INFORMATION SYSTEMS EDUCATION JOURNAL

Volume 16, No. 5
October 2018
ISSN: 1545-679X

In this issue:

iscap Information Systems & Computing Academic Professionals

The **Information Systems Education Journal** (ISEDJ) is a double-blind peer-reviewed academic journal published by **ISCAP** (Information Systems and Computing Academic Professionals). Publishing frequency is six times per year. The first year of publication was 2003.

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INFORMATION SYSTEMS EDUCATION JOURNAL

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Information and Communication Technology in the Classroom: BYOD and the University's Role

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Abstract

Personally-owned laptops and other *Bring-Your-Own-Device* (BYOD) scenarios have become increasingly prevalent in today's work environments and classrooms. However, few studies have examined the viability and practicality of such devices in the higher-education classroom. This study used a survey instrument to explore the concept of BYOD in the classroom. Specifically, undergraduate and graduate students were asked to report their use (both inside and outside of the classroom) of personally-owned devices, and their use of university-managed computer labs. The findings of this research will be of interest to higher-education faculty, administrators, and Information Technology departments.

Keywords: Laptop, Information and Communication Technology (ICT), Bring-Your-Own-Device (BYOD), Higher education

1. INTRODUCTION

The use of personal computing devices is becoming increasingly popular within business and within other professional organizations. A 2012 survey by Cisco of U.S. organizations found that 95% of the respondents allowed some form of *Bring-Your-Own-Device* (BYOD) in the workplace (Kaneshige, 2012). In fact, BYOD has been frequently described as the " . . . most radical shift in the economics of client computing for business since personal computers invaded the workplace" (Willis, 2012, p. 1).

Laptop computers have been referred to as the most used and most important devices for academia (Dahlstrom, Walker, & Dziuban, 2013). Although personal laptops have long been used in higher-education, their efficacy in the learning process has been fiercely debated. On one side of the debate, the use of laptops in the classroom has been found to keep students on task, increase students' capabilities for following lectures, and foster collaboration among students (Kay & Lauricella, 2016). On the other side of the debate, some researchers have noted many "off-task" uses of laptops by students, such as surfing social media, playing games, and watching videos and movies (Barak et al., 2006; Barkhuus, 2005).

Extensive research has also been conducted in the use of laptops in primary and secondary education (i.e., "K-12" grades). However, the implementation of laptops in K-12 education has been predominantly limited to *1:1 laptop initiatives*. In 1:1 laptop initiatives, the school district provides each student with his/her own laptop for classroom use (Tallvid, Lundin, Svensson, & Lindstrom, 2015).

Although the educational effectiveness of personal computing devices (e.g., laptops) has been widely researched, few authors have examined higher education's role in providing (or requiring) such devices. Specifically, what is the university's role in providing (or requiring) *Information and Communication Technology* (ICT) in the modern, higher-education classroom?

The purpose of this study was to survey undergraduate and graduate students to determine their use of personally-owned computing devices (e.g., laptops), and their use of university-provided computing devices (i.e., computer labs). Specifically, the study sought to answer the following research questions:

1. What percentage of students have their own personal laptop computer?
2. What percentage of the time do students use *personally-owned* laptops for homework and/or lab assignments both *within-class* and *outside-of-class?*
3. What percentage of the time do students use *university-provided* labs for homework and/or lab assignments both *within-class* and *outside of class?*
4. Is there a statistically significant difference in the use of *personally-owned* laptops and *university-provided* labs (for both *within-class* and *outside-of-class* work)?

2. DEFINITION OF TERMS

Information and Communication Technology (ICT) is defined as " . . . integrated systems which are capable of handling and linking up many types of information: written and spoken languages, still and moving visual images, and data of all kinds" (Adeyoyin, Okunlaya, Alawiye, & Emmanuel, 2013, p. 191). *Bring-Your-Own Device* or BYOD, are corporate policies that " . . . encourage practices of allowing employees to use their personally owned mobile devices to conduct their work, whether inside or outside of their workplaces" (Garba, Armarego, Murray, & Kenworthy, 2015, p. 38). In this definition, "mobile devices" could refer to laptop computers, or any other mobile computing device, such as a tablet or smartphone. Finally, *1 to 1 (i.e., 1:1) laptop initiatives* are programs in K-12 schools, where each student receives a laptop, from the school district, to " . . . supplement their regular classroom learning" (Hatakka, Andersson, & Gronlund, 2012, p. 94).

3. REVIEW OF LITERATURE

Current research studies into ICT and BYOD fall into three main categories: 1) educational effectiveness of 1:1 laptop initiatives, 2) impacts of BYOD policies in the workplace, and 3) the design and construction of BYOD-friendly environments (both in industry and in academia).

Brousard, Hebert, Welch, and VanMetre (2014) conducted focus groups and classroom observations of 650 students and 40 teachers in order to evaluate a 1:1 laptop initiative at a secondary school. The authors determined that the 1:1 laptop initiative in their study fostered a "flipped" classroom, in which the learning shifted from "teacher-focused" to "student-focused." The authors also found that the use of laptops in the classroom encouraged the teachers to use more "technology-rich" content in their instruction (p. 42).

Tallvid, Lundlin, Svensson, and Lindstrom (2015) collected data from 500 students over a three-year period to determine what uses of a 1:1 laptop initiative were "sanctioned" (i.e., education-related), and what uses where "unsanctioned" (i.e., not education-related). While the authors noted a significant percentage of "unsanctioned" use among students (e.g., playing games or watching movies), the research findings suggested that, as overall laptop use increased, both "unsanctioned" and "sanctioned" use of the laptops increased.

Finally, Tallvid (2016) conducted a qualitative follow-up study of 60 teachers to determine why some teachers were reluctant to adopt ICT as part of a 1:1 laptop initiative. Tallvid discovered "patterns of reluctance" among the teachers, such as "lack of technical competence, not worth the effort, insufficient material, diminishing control, and lack of time" (p. 503).

Overall, the findings from 1:1 laptop initiatives have been mixed. Some researchers have suggested that " . . . a link exists between 1:1 programs and student achievement" (Downes & Bishop, 2015, p. 2). However, other studies have revealed conflicting results. For example, Hur and Oh (2012) found that while 1:1 laptop programs did raise student engagement, there was no statistically significant improvement in students' test scores.

Studies involving BYOD policies in the workplace have primarily focused on information security and privacy risks. Garba, Armarego, Murray, and Kenworthy (2015) examined the benefits and costs associated with BYOD policies. The authors found

that cost savings from BYOD can be realized, such as reduced travel, facility, device, and data service costs. However, if not addressed, the risks to data security and privacy can outweigh the benefits of BYOD. The authors suggest that any organization considering BYOD must " . . . strike a balance between the availability and protection of information resources and assets" (p. 51).

Researcher Chris Rose (2013) took the cost benefit analysis of BYOD one step further. Rose not only looked at information security and privacy concerns, but also the branding and legal liability associated with BYOD. The author concluded "BYOD might initially sound like a bargain but the loss of brand identity, the possibility of legal liability, the difficulty of IT departments supporting different phone/version/carrier combinations and the many security problems . . . " may negate any anticipated benefits of BYOD (p. 68).

Finally, there is a growing body of research involving organizations that are designing specific BYOD-friendly spaces. For example, Dallis (2015) developed a case study from a facility redesign at Indiana University at Bloomington. The 27,000-square foot University Library was redesigned specifically to reflect "bring-your-own device interior designs" (p. 47). Even commercial airlines are redesigning their planes to cater to BYOD passengers. American Airlines recently announced that it is eliminating the seat-back screens from its new Boeing 737 Max jets (Ostrower, 2017). The announcement was made after the airline determined that 90% of its passengers bring their own mobile devices onboard. American Airlines states that "smartphones, tablets or laptops do a better job than the airline's individual screens" (p. 1).

4. RESEARCH METHODOLOGY

The current study involved an online survey that was completed by undergraduate and graduate students within *Computer and Information Systems* (CIS) courses at a private, medium-sized university. Participation in the survey was voluntary, and all responses were anonymous. The survey was created using *QuestionPro* survey software, and was available from November 17 to December 6, during the Fall semester of 2016.

The online survey consisted of 22 questions. Most of the questions were closed-ended, however, some questions provided an open-ended field so participants could elaborate on their answer. A total of 322 students opened the survey, 220 students began the survey, and 200 students completed the survey in its entirety. The 200 students who completed the survey make up approximately 26% of the total enrollment for CIS degree majors at the university. It should be noted that only the 200 completed survey responses were used in the current study (i.e., no incomplete surveys were considered in this study).

QuestionPro survey software was used for descriptive statistics and basic data analysis. For statistical testing, the survey responses were imported into IBM *SPSS* (Statistical Package for the Social Sciences) version 24.0. **Table 1: Participant Degree Type** and **Table 2: Participant Degree Program** in **Appendix A** show the demographic breakdown of the survey participants.

5. RESULTS

In order to address the first research question, "What percentage of students have their own personal laptop computer?," the survey participants were asked if they currently have their own laptop computer. Out of the 200 completed surveys, 186 (93.0%) participants reported that they owned a personal laptop computer.

Reviewing the results in terms of degree type, 139 (93.9%) undergraduate students stated that they owned a personal laptop. Twenty-nine (90.6%) Integrated (i.e., 5-year Bachelor's / Master's program) students reported owning a personal laptop. Finally, 18 (90.0%) graduate students reported owning a personal laptop. The results from the first research question are depicted in **Appendix B**, **Table 3: Student Ownership of Personal Laptop Computers.**

Participants who owned a personal laptop were also asked several follow-up questions, such as the age of the laptop and the operating system of the laptop. Fifty-three participants (28.5%) reported that their laptop was one year old or less. Fifty-nine participants (31.7%) reported owning a laptop that was two years old. Finally, 74 participants (22.6%) said they owned a laptop that was three years old or older.

In terms of the operating systems installed on the participants' laptops, the majority (59.1%) of personal laptops were running Microsoft Windows 10. According to participants, 15.1% of the laptops were running Windows 8, and 18.2% were running Apple's OS X. Finally, 7.0% of the participants reported that their laptops were running an

operating system described as "Other." The "Other" operating systems reported by participants included the following: Windows Vista, Windows 7, Debian 8, Red Hat Linux, and Linux Ubuntu.

The second research question proposed was, "What percentage of the time do students use *personally-owned* laptops for homework and/or lab assignments both *within-class* and *outside of class?"* To address this question, participants were asked to report both the amount of time that they use their personal laptop for homework or lab work *within-class*, and the amount of time that they use their personal laptop for homework or lab work *outside-of-class*. The following Likert-like scale was used to allow the participants to report the amount of work completed (both inside and outside-of-class) with their personal laptop: 5 = Greater than 75% of work completed, 4 = 75% of work completed, 3 = 50% of work completed, 2 = 30% of work completed, 1 = 20% or less of work completed.

As for *within-class* usage of personal laptops, the mean score reported by participants was 2.48. This score indicates that participants reported using their personal laptops for 30 to 50% of *within-class* work assignments.

In regard to *outside-of-class* usage of personal laptops, the mean score reported by participants was 3.68. This score indicates that participants reported using their personal laptops for 50 to 75% of *outside-of-class* work assignments. The results from the second research question are depicted in **Appendix C**, **Table 4: Student Use of Personal Laptops versus University Lab PCs.**

The third research question proposed was, "What percentage of the time do students use *university-provided* labs for homework and/or lab assignments both *within-class* and *outside of class?"* To address this question, participants were asked to report both the amount of time that they use a university-provided lab computer for homework or lab work *within class*, and the amount of time that they use a university-provided lab computer for homework or lab work *outside-of-class*. Again, the previously described 1 to 5 "usage scale" was used.

As for *within-class* usage of a university lab computers, the mean score reported was 2.22. This score indicates that participants reported using university-provided labs for 30 to 50% of *within-class* work assignments.

Regarding *outside-of-class* usage of university lab computers, the mean score reported by participants was 1.81. This score indicates that participants reported using university-provided labs for 20 to 30% of *outside-of-class* assignments. The results from the third research question are depicted in **Appendix C**, **Table 4: Student Use of Personal Laptops versus University Lab PCs.**

As shown in **Table 4**, the mean usage score of personal laptops reported by students is higher than the mean usage score of university-provided labs for both *within-class* work and *outside-of-class* work. **Table 4** also shows that the difference in mean usage scores is greater for *outside-of-class* work. The difference in mean scores does not, however, reveal if the difference between personal laptop usage and university lab usage is at a level that is statistically-significant.

The fourth and final research question explored whether or not there was a statistically-significant difference in usage between personally-owned laptops and university-provided lab computers. As in research questions two and three, student usage was measured in terms of both *within-class* work assignments and *outside-of-class* work assignments. The *Paired-Samples T-Test* was used to determine if the difference in mean scores was statistically significant at the .05 confidence level.

In analyzing the usage of personal laptops compared to university-provided labs for *outside-of-class* work, there was a significant difference in the mean scores for personal laptop usage (M=3.68, SD=1.312) and university lab usage (M=1.81, SD=1.282); $t(196)=12.852$, $p=.000$. In analyzing *within-class* work, however, there was not a significant difference in the mean scores for personal laptop usage (M=2.48, SD=1.473) and university lab usage (M=2.22, SD=1.410); $t(194)=1.576$, $p=.117$.

To thoroughly address the last research question, the current research also compared the *overall* mean usage scores between personal laptop usage and university-provided lab usage (i.e., regardless of whether the work was performed *within-class* or *outside-of-class*). Overall, there was a significant difference in usage between personal laptops (M=3.08, SD=1.516) and university-provided labs (M=2.02, SD=1.361); $t(391)=9.164$, $p=.000$. The Paired-Samples T-Test results are depicted in **Appendix C, Table 5: Paired Samples T-Test.**

6. DISCUSSION AND CONCLUSIONS

The context for this study was research into whether or not a standalone computer laboratory for information system computing majors as mandated by *ABET-CAC* accreditation was, in fact, a necessary and value-added resource. It appeared to the researchers that, with the student proliferation of BYOD in the classroom, dedicated computer laboratories may not have as crucial a role as was in the past. With a virtual machine environment available to all mobile devices (i.e., VMware, aka Horizon), students have a viable option that has emerged over the past few years. While subject to numerous variables, such as Wi-Fi speed, allocated memory availability in the virtual server, software licensing issues, and configuration setup expertise, virtual machine technology has offered students a robust alternative to standalone computer laboratories.

The survey results from the current study have shown that 93.9% of undergraduate students own a laptop computer, however, when excluding tablets and other mobile devices, only 4.5% of the surveyed undergraduate population did not own a laptop computer. With respect to the integrated undergraduate/graduate students (5-year Bachelor's/Master's degree) 90.6% owned laptop computers with 1.5% not owning them (the gap again explained by tablets and other mobile devices). Additionally, the survey of graduate students indicated that 90% owned laptop computers.

The findings from the survey related to computer laboratory usage and BYOD usage. In the context of classroom use of computers, the survey yielded a virtual split between students using University lab computers (mean of 2.22) and personal laptops (mean of 2.48). However, with respect to outside of class usage of computers to do assigned work, a resounding majority (mean of 3.68) used their personal laptops with a significantly smaller number (mean of 1.81) using university computer in the laboratory. Using a t-test, the survey demonstrated statistical significance (p=.000) in the difference between personal computer usage and university laboratory computer usage for out of class assignments.

It can be concluded that with the convenience, lower cost point, cultural affinity toward mobile computing, and efficient and cost effective virtual machine (i.e., cloud) availability of specialized software, students tend to prefer BYOD rather than utilize a dedicated university computer laboratory. As virtual machine capabilities improve, as specialized software is adapted to cloud environments, and as Wi-Fi security and reliability improves, we can see further increased use of BYOD mobile devices with less use and value-added associated with dedicated software-focused teaching labs. This questions the need for extensive dedicated computer laboratories for teaching purposes.

The above findings do not imply that special purpose computer responses should not be available for out-of-class work or special research projects. What it does question is the need for universities to allocate significant computer technology resources for teaching classrooms. Universities and accreditation groups, such as ABET-CAC, should consider furthering the discussion on virtual machine technologies, accreditation-required dedicated open labs, and required student laptop ownership. Student computer usage patterns for both classroom and laboratories have changed and continue to change. These changes have had a significant impact on curriculum, overall teaching and learning effectiveness, and accreditation, as well as efficient and effective financial resource allocation.

7. REFERENCES

Adeyoyin, S., Okunlaya, R., Alawiye, M., & Emmanuel, S. (2013). Information communication technology (ict) and national development: librarians' perspective. *Library Progress International,* 33(1), 189-201.

Armando, A., Costa, G., Merlo, A., & Verderame, L. (2015). Formal modeling and automatic enforcement of bring your own device policies. International *Journal of Information Security,* 14(2), 123-140.

Barak, M., Lipson, A., & Lerman, S. (2006). Wireless laptops as means for promoting active learning in large lecture halls. *Journal of Research on Technology in Education*, 38(3), 245-263.

Barkhuus, L. (2005). Bring your own laptop unless you want to follow the lecture: Alternative communications in the classroom. In *Proceedings of the 2005 International ACM SIGGROUP Conference on Supporting Group Work* (pp. 140-143), New York, ACM.

Broussard, J., Hebert, D., Welch, B., & VanMetre, S. (2014). Teaching today for tomorrow: A case study of one high school's 1:1 computer adoption. *Delta Kappa Gamma Bulletin, 80*(4), 37-45.

Dahlstrom, E., Walker, J. D., & Dziuban, C. M. (2013). *The ECAR study of undergraduate students and information technology (Research Report)*. Louisville, CO: EDUCAUSE Center for Analysis and Research.

Dallis, D. (2016). Scholars and learners: A case study of new library spaces at indiana university. *New Library World, 117*(1), 35-48.

Downes, J. M., & Bishop, P. A. (2015). The intersection between 1:1 laptop implementation and the characteristics of effective middle level schools. *RMLE Online, 38*(7), 1-16.

Garba, A. B., Armarego, J., Murray, D., & Kenworthy, W. (2015). Review of the information security and privacy challenges in bring your own device (BYOD) environments. *Journal of Information Privacy & Security, 11*(1), 38-54.

Hatakka, M., Andersson, A., & Grönlund, Å. (2013). Students' use of one to one laptops: A capability approach analysis. *Information Technology & People, 26*(1), 94-112.

Hur, J. W. & Oh, J. (2012). Learning, engagement, and technology: Middle school students' three-year experience in pervasive technology environments in South Korea. *Journal of Educational Computing Research*, 46(3),295-312.

Kaneshige, T. (2012). CIO.com CIO Challenge with BYOD: Don't fall down the rabbit hole. Retrieved August 24, 2012 from http://www.cio.com/article/706579.

Kay, R., & Lauricella, S. (2016). Assessing laptop use in higher education: The laptop use scale. *Journal of Computing in Higher Education, 28*(1), 18-44.

Ostrower, J. (January 25, 2017). American airlines eliminating in-seat screen on new jets. Retrieved from http://money.cnn.com/2017/01/25/technology/american-dropping-screens-from-boeing-737-max/.

Rose, C. (2013). BYOD: An examination of bring your own device in business. *The Review of Business Information Systems (Online), 17*(2), 65.

Tallvid, M. (2016). Understanding teachers' reluctance to the pedagogical use of ICT in the 1:1 classroom. *Education and Information Technologies, 21*(3), 503-519.

Tallvid, M., Lundin, J., Svensson, L., & Lindström, B. (2015). Exploring the relationship between sanctioned and unsanctioned laptop use in a 1:1 classroom. *Journal of Educational Technology & Society, 18*(1), 237-249.

Willis, D.A. (2012). Gartner publishes 'Bring your own device: New opportunities, new challenges' report. *Entertainment Close-Up.*

Appendix A

Table 1: Participant Degree Type

Type of Degree	Frequency	Percent	Cumulative Percent
Undergraduate	148	74.0	74.0
Integrated[1]	32	16.0	90.0
Graduate	20	10.0	100.0
Doctoral	0	0.0	100.0
Total	**200**	**100.0**	**100.0**

[1] - The *Integrated* program is a 5-year, combined Bachelor's/Master's program

Table 2: Participant Degree Program

Type of Degree	Degree Program	Frequency	Percent	Cumulative Percent
Undergraduate (B.S.)	Computer and Information Systems	65	28.0	28.0
	Cyber Forensics and Information Security	58	25.0	53.0
	Data Analytics	5	2.2	55.2
	Information Science	4	1.7	56.9
	Other[2]	48	20.7	77.6
Graduate (M.S.)	Data Analytics	23	9.9	87.5
	Cyber Security and Information Assurance	15	6.5	94.0
	Information Systems Management	4	1.7	95.7
	Internet Information System	3	1.3	97.0
	Engineering	7	3.0	100.0
Total		**232**[3]	**100.0**	**100.0**

[2] - The category *Other* predominantly included *Engineering*, *Accounting*, and *Actuarial Science*
[3] - 32 Student participants are counted twice due to the *Integrated Bachelor's/Master's Degree* program

Appendix B

Table 3: Student Ownership of Personal Laptop Computers

Type of Degree	n	Own Laptop Frequency	Own Laptop Percent
Undergraduate	148	139	93.9
Integrated	32	29	90.6
Graduate	20	18	90.0
All Degree Types	**200**	**186**	**93.0**

Appendix C

Table 4: Student Use of Personal Laptops versus University Lab PCs

ICT Use by Students		n	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean: Lower Bound	95% Confidence Interval for Mean: Upper Bound	Min.	Max.
Within-Class	Personal Laptops	195	2.48	1.473	0.105	2.375	2.585	1.0	5.0
	University Lab PCs	200	2.22	1.410	0.101	2.119	2.321	1.0	5.0
Outside-of-Class	Personal Laptops	197	3.68	1.312	0.093	3.587	3.773	1.0	5.0
	University Lab PCs	200	1.81	1.282	0.091	1.719	1.901	1.0	5.0

Table 5: Paired Samples T-Test

	Personal Laptops		University Lab PCs		Difference		
Factor	Mean1	Std. Dev.1	Mean2	Std. Dev.2	Mean Diff.	t-Stat.	Sig.
Within-Class	2.48	1.473	2.22	1.410	0.26	1.576	.117
Outside-of-Class	3.68	1.312	1.81	1.282	1.87	12.852	.000
Combined	3.08	1.516	2.02	1.361	1.06	9.164	.000