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Business Teachers' ICT Skills and Uses in an IoT Classroom

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Abstract

This report presents the results of a survey study conducted in the spring 2016 semester in the College of Business Administration at a major Midwestern university in the USA. The findings show that Information and Communication Technology (ICT) are included in all aspects of the participants' lives and they generally agree and are excited about the opportunity to have the new Internet of Things (IoT) Crestron System in the classrooms. However, despite the enthusiasm, only a minority of the teachers are engaged in content creation activities using technological, multimedia, or online tools. There is a gap between their everyday ICT skills and their skills for teaching and learning. This article describes this gap and provides suggestions for reducing it.

Keywords: *Crestron System, ICT competency, ICT skills, Internet of Things, Teacher training*

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Introduction

Ubiquitous Internet connectivity and widely accessible ICT devices in the last decade have changed the perspective of the higher education community [1]. Many have claimed that technological changes will dramatically alter both business and pedagogical models [2]. In fact, this trend has continued with the advent of the Internet of Things (IoT) and its place in higher education [3]–[6]. The evolution of ICT has directly affected the forms in which people interact, socialize, and work [7]. ICT skills and knowledge have been considered as the core literacy needed by students of 21st century [8]. Therefore, ICT offers both new approaches for learning, and new forms of interaction, thereby changing relationships in the classroom [9], [10]. ICT can also be used to promote the use of new methods of teaching and learning which include cooperative learning, critical thinking, social media-based learning, peer group interaction, problem solving and more [9], [11]–[14]. Future education systems require an in-depth review because the world is changing constantly and so are student expectations [15]. So, the role of ICT and related updates in education becomes a central issue in higher education [16].

The College of Business Administration (CBA) at a major Midwestern university in the USA recently invested in the construction and implementation of a new, state-of-the-art building to be used in teaching and learning. A primary goal for this building project was to understand current technology uses and migrate this to a new, ICT enhanced environment considering possibilities offered by the IoT. Purchasing equipment was one small part of this process. Evaluating teachers and ultimately how students are positively affected became a more important and more complex task.

IoT systems have enormous potential to bring meaningful value to higher education institutions. Educational infrastructures can benefit from IoT systems in building automation, energy management and conservation, and building and space access, as well as environmental control systems for research environments, academic learning systems, and safety systems for students, faculty, staff, and the public. However, that value cannot be realized, without a thoughtful and responsible implementation [17], [18]. This issue highlights the challenge teachers face with current students who have extensive natural experience with technology and communication tools but lack task-oriented understanding [19], [20]. To fully utilize a new set of resources with an eye toward IoT, the CBA installed a demo classroom. It was implemented with a fully outfitted Crestron System to prepare faculty to teach in the new building. This classroom was a prototype with the same or similar equipment as what the new building was projected to use. This effort was expended to promote active learning and transform the teaching and learning space in an orderly and helpful way with a focus on communication and interaction [21].

The role of communication is complex in teaching and learning. The first step toward becoming a good teacher, is to become a great communicator who is aware and adaptive to students and circumstances. Communicating with clarity is the key to ensure students' interest in academic goals [22], [23]. The principle way to complete these instructional goals is to be as clear as possible. Clarity is an important teacher communication attitude [23]. Creative uses of ICT can help, in a positive way, to speak the same language as the new generation of students, since they expect to use technology often and in many ways [24]–[27]. According to some scholars, although not all [28], many students are “Digital Natives” [24] or at least have expectations that include the use of new technologies [29]. They prefer to receive information quickly, they enjoy the multi-tasking and non-conventional access to information, and they sometimes get bored with lectures [29]. They desire active rather than passive learning [24], [30]. Using this same analogy, many teachers, are “Digital Immigrants”, aliens in the digital world [28]. The disparity between teachers and students becomes a big challenge in current education practices [21], [31].

Context and Setting

Currently, a new phase of Internet use is on the way: a world of networked smart devices connected each other [32]. This approach has come to be known as the ‘Internet of Things’ (IoT). The IoT links smart objects to the Internet and can enable new forms of data exchange. Cisco estimates by 2020, the IoT will consist of 50 billion devices connected to the Internet [33], [34]. In a future scenario, the use of IoT systems will enhance productivity, create new business models, and generate new revenue streams. Currently, the world is experiencing a rapidly moving technology revolution that uses these ideas [17], [35]–[37].

The CBA’s Classroom Related Technology

The demo CBA classroom included a Crestron System. Its primary use was to transform the classroom into an interactive and collaborative learning environment using technology components:

- A comprehensive control panel that allows easy selection of content and/or devices to display on the projectors.
- Wireless sound system with lapel microphones to be heard throughout the room.
- Capability to show different content on two projectors, i.e. computer on one projector and an electronic whiteboard on the other screen, or computer on one screen and a student's laptop on the other screen.
- Annotation monitors that allow writing on certain content (e.g. PowerPoint Slides) showing on the projectors (electronic whiteboard).
- Mediasite (sonicfoundry.com) unit to allow lecture capture and web conferencing using different software.
- Wireless IoT integration of smart devices to the projectors (laptops, phones, iPads, hearing devices, etc.)
- A document camera to interact with physical paper sheets or objects in real time.

Goals and Research Questions

Goals and objectives were created to guide the implementation of the teaching technologies. Among these were: 1) investigate faculty access to and use of ICT devices and applications in an IoT environment; 2) examine faculty competencies with ICT tools for daily use and for teaching and learning; and, 3) evaluate the perceptions about using classroom-related technology in teaching in the modern IoT-equipped building of the Business College. The research questions became: 1. What is the general profile of faculty's experiences and competencies with ICT? 2. What are teachers' competencies regarding ICT in an IoT environment for teaching and learning? 3. What is the faculty perception about usefulness, ease of use, facilitating conditions, and behavioral intention for using the CBA's classroom-related technology in teaching and teaching-related tasks?

Research Method

Participants

The participants in this research were the faculty at the College of Business Administration at a major Midwestern University in the USA. The sample consisted of 32 people (F=34%; M= 66%), aged between 31 and 66 (Average=50.8). The faculty roles included: Instructor (38%), Professor (52%), Administrator (3%), Staff Member (3%) and other (3%). This constituted approximately 52% of the CBA faculty members.

Instrument

A survey designed by the authors and delivered via a Qualtrics platform was applied (questions were previously tested and validated for reliability), asking about business faculty access, use, and skills with emerging technologies and technological tools; their attitudes towards ICT for teaching and learning; and, the use of the CBA's classroom-related technologies. The survey was divided in four main sections:

1. Demographic information (including role, gender and age)
2. The ownership of a range of ICT devices (desktop, laptop/notebook, netbook, tablet, game console, smartphone). Individual ICT experience was evaluated by asking participants "if they have the device?" in various categories.
3. The use and competency of ICT applications/tools was measured by asking "How many hours do you spend in a week (time range: 0, 1-2, 3-4, 5-6, and more) to use the following applications/tools?" This was done for: a) communication/networking; b) media consumption; c) others in general, and d) content creation.
4. The final section asked for feedback regarding the example classroom set up for training in the following areas: a) Perceived usefulness; b) Perceived ease of use; c) Facilitating conditions within the university; and, d) Current CBA's classroom-related technology usage in teaching and teaching-related tasks.

Procedure

Data was collected at the end of the spring semester, April and May, 2016, when the CBA's example classroom was being used for training before the College moved to the new modern building. The classroom was set up in order to be used by faculty during their free time after scheduled classes. During the spring, 2016 semester, the CBA Information Technology (IT) department scheduled times for training which included teaching circles, and individual times to review the equipment. The

classroom was available every day from 16:00 – 17:00 and also each Monday from 14:30 - 15:30 p.m. and Thursdays from 10:45 - 11:20 a.m. The survey was sent online using Qualtrics. Participation was voluntary and confidential.

Data Analysis and Results

Device Ownership and Usage of ICT

The combination of the mobile computing revolution and the lower costs for ICT devices has modified the teaching landscape [38]–[41]. Currently, Mobile computing is a key technology in teaching and learning [13], [42], and appears to be the path for the future [43]. Most faculty members have desktops (86%), laptops/notebooks (79%), netbooks (3%), tablets (76%), game consoles (24%) and smartphones (83%). Additional analyses show that all respondents have access to some type of an ICT device. It is interesting that most faculty members have more than four devices.

Usage of ICT Applications

Tables 2, 3 and 4 summarize results of how long teachers spend in a week using different ICT applications. In general, findings show that teachers incorporate a range of traditional and emerging technologies in their daily lives.

Table 2. Communication / Networking Tools

Question	% have used it	Mean	SD	Variance	Time % 0	1-2	3-4	5-6	more
Send & receive mails	100	4.69	0.66	0.44	0.00	0.00	10.34	10.34	79.31
Social networking websites.	62.07	2.59	1.59	2.54	37.93	17.24	13.79	10.34	20.69
Participate in message boards	34.48	1.34	0.48	0.23	65.52	34.48	0.00	0.00	0.00

As Table 2 shows, 100% of faculty use email and 79% spend more than 6 hours a week sending and receiving emails. These results have an inherent relationship with their teaching activity because the learning management system (LMS) “Canvas” used by the university has email built-in. Twenty percent use emails between 3 to 6 hours a week. Taking into account that the average age of the faculty is 50, 38% do not use chat or social networking websites, 21% use it more than 6 hours, 17% between 1-2 hours, and 14% between 3-4 hours and 10% use it in the range of 5-6 hours per week. Regarding participation in message boards, 35% use it from 1-2 hours and the rest of participants do not use it.

Table 3. Media Consumption Tools

Question	% have used it	Mean	SD	Variance	Time 0	1-2	3-4	5-6	more
Watch videos / video casts	82.76	2.25	1.04	1.08	13.79	65.52	3.45	6.90	6.90
Listen to music/audio podcast	51.72	2.14	1.48	2.20	44.83	27.59	6.90	0.00	17.24
Read news/magazines online	93.10	2.96	1.07	1.15	3.45	34.48	31.03	17.24	10.34
Social bookmarking / tagging	37.93	1.46	0.64	0.41	58.62	31.03	6.90	0.00	0.00
Read eBooks	58.62	2.41	1.50	2.25	34.48	24.14	13.79	3.45	17.24

In regards to media consumption tools, Table 3 shows that 83% of teachers watch videos, 66% spend 1-2 hours watching videos, 3% watch 3-4 hours, 7% watch between 5-6 hours and the same percent watch more than 6 hours a week. 52% of the sample listens to music/audio, 17% listen to more than 6 hours a week. Ninety-three percent of participants read news and magazines online, 17% read between 5-6 hours, 10% read more than 6 hours and the rest fall into the range of 1-4 hours of reading per week. Only 38% use social bookmarking and tagging, 31% use it approximately 1-2 hours per week and the rest (7%) use it 3-4 hours. These results appear to correlate with the social networking website use displayed in results in Table 2.

Table 4. Other Tools

Question	% have used it	Mean	SD	Variance	0	1-2	3-4	5-6	more
Search information online	100	3.69	0.93	0.86	0.00	3.45	51.72	17.24	27.59
Use productivity tools	79.31	2.83	1.39	1.93	20.69	24.14	24.14	13.79	17.24
Shop on line	96.55	2.41	1.02	1.04	3.45	75.86	6.90	3.45	10.34
Maintain online photo album	31.03	1.52	0.95	0.90	68.97	17.24	10.34	0.00	3.45
Play online games	31.03	1.55	1.02	1.04	68.97	17.24	6.90	3.45	3.45
Participate in multiusers virtual environment	3.45	1.07	0.37	0.14	96.55	0.00	3.45	0.00	0.00

Table 4 displays information about general online tool usage. One hundred percent of teachers search for information online, the average being 3.69 hours per week. 30% do it for more than 6 hours per week. Almost 21% of faculty do not use productivity tools and 17% of them use these tools more than 6 hours/week. Only 3% of the population does not shop online and 76% shop online between 1-2 hours/week. In the sample, 31% of the participants maintain online photo albums and 69% do not use this technology. Three percent spend more than 6 hours updating online photo albums. Sixty-nine percent of the participants do not play games online. Seventeen percent play 1-2 hours per week. Seven percent play between 3 and 4 hours, 3% play for between 5 and 6 hours per week, and 3% play more than 6 hours/week. Ninety-seven percent of the respondents do not participate in multiuser virtual environments and the rest (3%) do between 3-4 hours/ week.

Competency in Using ICT for Teaching

Results show that teachers have competences using ICT applications for communication/networking, media consumption and in other areas. However, they do not use emergent applications related to content creation. A majority are even unfamiliar with these technologies. Table 2, 3, and 4 results show that teachers perceive themselves comfortable and capable with core technology applications such as email (mean = 4.69), networking (mean = 2.59), watching video (mean = 2.25), listening to music (mean = 2.14), reading online news (mean = 2.96), searching information online (mean = 3.69) and using productivity tools (mean = 2.68). A majority of them use a variety of media tools. Table 5 provides results about teacher knowledge using other, more advanced ICT applications and tools.

The proportion of teachers who had not used tools for content creation was greater than those who had. From the analysis, the teacher usage outcomes are (those who do not versus those who do): write blogs (80% vs 17%), create graphics (76% vs 24%), create/edit wikis (83% vs 14%), design websites (79% vs 17%), produce videos (79% vs 17%), create online mindmaps (100% vs 0%), and produce audio podcasts (90% vs 10%). In general, these results provide a picture of faculty that suggests the basic ICT applications are used regularly but content creation tools are not.

CBA's Classroom-Related Technology

Likert scale-based questions were used to obtain information regarding faculty attitudes toward technology use. For an easy presentation in the tables, authors coded these categories as follows: Strongly agree (SA), Agree (A), Somewhat agree (SWA), Neither agree or disagree (N), Somewhat disagree (SWD), Disagree (D), and Strongly disagree (SD).

Table 5. Content Creation

Question	% have used it	Mean	SD	Variance	0	1-2	3-4	5-6	More
Write blogs/ microblogs	17.24	1.18	0.39	0.15	79.31	17.24	0.00	0.00	0.00
Create graphics	24.14	1.24	0.44	0.19	75.86	24.14	0.00	0.00	0.00
Create or edit wiki	13.79	1.34	0.94	0.88	82.76	10.34	0.00	3.45	3.45
Design websites	17.24	1.31	0.81	0.65	79.31	17.24	0.00	0.00	3.45
Produce videos	17.24	1.41	0.98	0.97	79.31	10.34	3.45	3.45	3.45
Create online mindmaps	0	1.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
Produce audio podcast	10.34	1.14	0.44	0.19	89.66	6.90	3.45	0.00	0.00

Perceived Usefulness about CBA's Classroom-Related Technology

Table 6 indicates that no one strongly disagrees with using the CBA's classroom-related technology; 45% and 21% agree and strongly agree that using the CBA's classroom-related technology enables them to accomplish tasks more quickly. Seventy-six percent think ICT enhances the quality of their work. Seventy-two percent agree with the statement that ICT makes it easier to do their work, and 76% find the CBA's classroom-related technology useful in their work. Only 3% disagree with various

items except for the category related to 'do their work easier'. In this case, the percentage of disagreement is 7.

Table 6. Perceived Usefulness About Using the CBA's Classroom-Related Technology

Question	% SA A SWA N SWA D SD						
	SA	A	SWA	N	SWA	D	SD
Using the CBA's classroom- enables me to accomplish tasks more quickly.	20.69	44.83	20.69	6.90	3.45	3.45	0.00
Using the CBA's classroom enhances the quality of my work.	34.48	41.38	10.34	10.34	0.00	3.45	0.00
Using the CBA's classroom makes it easier to do my work.	37.93	34.48	10.34	10.34	0.00	6.90	0.00
I find the CBA's classroom useful in my work.	37.93	37.93	13.79	6.90	0.00	3.45	0.00

Perceived Ease of Use about Using the CBA's Classroom-Related Technology

The training plan developed by the IT department of the CBA, according to the data in Table 7, is positive. Approximately 62% (vs. 0%) of the sample agreed that learning to use the CBA's classroom-related technology was easy for them. 59% (vs. 7%) found it easy to use. 55% (vs. 3%) became skillfull in using it. Fifty-five percent (vs. 7%) found the technology classroom easy to use.

Facilitating Conditions within the University about Using the CBA's Classroom-Related Technology

Promoting and facilitating access to the CBA's classroom-related technology was a key goal of the IT department. Seventy-nine percent of the respondants agreed that all the necessary resources: hardware, software and communication networking were available. Only 7% somewhat disagree. Sixty-nine percent agree and could very quickly access the resources; 3% disagree. Also, 69% agree that support and guidance existed to use the available resources. In this category, no one disagreed and 7% were neutral. Seventy-two percent agreed that a specific person or group exists for assistance with technology difficulties, and only 3% somewhat disagree. See Table 8.

Table 7. Perceived Ease Use about Using the CBA's Classroom-Related Technology

Question	% SA A SWA N SWA D SD						
	SA	A	SWA	N	SWA	D	SD
Learning to use the CBA's classroom is easy for me.	31.03	31.03	20.69	10.34	6.90	0	0
I find it easy to use the CBA's classroom to do what I want to do.	24.14	34.48	31.03	3.45	0	6.90	0
I find it easy for me to become skillful in using the CBA's classroom-related technology.	31.03	24.14	34.48	3.45	3.45	3.45	0
I find the CBA's classroom easy to use.	27.59	27.59	31.03	6.90	0	6.90	0

Current CBA's Classroom-Related TECHNOLOGY Usage in Teaching and Teaching-Related Tasks

In Table 9, 93% expressed that they use the CBA's classroom-related technology when they are teaching. 3% disagreed with that statement. Meanwhile, 83% used it for facilitating teaching; and 7% disagreed. Moreover, 55% used it for preparing teaching materials; and 21% disagreed. In addition, 52% used it for enhancing their teaching knowledge. Fourteen percent did not. Sixty-six percent used the CBA's classroom-related technology for student contact and for giving advice; the remaining 17% were neutral in this specific aspect.

Table 8. Facilitating Conditions within the University about Using the CBA's Classroom-Related Technology

Question	% SA A SWA N SWA D SD						
	SA	A	SWA	N	SWA	D	SD
The resources necessary (e.g. new computer hardware and software, communication network etc.) are available for me to use the CBA's classroom effectively.	31.03	48.28	10.34	3.45	6.90	0.00	0.00
I can access the CBA's classroom very quickly within my University.	34.48	34.48	17.24	10.34	0.00	3.45	0.00
Guidance is available to me to use the CBA's classroom effectively.	27.59	41.38	24.14	6.90	0.00	0.00	0.00
A specific person (or group) is available for assistance with the CBA's classroom difficulties.	31.03	41.38	20.69	3.45	3.45	0.00	0.00

Table 9. Current CBA's Classroom-Related Technology Usage in Teaching and Teaching Related Tasks

Question	% N						
	SA	A	SWA	N	SWA	D	SD
I use the CBA's classroom when teaching in classes.	58.62	34.48	0.00	0.00	3.45	3.45	0.00
I use the CBA's classroom for facilitating teaching (e.g. online syllabus, lectures, noted, tutorials, tests, quizzes, and providing grade etc.).	58.62	24.14	3.45	6.90	0.00	6.90	0.00
I use the CBA's classroom for preparing teaching materials.	37.93	17.24	6.90	13.79	3.45	17.24	3.45
I use the CBA's classroom for enhancing my teaching knowledge.	24.14	27.59	17.24	17.24	0.00	10.34	3.45
I use the CBA's classroom for student contact and giving my advice.	31.03	34.48	10.34	17.24	0.00	3.45	3.45

Behavioral Intention to Use the CBA's Classroom-Related Technology in the Future in Other Work

Results in Table 10 have a direct relationship with the attitude and intention of teachers in using the CBA's classroom-related technology. Twenty-one percent disagreed with using it more for searching for information for their research. Twenty-four percent agreed that it can be used for more purposes and 38% were neutral. Additional details are provided in Table 10.

Table 10. Behavior Intention to Use the CBA's Classroom-Related Technology

Question	% N						
	SA	A	SWA	N	SWA	D	SD
I intend to use the CBA's classroom- more for searching information for my research.	10.34	13.79	6.90	37.93	10.34	17.24	3.45
I intend to use the CBA's classroom more to assist administrative tasks.	17.24	6.90	13.79	34.48	6.90	13.79	3.45
I intend to use the CBA's classroom more for personal tasks.	6.90	6.90	3.45	27.59	6.90	34.48	13.79
I intend to use the CBA's classroom more for enhancing personal knowledge.	10.34	13.79	10.34	31.03	6.90	17.24	10.34
I intend to use the CBA's classroom more for personal contact.	13.79	6.90	3.45	24.14	6.90	24.14	20.69
Overall, I intend to use the CBA's classroom more in the future in all of my work.	27.59	20.69	10.34	20.69	6.90	6.90	6.90

Discussion

This report provided a glimpse of teachers' access and competency with ICT devices and applications in a college of business moving into an IoT environment. Our first goal was to determine faculty access level to technology. Our survey revealed that overall, participants have access to many different ICT devices such as desktops, laptop/notebook computers, tablets and smartphones. In pursuit of our study's second goal, we found that faculty in the CBA have a medium to high level of usage of the core set of ICT applications for teaching and learning, which can be attributed to the technology emphasis and facilities provided by administration and the college IT department.

However, when basic computer devices and the core set of ICT general applications are analyzed, the patterns of access/ownership and the competency level emerging applications show considerable variation. General ICT application skills do not necessarily translate into sophisticated skills with other content creation applications. Participants make more use of ICT for communication purposes like sending and receiving emails, media consumption, information searching and productivity tools. The move into more sophisticated IoT applications has just begun.

Lower percentages of participants spend time in content creation activities. The results of this report highlight weaknesses in regards to this very important item. It is clear that a complex mix of technology experiences and skills exist among the participants, which could correlate with age, discipline or other factors related to the characteristics of the faculty members. This is not an insurmountable problem. Since a high level of core ICT competencies exist, there is no reason to doubt that additional skills can be developed in the context of training and administrative encouragement.

Our third goal was to determine the behavioral intent of the CBA faculty in areas that extend beyond teaching. Most faculty appeared to realize skills learned in the IoT teaching environment could be helpful in research, administration, personal areas and communication, but fewer than half indicated an intention to use these tools in those areas. Again, training programs that promote additional uses could prove beneficial.

The primary findings of this study provide interesting information about teachers in higher education settings. Most significant is that use of newer technologies in non-academic settings has started to enter the classroom but still has not reached the levels that are possible. Teachers know that

ICT can enable new forms of teaching and learning, but it is necessary to work and develop skills according useful to educational goals and pedagogy which make the use of ICT for teaching and learning more meaningful. To transfer from a social or entertainment technology to a learning technology is neither automatic nor guaranteed [8]. The higher education community has started the transition but still has more to accomplish, even in new environments with access to technology, help sessions, technical support and the newest software systems. While teachers understand the potential benefits, these remain to be fully operationalized.

Conclusions

This study suggests that the IT department of the CBA should provide a teacher training program related to content creation applications. This training can be a great complement to the process already started with the CBA's classroom related technology training and use. This will help ensure success in advanced ICT in an IoT environment for teaching and learning. Not all teachers possess sophisticated knowledge and understanding of ICT. However, the faculty has a wide variety of information literacy capabilities and latent capabilities. It becomes apparent that a gap exists between teachers' use of technology for personal and social reasons compared to use in classroom and educational settings. Proper training can reduce this gap and encourage innovative teaching practices.

This investigation promotes more in depth, qualitative investigation of teachers' perspectives on technology. Future work can examine the way in which educators' competencies in technology are integrated for teaching and learning. By repeating the same study after the move into the new college of business building, follow-up measures can be conducted to determine if new training initiatives and the presence of more ICT resources impact attitudes and overall usage of these important tools for teaching and learning.

Building the IoT has become a global initiative sparking interest in a variety of educational, governmental, and organizational enterprises. The CBA initiative outlines the basis to create a smart environment to improve teaching and learning activities [36], [44]. Like other institutions, the CBA has positioned itself to take advantage of these new trends [45]. With further investment in teacher training, these efforts should be successful.

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