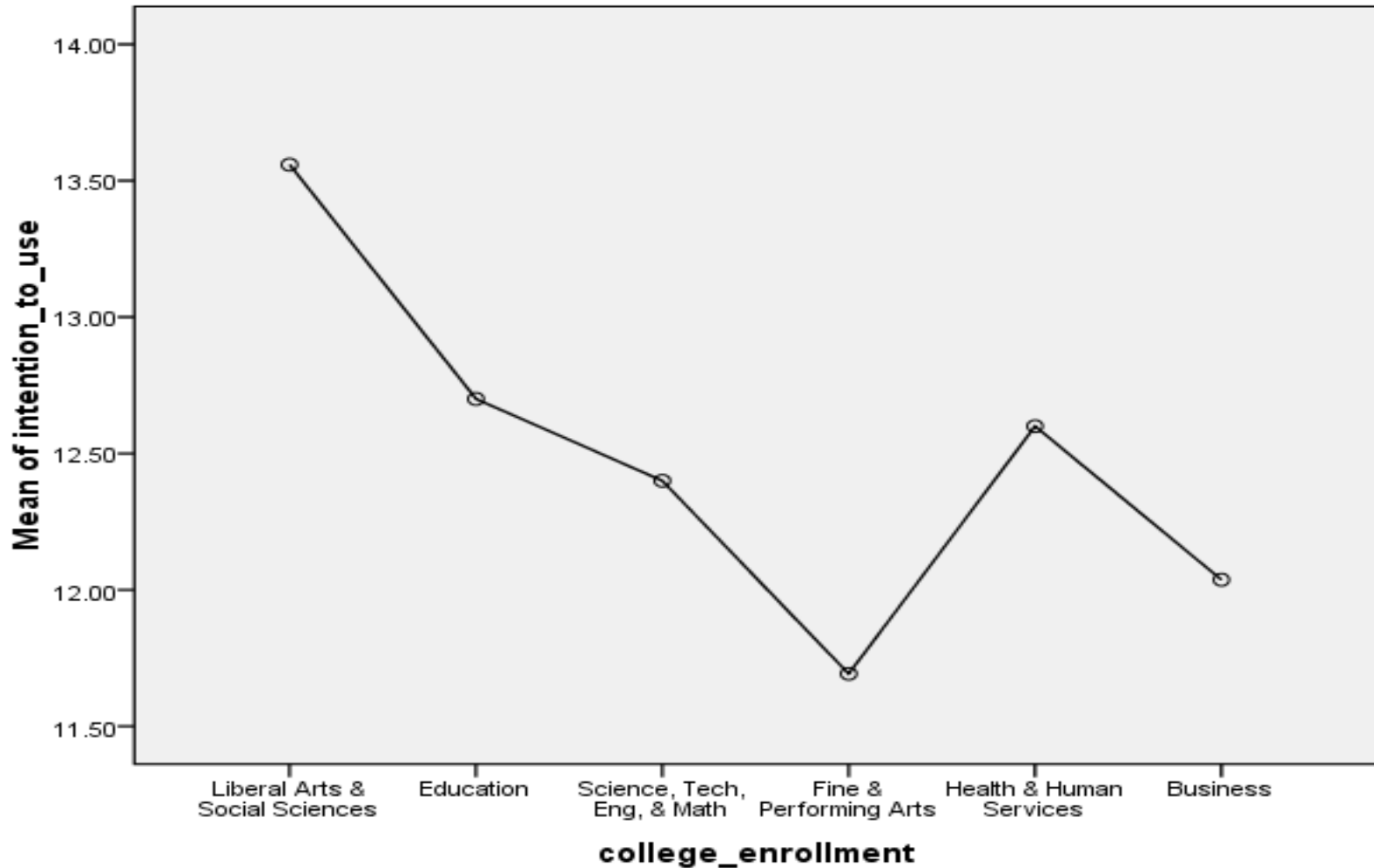
Wireless Intention to use - Gender



Wireless Intention to use – Year of study



Wireless Intention to use – College enrollment



Discussion

Lu et al. (2005) comparison

- Demographic differences
 - Graduate students
 - 49% male
 - 77% of participants had no wireless experience
 - 33% had six months of experience or longer

Factor Loading Scores – Lu et al. (2005)

Table 5.1

Lu et al. (2005) reported results

Constructs	<i>M</i>	<i>SD</i>	Cronbach's Alpha	Factor Loading
Intention to Adopt			.81	
Assume access	5.55	1.60		.82
Given access	5.68	1.41		.93
Wireless Trust			.84	
Notified info collected	3.01	1.79		.79
Access data collected	3.37	1.73		.79
Choice sharing info	3.75	1.84		.73
Secure data transmitted	4.13	1.71		.72
Protect info	2.83	1.62		.47
Wireless reliable	3.94	1.56		.51
Facilitating Conditions			.86	
Policies encourage use	3.69	1.60		.69
Legal protections using	3.81	1.60		.60
Assistance using wireless	4.03	2.02		.62
Instruction available	3.97	1.84		.82
Training Available	3.87	1.87		.84
Overall use supportive	3.48	1.88		.75

Limitations

- Small sample sizes
 - Suspect to variance equality problems
- Female participants greatly outnumbered male participants
 - Not proportional to university population
- Results only reflective of residential students
 - Attitudes of commuter students may differ

Wireless at YSU

- System reporting tools identified 1,909 unique users
 - 989 had used YSUOPENNETWORK
 - 901 had used YSUWIRELESS
 - 19 had used other networks
- Simultaneous users
 - Nearly 200 on YSUOPENNETWORK
 - Nearly 170 on YSUWIRELESS
- 14% penetration rate of 13,100 students

Wireless at YSU

- Requests for wireless
 - Do not translate into wireless usage
 - Often on-demand and on-location

Wireless dilemma

- Common approach to solving on-demand and on-location
 - Ubiquitous wireless coverage
- Wireless project failures
 - City of Pittsburgh (Lyons, 2008)
 - City of Philadelphia (Matteo, 2008)
- Wireless convenience replaced by wireless security
 - Carnegie Mellon University wireless upgrade (Cox, 2007)

Future research

- Identify factors explaining why students with intentions to use wireless are not using wireless.
- How do students see more wireless hotspots as a reason to increase their wireless usage?
- Alternative deployment solutions to ubiquitous wireless coverage
- Wireless acceptance of commuter students
- Continued research on the factors of wireless trust, facilitating conditions, and intention to use wireless (Lu et al., 2005)

Measuring wireless network success: An analysis of a University in Ohio

Jason Rakers

3/11/2009