WEARABLE TECHNOLOGY IN EDUCATION

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Abstract

Despite the exceptional growth and potential of wearable technology, these devices and learning applications are still in their early stages. In an effort to support technology innovation many educational intuitions are incorporating wearable technology in the virtual and physical classroom experience. While extant literature has focused on technology diffusion or usage within various domains, new methods and models are required to fully understand wearable technology product usage. Educational organizations fully expect to gain benefits through the use of wearable technology, however several cases show some portion of users will resist the new technology. This paper identifies factors associated with wearable technology usage through an explanatory model, and develops recommendations for the practical steps and best practices for wearable technology adoption in an educational learning environment.

Keywords: *Wearable Tech, BYOT, WTAM, Google Glass, Educational Technology, Technology Acceptance*

BYOT

Bring your own technology (BYOT) and is a new paradigm where students are able to bring their personal devices and connect within a classroom, most commonly a laptop computer or tablet device. Many school districts have begun to implement policies and programs to improve educational learning opportunities for students who have a wide variety of technology devices. These technology policies also allow districts with limited budgets to enable usage of technology while improving student engagement at a lower cost. For example school districts from Central Florida, Houston, and Atlanta have lead the BYOT trend. In Volusia County Florida, signs restricting technology usage a few years ago have now been replaced with BYOT (Richtelmarch, 2013). While significant learning capabilities are available for BYOT, there are also significant technical challenges along with learning model and organizational adaptation.

BYOT AND WEARABLE TECHNOLOGY

One of the latest trends and categories within BYOT is wearable technology such as smart watches and glasses. Shipments of 100 million wearable tech devices were estimated in 2014, with 485 million by 2018. To further educational learning opportunities these devices can be incorporated within an innovative classroom environment. With wearable technology in education, instead of demanding students turn off or put away technology devices, educators capture students use and interest of wearable technology within a learning context (Woodside and Amiri, 2014).

The first true wearable computer was invented and tested at a Las Vegas Casino in 1961. It was a foot-controlled machine that mathematicians Edward Thorp and Claude developed to help them win at roulette. The next known shoe-based computer was invented in 1983 which was used to count cards. By having the computers, the wearers were able to have superhuman capabilities, granted they remained hidden. A few years later, wearable technologies started to show up on people's faces and were called "On-Your-Face Wearables." These wearables were designed to enhance the wearer's ability to remember, record, and retrieve information. On-your-face wearables drew stares from people, and the users proudly called themselves cyborgs (Garfinkel, 2014).

One of the recent on-your-face wearable technologies that have generated significant interest and attention is Google Glass, an eyewear with connection to a smartphone, GPS, voice activation, camera and video recording. Snapchat also has released Spectacles a wearable eye ware technology product similar to glasses which allow users to take short videos, pictures, and share them with friends or post online (Snapchat, 2016).

These devices utilize demonstrated technology such as Wi-Fi, Bluetooth, Near Field Communication (NFC) and Global Positioning Systems (GPS). Despite the non-educational uses, educational institutions are seeking ways to best utilize this technology in the classroom. Three challenges that are examined in every wearable technology are the input, the output, and the software. For the input part of Google Glass, the wearable technology has a camera, a touchpad, and a nine-axis sensor. Google Glass has two output features that are the tiny prism that displays images and the speaker for the audio. Finally, the software has been programmed by Google to detect whether the use is walking, standing, talking to a person, talking to the wearable, and understanding voice commands (Garfinkel, 2014; Woodside et al., 2015). Wearable computing pioneer Thad Starner wrote about the three key challenges faced by wearables, which were input, output, and software. Google Glass seeks to conquer these key challenges with its innovative design, technology and software. Google Glass, developed by Google, is an eyewear with connection to a smartphone, GPS, voice activation, camera and

video recording. These devices utilize demonstrated technology such as Wi-Fi, Bluetooth Smart, Near Field Communication and GPS (Garfinkel, 2014).

As wearable technology advances, the realization that these technologies can assist teaching and learning is also increasing. However despite the benefits, factors exist that determine whether the wearable technology will be utilized. This study develops and tests an expanded wearable technology model and measures user's beliefs, attitudes, and perceptions towards the technology. As educators and organizations are beginning to dive into the wearable technology sector, it is critical to understand whether these products are useful and will be accepted by students.

WEARABLE TECHNOLOGY ACCEPTANCE MODEL

Despite the exceptional growth and potential of wearable tech, these devices and learning capabilities are in their early stages. While the opportunities are many, there are also challenges including connectivity, compatibility, capabilities, input mechanisms, battery life, errors, resolution, user interface and graphical limitations. Given the challenges, the success of adapting existing learning methods and adopting new wearable technologies in an educational or organizational setting is dependent on usage of the new methods and technologies. In prior studies, demographic or personal characteristics have also been shown to generate differences in technology usage, which is an important consideration for educational and organizational settings with a diversified user base (Wang and Wu, 2009).

The technology acceptance model was developed to explain intention of computer usage, and included the factors of perceived usefulness, perceived ease of use, attitude. The model was formed to generally predict and explain the factors in user acceptance of information systems (Davis, Bagozzi, and Warshaw, 1989). In an educational study example using the technology acceptance model, authors reviewed the technology acceptance model with regard to mobile technology adoption by lecturers. The study findings showed that while technology in the classroom is growing, a significant portion are still resistant to the usage of technology in the classroom. The authors found perceived usefulness, ease of use, digital literacy, digital anxiety, and self-efficacy were the significant factors in lectures intention to use mobile technology for learning (MacCallum, Jeffery, and Kinsbuk, 2014). The technology acceptance model is also generalizable to technology acceptance areas outside of education, for example in a related and generalized mobile technology acceptance study, the authors reviewed mobile acceptance for individuals and found that the intention to use a mobile phone is influenced by perceived usefulness, perceived ease of use, and attitude (Mekic and Ozle, 2010).

While extant literature has focused on technology diffusion or usage within various domains, new methods and models are required to fully understand wearable tech products such as Google Glass. Organizations fully expect to gain benefits through use of technology, however several cases show some portion of users will resist the new technology. This resistance is particularly evident in cases of wearable technology, where despite the widespread technology diffusion within current society, a backlash has occurred with Google Glass in so much as being banned from use in public establishments (Levy, 2014). Among the influences, prior research shows perceptions of use as a predictor of actual usage and contained within a theoretical model of technology acceptance (Robinson, Marshall, and Stamps, 2005; Spiegel, 2014). This project seeks to identify the wearable technology factors associated with technology usage and develop an explanatory model and prescribe the best practices for adoption.

This manuscript describes an exploratory study that investigated wearable technology usage of students in a higher education environment. Utilizing prior research, a wearable technology model is generated to explain factors that lead to wearable technology usage by students. Theoretical foundations and factors from prior literature were included in the research model to allow for increased application to the higher education setting and wearable technology. This research contributes to innovative business education research by extending existing literature to incorporate wearable technology factors. Factors that influence technology usage are critical administrative and educational decisions that require additional decision support and strategic recommendations. The research model is shown in Figure 1.

Perceived Usefulness

Researchers have found that perceived rather than objective technology factors are more applicable to decision making by individuals. For wearable technology to be utilized, the technology needs to be seen as beneficial to the individual. Increases in perceived usefulness have been shown to have a positive influence on intention to use a technology (Chau, Hu, 2002). As a result, the hypothesis was developed:

H1: Perceived usefulness will have a positive effect on the intention to use wearable technology.

Perceived Ease of Use

Perceived ease of use is the extent an individual considers a technology effortless. Many technologies may have complex and sophisticated underpinnings which may or may not be known by the individual. Having a positive perception toward technology ease of use has been found to have a positive influence on intention to use a technology (Chau, Hu, 2002). As a result, the hypothesis was developed:

H2: Perceived usefulness will have a positive effect on the intention to use wearable technology.

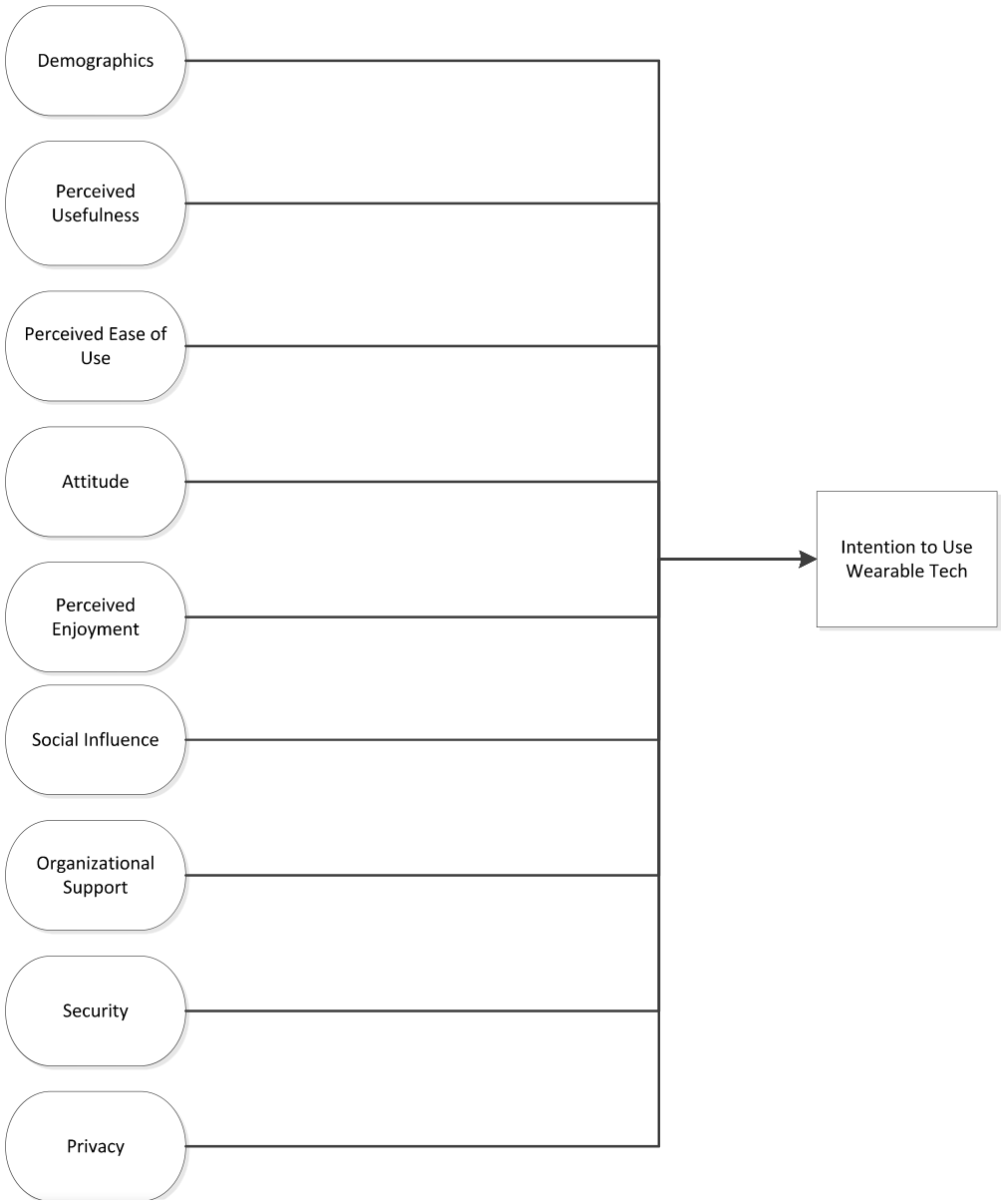

FIGURE 1. Wearable Technology Acceptance Model

Attitude

Attitude is the positive or negative assessment of using technology. Students have learned of technology through a variety of external sources which have

formed beliefs about positive or negative effects of using technology which would results in a positive or negative intention to use the technology (Chau, Hu, 2002). As a result, the hypothesis was developed: hypothesis was developed:

H3: Attitude toward wearable technology will have a positive effect on the intention to use wearable technology.

Social/Peer Influence

Social and peer influence can also impact student's technology decisions. In a classroom setting peer influences may have a greater impact towards perceptions and intention to use the technology Chau, Hu, 2002). As a result, the hypothesis was developed: hypothesis was developed:

H4: Peer influence will have a positive effect on the intention to use wearable technology.

Perceived Enjoyment

Perceived enjoyment or fun can also impact student's technology usage decisions. Prior research has shown mobile devices with use friendly interfaces are viewed more favorably and can influence the intention to use the technology (Mekic, Ozlen, 2014).

H5: Perceived enjoyment will have a positive effect on the intention to use wearable technology.

Security and Privacy

Security and Privacy of technology can have an impact the intention to use a technology. This also applies to other examples including financial institutions and mobile devices. Private information such as emails, photos may be stored on the device and it is important to users that this information is secure. In prior research security and privacy were combined components though have been separated to measure the impact of each (Mekic, Ozlen, 2014):

H6: Security will have a positive effect on the intention to use wearable technology.

H7: Privacy will have a positive effect on the intention to use wearable technology.

Organizational Support

Organizational support may also be seen as a social construct, and includes the interpersonal agreements that an individual made with others in a social setting. This includes the support of senior management, supervisors, training, and the organizational resources in support of using the new system for one's job or

direct benefit. This support may also take the form of training and resources (Venkatesh, Morris, 2003; Kim, Kankanhalli, 2011).

H8: Organizational support will have a positive effect on the intention to use wearable technology.

TABLE 1
Summary of Supporting Works for Research Hypotheses

Hypothesis	**Supporting Works**
Perceived Usefulness	Chau, Hu, 2002
Perceived Ease of Use	Chau, Hu, 2002
Attitude	Chau, Hu, 2002
Perceived Enjoyment	Mekic, Ozlen, 2014
Social/Peer Influence	Chau, Hu, 2002
Security	Mekic, Ozlen, 2014
Privacy	Mekic, Ozlen, 2014
Organizational Support	Venkatesh, Morris, 2003; Kim, Kankanhalli, 2011

RESEARCH METHOD, ANALYSIS, AND RESULTS

A survey was utilized for measurement of the study variables. The survey was developed followed Moore and Benbasat's (1991) identified stages of item creation, scale development, and testing. During item creation, existing items were utilized from prior literature, and then additional items added to those components which fit the definitions. Scale development, where similar categories of items were created and refined as needed. Testing, in which sample surveys were conducted, and then was followed by revisions and larger distribution, the final survey contained a measurement scale of 1-5 and was also randomized to reduce order effects.

A multi-stage stratified convenience sampling method was used to survey the students. An initial group of 58 undergraduate students with users from varying academic departments were surveyed. Based on demographics, survey participants included 52% female and 48% male, with 54% 20 years of age or under, and 98% 30 years of age or under. A path analysis was employed using SmartPLS 3.1.6 software to analyze the results and determine model fit (Ringle, Wende, Will, 2014). The results showed that 70% of the variability in wearable technology usage was explained in the model. The path analysis model describes the relationships between the latent variables and manifest variables which measure the latent variables. The original research model includes nine latent variables of demographics, perceived usefulness, perceived ease of use, attitude, perceived enjoyment, social influence, organizational support, security, and privacy. All latent constructs except for age exceeded a 0.70 composite

reliability benchmark, which is a measure of the internal consistency of the manifest variables on the latent factor. These latent variables are measured to show the impact on intention to use or wearable technology that is based on which factors such as perceived enjoyment, best explain intention to use wearable technology. As shown in table 2, perceived enjoyment had the greatest explanatory variance on the intention to use wearable technology, followed by perceived usefulness and demographics. Security and attitude had a negative correlation on the intention to use wearable technology.

TABLE 2
Summary of Quantitative Research Results

Factor	Mean	Standard Deviation	Explanatory Variance
Perceived Enjoyment	3.615	1.161	0.423
Perceived Usefulness	3.276	1.078	0.358
Demographics	-	-	0.251
Organizational Support	2.868	1.182	0.198
Privacy	3.052	1.071	0.135
Influence	3.006	1.078	0.094
Perceived Ease of Use	3.454	1.078	0.027
Security	3.167	1.059	-0.051
Attitude	3.323	1.164	-0.121
All Factors	3.203	1.151	0.653

INFORMATION TECHNOLOGY IMPLICATIONS AND DISCUSSION

A practical and managerial approach is also developed describing recommended and best practices identified for use of wearable technology. After analyzing the data, it has been determined that students would be interested in learning more about wearable technology and would intend to utilize these capabilities in the classroom. To ensure a successful implementation in the classroom, a practical and managerial section is included for describing recommended and best practices identified for use of wearable technology within the educational context. Key policy and procedure examples include: acceptable usage, technical support levels, network and software access, technology ethics, staff training, device management, and security. This has been further defined to a three component plan of 1. Educate, 2. Ethics, and 3. Experiment. Where educate includes staff training, management, support, and access. Ethics includes acceptable usage in alignment with the mission and values of the learning

organization. Experiment includes active learning and development of the wearable technology within the overall environment.

The first step will be to educate the teachers and students on how to make productive use of wearable technology in the classroom, the second step will be to work on the ethics of the technology to address security and privacy concerns, and finally the third step will be to experiment to continuously improve wearable learning in the classroom.

Educate

In the first planning phase of educating, the key stakeholders including instructors, students, and staff would be trained using the wearable technology. This training may include features and functionality, device management, access levels, technical support policies, step by step guides, and usage tips. This is a critical first step for ensuring successful usage and overcoming the initial resistance barriers. Organizational support is also important from leaders of the organization including academic leaders, student leaders, and staff leaders to express the importance of the adoption which will also lead to increase peer and social influence and increase positive attitudes towards adopting the wearable technology successfully. Education should also be customized to meet the demographics of the stakeholders and ensure the delivery is in a consistent manner.

Ethics

In the second planning phase of ethics, acceptable use of the wearable technology, security, and privacy should be addressed. In a study relating to general smartphone adoption, authors found that security and privacy issues need to be lessened to increase the intention to use smartphones. The authors recommended increased focus be spent on protecting sensitive information and improving overall security of devices through safeguards (Mekic and Ozle, 2010). In this study security and privacy both presented as significant concerns. Google Glass for example has features including a recording capability, and stores user data in online based accounts. Trusting the security and privacy of the wearable technology is important to adoption. These security and privacy concerns can be addressed through administrative and technical safeguards. For administrative safeguards clearly defined policies and procedures on acceptable and ethical use of the wearable technology should be developed. For technical safeguards, security protocols such as passwords, encryption, and secure connections are required to protect security and privacy. Overall, students trust the security and privacy of wearable technology and in support of their learning and that trust must be preserved.

Experiment

In the third planning phase of experimenting, varying wearable technologies such as Google Glass, Spectacles, and others along with varying pedagogies should be

tested and assessed with measurable results for comparison. For example use of wearables in flipped classroom environments, online discussions, in class activities, among others. These results should be shared with the community and continuously improved to increase learning outcomes. Over time this can also lead to increased enjoyment, usefulness, and ease of use of wearable technologies if adopted and utilized throughout varying courses and applications.

CONCLUSION AND FUTURE DIRECTIONS

Many studies have reviewed instructor resistance to technology, by showing instructor beliefs and value of the technology (MacCallum, Jeffery, and Kinsbuk, 2014). A new model is developed and tested to measure the impact of factors on usage of wearable technology in education. This research expands and incorporates factors for wearable technology, and the role that students play in the use of this technology and the factors that need to be reviewed during implementation of the technology in a classroom. With the explosion of smart devices and wearable technologies, along with profit pressures that generate demand for students to bring their own technology, wearable technology trends must be addressed and leveraged for success.

A limitation may be external validity or ability to generalize across time, location, or person. Generalization uses an inductive process to extrapolate beyond the data, where trivial and interaction factors are identified, and attempts are made to close the experiment gap between time, location or person. To improve external validity, this study seeks to model a specific wearable technology only in Google Glass. This study includes a single sample study, and quantitative analysis of a singular organizational dataset. This developed and detailed model can be completed with additional samples to further generalize the approach. This model may also be extended within differing industries and application settings to incorporate other concepts in the model. Future directions include determining fit by industry and technology type as well as longitudinal studies to determine if intention to use wearable technology changes over time with continual improvements in the pedagogical delivery and technology advancements. Additional areas include exploring capabilities by vendors and comparing systems with enhanced information features, such as those found within the next generation of wearable tools and online learning environments.

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APPENDIX A
Wearable Technology Questionnaire

Demographics:	**Age:**	**Position:**
Gender:	< 20	Student
Male	21-30	Faculty
Female	31-40	Staff
	41-50	
	51-60	
	>60	

#	**Please select your level of agreement for each of the following statements below in terms of Google Glass, with 1 being least favorable agreement, and 5 the most favorable agreement.**	**1**	**2**	**3**	**4**	**5**
1	Using Google Glass can improve my education					
2	In general, the university has supported the use of Google Glass in education					
3	Using Google Glass can enhance my effectiveness in learning					
4	I would find Google Glass easy to use in the classroom					
5	I would find Google Glass to be useful in my classroom					
6	Using Google Glass in my classroom for would be enjoyable					
7	I trust the security technology Google Glass is using in my classroom					
8	I trust using Google Glass would be secure in my education					
9	Using Google Glass in education would be pleasant					
10	Using Google Glass learning would be fun					
11	I trust using Google Glass for learning would be secure					
12	The university provides guidance on how to change to the new way of learning with Google Glass					
13	Using Google Glass in education is a good idea					
14	Using Google Glass in my classroom					

	would be pleasant					
15	Students in my classroom think I should use Google Glass					
16	I trust using Google Glass for learning would protect privacy					
17	I would find it easy to get Google Glass to do what I need it to do in my education					
18	I intend to use Google Glass for learning as needed					
19	Faculty who influence my learning think I should use Google Glass					
20	Learning to use Google Glass would be easy for me					
21	Whenever possible, I would use Google Glass in my classroom					
22	I trust the ability of Google Glass to protect my privacy in education					
23	To the extent possible, I would use Google Glass in my education frequently					
24	Administrative Staff who influence my education think I should use Google Glass					
25	I trust the ability of Google Glass to the privacy of others in the classroom					
26	Using Google Glass would be beneficial to my learning					
27	The university provides resources for using Google Glass in the classroom					

Research Model:
Scale: 1-5 (strongly disagree, disagree, neither agree or disagree, agree, strongly agree)

Perceived Usefulness (Chau, Hu, 2002)**:**
Using Google Glass can improve my education
Using Google Glass can enhance my effectiveness in learning
I would find Google Glass to be useful in my classroom

Perceived Ease of Use (Chau, Hu, 2002)**:**
Learning to use Google Glass would be easy for me
I would find it easy to get Google Glass to do what I need it to do in my education
I would find Google Glass easy to use in the classroom

Attitude (Chau, Hu, 2002)**:**
Using Google Glass in education is a good idea
Using Google Glass in my classroom would be pleasant
Using Google Glass would be beneficial to my learning

Perceived Enjoyment (Mekic, Ozlen, 2014):
Using Google Glass in my classroom for would be enjoyable
Using Google Glass in education would be pleasant
Using Google Glass learning would be fun

Social/Peer Influence (Chau, Hu, 2002)**:**
Students in my classroom think I should use Google Glass
Faculty who influence my learning think I should use Google Glass
Administrative Staff who influence my education think I should use Google Glass

Security (Mekic, Ozlen, 2014):
I trust the security technology Google Glass is using in my classroom
I trust using Google Glass would be secure in my education
I trust using Google Glass for learning would be secure

Privacy (Mekic, Ozlen, 2014):
I trust the ability of Google Glass to protect my privacy in education
I trust the ability of Google Glass to the privacy of others in the classroom
I trust using Google Glass for learning would protect privacy

Organizational Support (Venkatesh, Morris, 2003; Kim, Kankanhalli, 2011):
The university provides guidance on how to change to the new way of learning with Google Glass
The university provides resources for using Google Glass in the classroom
In general, the university has supported the use of Google Glass in education

Behavioral Intention (Chau, Hu, 2002)**:**
Whenever possible, I would use Google Glass in my classroom
I intend to use Google Glass for learning as needed
To the extent possible, I would use Google Glass in my education frequently