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## IoT influence in higher education learning

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### Abstract

The use of technology for educational purposes has been increasing over the years. The Internet of Things (IoT) is being used in education to improve students' experiences in classrooms as well as online. This quantitative study determines whether there were statistically significant differences in the frequency of usage of IoT devices and the perceived benefits in learning. Based on the results, by using IoT devices, such as tablets, laptops, smartphones, televisions, smart watches, etc., at least once a day, but preferably multiple times a day, higher education students perceive beneficial improvements in their learning experience.

**Keywords:** Internet of Things, IoT, Usefulness, Individual Learning

### Introduction

The term Internet of Things (IoT) has been used to refer to the technology that is embedded in objects we use on a regular basis. It describes how things are connected to the internet in order to provide a service or to collect data. IoT can be defined as smart devices connected to the internet that can communicate with other smart devices through the cloud (Lee & Shin, 2019; Domingo, 2012). Objects that have internet connection capabilities can be considered smart devices. These not only include objects like smartphones, tablets, and computers, but also include watches, cars, refrigerators, TVs, and a wide list of things that we use every day.

In the educational field, students and faculty use smart devices to support learning, either in face-to-face courses as well as hybrid and fully online education. According to Asseo, Johnson, Nilsson, Neti, & Costello, (2016) IoT in the higher education field has a great potential since, by collecting students' interactions, IoT can help on the improvement of engagement. More interactive processes could be created using smart devices to teach online and around the campus. The amount of data gathered from students using IoT devices for educational purposes is important, as well as the usage of these devices (Sheth, 2016). The information collected becomes usable when it is linked to a database, allowing the researcher to analyze the data (Asseo et. Al., 2016). This analysis allows researchers and stakeholders to make improvements in the educational processes. Higher education students can also benefit from the use of high-quality online content and remote presence, as well as the automatization of regular procedures that are fade into the background. In other words, the on-ground or the virtual campus could provide a better educational experience for everyone (Asseo et. al., 2016).

The increasing use of IoT devices at institutions of higher education will lead to changes in educational technology and teaching methodologies (Tianbo, 2012). Safdar, Safdar, Hafeez, and Malik (2019) conducted a study revealing that IoT aids in the creation of smart lesson plans, smart classrooms, and smart campuses. The use of smart technology allows connectivity of educators and students around the world.

Technology not only promotes creativity and peer collaboration, either online or in-campus, but also enhances the access of information and enriches the teaching and learning process.

In recent years, universities have started to move away from traditional textbooks to adopt e-learning applications and digital books. This change has allowed students to benefit from the diverse e-book features and accommodating student's habits (Casselden & Pears, 2020). This has been supported by student's increased usage of IoT devices such as smartphones and tablets to access course content. This practice has led to a significant increase in the number of hybrid and fully online courses in some universities, allowing students to learn at any location and at their own pace. The online teaching and learning process has become a similar experience as provided by traditional classroom instruction (Aldowah, Ghazal, & Muniandy, 2015; Lim, 2021). In some cases, this flexibility in learning has resulted in higher progression and satisfaction rates among students (Ghazal, Samsudin, & Aldowah, 2015). Also, as students enter the workforce, knowledge and use of IoT devices provide a big advantage in their careers.

In digital learning environments, IoT has played an important role in both individual and team learning and collaboration. In this study, we analyze perceptions of higher education students regarding their perceived usefulness of IoT devices, focusing on portable devices such as smartphones and tablets, as well as the impact that these devices have in the development of their individual learning and team collaboration.

## Methodology

### Participants

A convenience sample of students at a public university located within the Southeastern United States was utilized as a part of this research study. The sample consisted of participants from the University's six academic units: (1) School of Arts and Letters, (2) School of Aviation, (3) School of Business, (4) School of Health and Natural Sciences, (5) School of Computing, and (6) School of Education and Behavioral Sciences. Both undergraduate and graduate students were included in the sample. Two hundred and twenty-eight surveys were completed. From the sample (N=228), 46% were male (N=104) and 53% were female (N=120). Participant characteristics are shown in Table 1.

### Instrumentation

The survey for this study consisted of 21 questions. Questions 1-6 were used to collect demographic data, such as gender, age, class standing, academic department, perceived experience using IoT devices, and frequency of IoT usage. Questions 7-21 utilized a five-point Likert scale which ranged from (1) "strongly disagree" to (5) "strongly agree" to measure student perceptions of the benefits of IoT device usage in higher education for individual and overall learning. The construct items were adapted and based on an instrument previously developed and validated by Hsu and Lin (2016).

### Procedures

After IRB approval, the survey was administered electronically using Survey Monkey©. An email with an invitation to participate in the study and the hyperlink to the instrument was sent to the University's student email distribution list. Participants were guaranteed anonymity of responses and assured that responses would not be shared. The email invitation was re-sent 15 days later for a total of 30-day data collection period.

Once the responses were collected and analyzed, questions were eliminated if they did not load above a 0.5 or if they loaded on more than one factor in a Varimax factor analysis. The resulting measures included – IoT for overall learning ( $\alpha = .91$ ) consisting of questions 7-13, and IoT for individual learning ( $\alpha = .96$ ) consisting of questions 14-16 and 18-21.

## Results

Demographic data was collected and is presented in Table 1. Students from all of the University’s academic Schools were represented. Results indicate that the majority of students were female, in the 18-24 age range, with sophomore class standing from the School of Computing which consists of the Departments of Information Technology and Mathematics and Statistics. The majority of the participants reported good to excellent experience in the usage of IoT devices. Over 80% of the participants indicated that they use IoT devices multiple times a day.

**Table 1. Descriptive Statistics for IoT Usage**

Characteristic	n	%
<b>Gender</b>		
Male	104	46
Female	120	53
<b>Age</b>		
18-24	128	56
25-29	22	10
31-35	18	8
36 or older	60	26
<b>Class Standing</b>		
Freshman	37	16
Sophomore	58	25
Junior	41	28
Senior	49	22
Graduate	43	19
<b>Academic Department</b>		
School of Arts & Letters	20	9
School of Health & Natural Sciences	39	17
School of Aviation	17	8
School of Business	17	8
School of Computing	98	43
School of Education & Behavioral Sciences	37	16
<b>IoT Experience</b>		
Excellent	70	31
Good	125	55
Average	28	12
Below Average	3	1
Poor	2	0.9
<b>IoT Usage</b>		
Multiple Times a Day	184	81
Once a Day	21	9
Every Other Day	8	4
Three to Four Times a Week	7	3
More than Four Times a Week	3	1
Never	5	2

In response to research question one, the results indicate that on average, students agree that IoT devices can be useful for both individual learning purposes ( $M=4.0$ ;  $SD=0.84$ ) and overall learning ( $M=4.0$ ;  $SD=0.78$ ). Females reported IoT device usage more beneficial than males, with a significant difference between males and females when it comes to overall learning [ $F(2,225)=5.23$ ,  $p=.006$ ].

To answer research questions 2-3, a series of one-way ANOVAs were conducted to compare the effect of the independent variable on perceptions of IoT benefits to individual and overall learning. Regarding research question 2, there was a significant difference in IoT device frequency of usage and perceived benefits to individual learning [ $F(5,222)= 5.11$ ,  $p=.001$ ]. Post hoc comparisons using the Tukey HSD test indicated that the mean individual learning score for those who never used IoT devices was significantly lower ( $M=2.30$ ;  $SD=1.27$ ) than those who used an IoT device three to four times a week ( $M=3.78$ ;  $SD=.76$ ), more than three to four times a week ( $M=4.29$ ;  $SD=.62$ ), every other day ( $M=3.86$ ;  $SD=.97$ ), once every day ( $M=4.02$ ;  $SD=.75$ ), and multiple times a day ( $M=4.11$ ;  $SD=.80$ ). No other significant differences were found.

Finally, in terms of research question 3, there was a significant difference in IoT device frequency of usage and perceived benefits to overall learning [ $F(5,222)=4.04$ ,  $p=.002$ ]. Post hoc comparison using the Tukey HSD test indicated that the mean overall learning score of those who never used IoT devices was significantly lower ( $M=2.71$ ;  $SD=1.24$ ) than those who used IoT devices at least once every day ( $M=3.88$ ;  $SD=.68$ ) and those who used IoT devices multiple times a day ( $M=4.10$ ;  $SD=.73$ ).

### Discussion

The purpose of this study was to determine whether there were significant differences between the frequency that students use IoT devices and the perceived benefits on their learning. Data collected from 228 participants were analyzed using a series of one-way ANOVAs.

The results indicated that participants perceive IoT devices to be useful for learning purposes. There was a significant difference between males and females in terms of perception of overall learning, where females reported the use of IoT devices more beneficial. Also, there was a significant difference between the frequency of use of IoT devices and perceived benefits to individual learning and overall learning. The results suggested that participants who use IoT devices at least once every day perceive that their learning performance can be improved; with an internet connection available, students can learn at their own pace having a wide choice of learning materials at their fingertips. They can easily engage and collaborate with peers and instructors through a variety of IoT devices, such as laptops, tablets, smartphones, televisions, and any other object that facilitate educational activities through the internet (Pruet, Farzin, Ang, & Chaiwut, 2015)

Nowadays, with educational resources available in a digital form, the educational experience could be similar at home and in the classroom (Insider Intelligence, 2022). In this study, we explored if the frequency of use of IoT devices had a significant difference on the learning benefits perceived by students. The results suggest that the frequent use of IoT devices for educational purposes improves the learning performance of higher education students.

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