Learning with Wearable Technologies: A Case of Google Glass

Daniyar Sapargaliyev(✉)

Almaty Management University, Almaty, Kazakhstan
dsapargalieff@gmai.com

Abstract. The purpose of this study is to determine how wearable are used in education. Different types of wearable technologies, such as smart watches, fitness trackers, smart glasses, HoloLens or even smart clothing are gradually changing the structure of global consumer market. These changes inevitably lead to transformation of educational spaces. This paper presents a review of scientific literature for the last three years (2013-2015) in the field of using Google Glass as a teaching and learning tool. We have analysed over thirty papers in reviewed journals, proceedings of conferences and scholarly web sources. In recent years, there has been an increasing amount of literature on the use wearable technologies in education. Wearable devices are used by explorers, librarians and educators at workplaces, university libraries, laboratories and classrooms. Learning with wearables is one of the most widespread trends in medical or especially surgical education. Wearable computers are actively used by library staff and assist to library patrons at universities. Some of the pilot projects in learning with wearables help students to study anatomy, physics and other discipline through application prototypes. Overall, some sources indicate that learning with wearable technologies has big perspectives while other ones show several examples of low efficiency in using wearable technologies in education.

Keywords: Wearable devices · Hands-free learning · Mobile learning · Google glass

1 Introduction

First wearable computers appeared in the early 1960s (Thorp 1998). In the end of 1990s, Steve Mann created the 'EyeTap Digital Eye Glass' that was the one of the first attempts to make a head-mounted display computer (Mann 2012). In 2013, Google started to sell a prototype of 'Google Glass', a new type of wearable technology with an optical head-mounted display. The Glass displays information in a smartphone-like hands-free format (Google 2015). In the next 5 years, the importance of wearable technology will significantly grow up and wearable computers will be used by the college-aged students (Johnson et al. 2015). In recent years, researchers have shown an increased interest in the use of different types of wearable computers, such as watches, brain-computer interfaces, body sensors and even digital tattoos in everyday life (Pedersen, 2013).

There is a growing body of literature that recognises the importance of using wearables in libraries, universities and other public spaces. One of the most popular

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wearable devices is Google Glass and several educators studied the best practices of using Google Glass in the classrooms and learning environment (Boykin 2014; Woodside 2015). This wearable computer allows involving students to team-based research projects (Paterson and Glass 2015) and could be used as real-time assistive teaching tool (Kirkham and Greenhalgh 2015). Nevertheless there are some studies of negative impacts of wearables (Norman 2013; Pedersen 2013).

However, much of the research up to now has been descriptive in the use of wearables in educational purposes. One of the main ideas in these studies is how to provide seamless transition from the use of hand-held devices to hands free wearables in the classroom and outdoor (Clark 2013).

The purpose of this paper is to review recent studies into the theoretical and practical use of wearable technologies in libraries, medical faculties and universities.

2 Method and Limitations

The method consisted of searching the relevant terms 'wearable technology (or technologies)' and 'Google Glass' in education, learning and teaching. We have used the numerous databases of peer-reviewed literature: such as ISI Web of Science, Scopus, IEEE Xplore, SpringerLink and EdITLib. The aim of our study was to find and analyse related academic literature in the field of the use wearable technologies in education. The main focus of the search was devoted to the use Google Glass as a teaching and learning tool. We considered the conference papers, reviews, reports, web-documents, magazines and journal articles written in English language in the period from January 2013 to July 2015. In most cases, the findings and materials were based on description of pilots and experiences in United States' universities. Due to practical constraints, this paper cannot provide a comprehensive review of the use of wearable computers in education.

3 Google Glass in Library Spaces

We start our study from the description and analysis the pilot projects in public and universities libraries. These organisations were one of the first participants of the Google Glass Explorer Programme (Google 2015) and they received technical possibilities to test a new type of wearable devices at learning spaces.

Today libraries remain the important educational sites with providing physical and digital access to information. But the fast development of information technologies reshapes these public buildings into virtual spaces. The use of wearable devices can crucially help library staff to attract new generation of readers. Emerging technologies allow presenting librarian interaction in different formats. For example, the workers of Arapahoe public library (Colorado, USA) used Google Glass as a new tool to access educational information. Locals and their kids started to visit the library for testing wearable devices and suggested the ways how to use these tools in the library spaces (Asgarian 2014).

The different situation is in university libraries. Evidently, there are many students and professors that visit university libraries every day and spend many hours for searching information at these spaces. Many university libraries invest in new technologies and try to improve digital access to learning materials (Table 1).

Table 1. Glassware apps for libraries.

Glassware	Aim	Library	Author
MyGlass app	Records debates from the first-person perspective to examine speech techniques	Claremont University Library	(Thomas 2014)
Scan and Deliver app	Allows library staff to fulfill patron scanning requests directly from the library stacks	Yale University Library	(Patrick 2014)
ShelvAR app	Identifies shelf reading and inventory management	Miami University Library	(Hawkins 2014)

For example, Miami University Library started to use Google Glass for shelf reading and inventory management. The special Glassware application "ShelvAR" frees the readers from the necessity of holding the mobile phone up to the books. Meanwhile the librarians complained of a difficult work on closed networks with this wearable device and also there was a lot of not secure data passing through Glass (Hawkins 2014).

Access services staff of the Yale University library developed special Google Glass application called "first-person scanner" which allows librarians to fulfill patron scanning requests directly from the library stacks (Patrick 2014).

The students of the Claremont University tried to create several Glassware apps for enhancing learning and providing different ways of accessing information. New applications allow examining speech techniques and tracking eye patterns in public speaking from the first-person perspective (Thomas 2014).

Together these examples provide important insights into using Google Glass and other wearables in the nearest future. How many university's libraries across the globe will demonstrate the possibilities of emerging technology for readers and visitors. Probably, the results of pilot projects are still not enough scalable for further implementations.

4 Wearables in Teaching and Learning

The first serious discussions and analyses in the use of wearable technologies in teaching and learning emerged during the last three years (2013-2015). Some studies have examined the relationship between mobile learning and the use of emerging technologies (including big data and wearables) in higher education. For example, Bower and Sturman (2015) investigated educational affordances of wearable technologies in teaching and presented wearables as a new generation of mobile learning

tools. In another study, Llorente and Morant (2014) reported that modern wearable computers allow students and professors to communicate with big data resources in higher education environments.

There have been a number of pilot studies involving wearables for efficiency and effectiveness of using Google Glass in learning environment (Coffman and Klinger 2015). For example, Knight *et al.* (2015) reported that the use of Google Glass as a teaching tool can replace existing equipment and help to broadcast learning information onto mobile devices of the students. Also the Glass allows teacher to share information in various modes of interaction including flipped classroom (Parslow, 2014). Salamin (2014) describes the method of the use Google Glass to enrich printed books and strengthen students' motivation for learning by intertwining wearables and traditional textbooks.

Burke (2014) argues that one of the important features of Google Glass is to present text based translations in real time. This wearable computer can be helpful in mobile-assisted (or wearable-assisted) language learning and students would have the benefits of real time decoding in different languages.

All of the studies reviewed here support the idea that Google Glass can be successfully used in several educational directions – mobile learning, flipped classroom, mobile-assisted language learning and even the use of big data. But we want to consider practical examples of the use Glassware apps in possible learning situations. There are three Glassware prototype applications presented on Table 2, which allow using its in different educational goals.

Table 2. Glassware applications for teaching and learning.

Glassware	Aim	Authors
gPhysics App	'To perform an educational physical experiment in the area of acoustics'.	Weppner *et al.* (2014)
Glass Personal Inquiry Manager (GPIM App)	'To support the learning- and inquiry-process just in time and in an unobtrusive way'.	Suarez *et al.* (2014)
Glassist App	'To allow teachers to create individual portfolios for students, manage their information and share it with peers'.	Silva *et al.* (2014)

In their application prototype 'gPhysics App', Weppner *et al.* (2014) presented the tool for finding relationship between the frequency of the sound generated by hitting a water glass and the amount of water. The other researchers, Suarez *et al.* (2014) introduced the design and functionalities of a prototype for Inquiry-based learning (IBL) providing a more seamless learning experience. And the last example, Silva *et al.* (2014) demonstrated 'Glassist App' for helping teachers' management tasks. This tool can recognise students face and display relevant information about them.

Contrary to expectations, this study did not find a significant difference between the Glassware applications, because firstly all presented apps are still on testing stage and secondly these prototypes were realised in the local spaces without wide introduction.

5 Google Glass in Medical Education

In recent years, there has been an increasing amount of literature on using wearable technologies in medical education. The generalisability of much published research on this issue is problematic. The most of the studies were conducted only in one country with limited amounts of participants. The medical faculties and schools of the United States' universities started to use wearables in early 2013 and almost all these pilot projects were involved in Google Glass Explorer Programme. Meanwhile, there were some enthusiastic expectations of the revolutionary changing in medical education, but later the limitations of spreading the device required a pragmatic assessment in its use. Nevertheless the first use of Google Glass and other wearable devices in medical education slightly changed the vision of healthcare and shortened distance between the patient and caregiver (Nosta 2013). Today, there are three main directions in medical education that can be identified for successfully use Google Glass as a teaching and learning tool. We tried to describe how to use wearable devices for studying different disciplines such as surgery, cardiology and anatomy.

5.1 Surgical Education

There is a small volume of published studies describing the role of wearable devices in surgical education. But the study by Bola and Brighton (2015) offers probably the most comprehensive analysis of using Google Glass as a surgical training tool. The authors defined the three main ways of using the Glass for surgical practice:

1 Tool for self assessment.
2 Evidence for annual review of competence progress.
3 Consultant support (video conferencing to other consultants at different sites in cases of unusual anatomy or difficult cases).

Moreover, the Glass can help medical students to efficiently learn in difficult practical situations. For example, when emergency cases where a senior is not available, this wearable device provides communication between the junior and senior surgeon in real- time.

In the same vein, Ponce *et al.* (2014) in their study mention the usefulness of combining real-time augmented reality and wearable computing devices in the field of surgery. The authors described one of the first surgical cases adopting the combination of real-time augmented reality and the Google Glass. The surgical procedure was integrated with the virtual interactive presence and augmented reality system through Google Glass. This combination allowed the local surgeon to interact with the remote surgeon within the local surgical field.

5.2 Cardiology Teaching

One of the first studies in the use of wearable technology to improve cardiology learning was carried out by Vallurupalli *et al.* (2013). The authors explored different educational levels in cardiovascular practice for medical trainees. In this investigation,

live streaming video demonstrated several practical actions in cardiology via Google Glass. Medical students received and saved learning information on their mobile devices.

The practice of remote and real-time mentorship relationships between students and experienced experts was described in a pilot study by Russell *et al.* (2014). The authors attempted to use Google Glass for telementoring of cardiac ultrasonography. In this study, medical students were able to obtain adequate imaging through Google Glass to determine a healthy patient's ejection fraction. These students received real-time telementored consultations through Google Glass via Google Hangout from a remotely located expert.

5.3 Studying Anatomy

A small but growing body of literature attempts to describe the use of the wearables in learning of anatomy. These studies discuss the recent experiences in using Google Glass for teaching of anatomy in medical schools. For example, Benninger (2015) demonstrated the method that melds traditional medical palpation with Google Glass in teaching of human anatomy. The Glass has provided access to a live ultrasound image for viewing anatomical plane while examining the patient. Ciomek et al. (2015) performed a similar study of using the Glass for clinical and educational value within anatomic pathology. The analysis of surgical specimens in pathology requires high quality photographic and video records. Video and photo fixation of the intact and fresh specimens at the time of initial dissection helps students to avoid potential errors in diagnosis and reporting.

The other successful example of using wearable devices for video recording was presented by Tully *et al.* (2015). In this study, medical students have used the Google Glass to record their first-person perspective for the further analysis and evaluation of their interpersonal communication skills and nonverbal behaviors with the patients.

The studies presented thus far provide evidence that the Glass is considered by the researchers as a tool for transmitting of live video for different practical situations and medical procedures. But sometimes Google Glass helps to improve communication between students and experienced practitioner and allows working in groups. Current stage in development of wearable technologies does not detect any evidence for widely usage the Glass and other devices in global aspect, but we expect that in the next five years the situation will change radically.

6 Conclusion

The main goal of the current study was to determine how wearable technologies are used in education. One of the more significant findings to emerge from this study is that wearables have a big potential for development and attractive opportunities for student and educators. We think that there will be very promising pilot projects on using wearable technologies in libraries. These spaces have much informal approach to learning with less technical (closed network, software incompatibility) and ethics (cyber security, privacy and face recognition) restrictions. Sometimes the use of Google Glass for teaching are considered by the researchers only in the classrooms, but the main potential of the wearables can be effectively used in outdoor spaces. Google Glass

is one of the best tools for streaming live video, but with very short battery life. These problems will be solved in the next years and teacher should be ready to easy use wearables in their everyday practice.

We hope that the results of this study complement those of earlier studies. The most of them were based on suggestions and recommendations without significant practical findings. Robust and ubiquitous spread of mobile technologies and fast growth of wearables will lead to transition from handheld to hands-free approaches in learning and teaching in the nearest future. Further research could also be conducted to determine the effectiveness of the use wearable computers in outdoor and workplace learning. A future study needs to examine more closely the links between mature mobile learning projects and new pilots in learning with wearables.

References

Asgarian, R.: Arapahoe library invests in Google Glass. Libr. J. **139**(1), 16–18 (2014)

Benninger, B.: Google Glass, ultrasound and palpation: the anatomy teacher of the future? Clin. Anat. **28**(2), 152–155 (2015)

Bola, S., Brighton, G.: Can Google Glass be a surgical training tool? Br. J. Surg. **102**(5), 1–18 (2015)

Boykin, E.: Google Glass in the Class: Wearable Technology of the Educational Future (2014). https://dukedigitalinitiative.duke.edu/google-glass-in-the-class-wearable-technology-of-the-educational-future/. Accessed 25 July 2014

Bower, M., Sturman, D.: What are the educational affordances of wearable technologies*?*. Comput. Edu. **88**, 343–353 (2015)

Burke, M.: 5 ways Google Glass can be used in education (2014). http://www.emergingedtech.com/2013/04/5-ways-google-glass-can-be-used-in-education/. Accessed 25 July 2014

Ciomek, N., Zhu, H., Cordon-Cardo, C.: Diagnostic and educational uses of google glass in anatomic pathology. Lab. Invest. **95**(1), 395A–395A (2015)

Clark, D.: Google Glass: 7 amazing uses in learning (2013). http://donaldclarkplanb.blogspot.com/search?q=Google+Glass. Accessed 11 December 2013

Coffman, T., Klinger, M.: Google glass: using wearable technologies to enhance teaching and learning. In: Slykhuis, D., Marks, G., (eds.) Proceedings of Society for Information Technology & Teacher Education International Conference 2015, pp. 1777–1780. (2015)

Google: Google Glass explorer edition (2015). http://www.google.com/glass/start/. Accessed 11 July 2015

Hawkins, D.: Library services and Google Glass (2014). http://www.libconf.com/2014/04/09/library-services-google-glass/. Accessed 25 July 2014

Johnson, L., Adams Becker, S., Estrada, V., Freeman, A.: NMC Horizon Report: 2015 Higher Education Edition. Austin, Texas: The New Media Consortium (2015). http://cdn.nmc.org/media/2015-nmc-horizon-report-HE-EN.pdf. Accessed 19 July 2015

Kirkham, R., Greenhalgh, C.: Social access vs. privacy in wearable computing: a case study of autism. IEEE Pervasive Comput. **14**(1), 26–33 (2015)

Knight, H., Gajendragadkar, P., Bokhari, A.: Wearable technology: using Google Glass as a teaching tool. BMJ case reports (2015)

Llorente, R., Morant, M.: Wearable computers and big data: Interaction paradigms for knowledge building in higher education. In: Peris-Ortiz, M., Garrigós-Simón, F., Pechuán, I.G. (eds.) New Directions in Research, Practice and PolicyInnovation and Teaching Technologies, pp. 127–137. Springer, Switzerland (2014)

Mann, S.: Through the glass Lightly. IEEE Technol. Soc. Mag. **31**(3), 10–14 (2012)
Norman, D.: The paradox of wearable technologies. Technol. Rev. **116**(5), 101–103 (2013)
Nosta, J.: How Google Glass Is changing medical education (2013). http://www.forbes.com/sites/johnnosta/2013/06/27/google-glass-teach-me-medicine-how-glass-is-helping-change-medical-education/. Accessed 29 June 2013
Parslow, G.: Commentary: Google glass: a head-up display to facilitate teaching and learning. Biochem. Mol. Biol. Edu. **42**(1), 91–92 (2014)
Paterson, M., Glass, M.R.: The world through glass: developing novel methods with wearable computing for urban videographic research. J. Geogr. High. Edu. **39**(2), 275–287 (2015)
Patrick, A.: Google Glass available for faculty and student groups during spring Semester (2014). http://www.library.yale.edu/librarynews/2014/01/google_glass_available_for_fac.html. Accessed 25 July 2014
Pedersen, I.: Ready to wear (or not): examining the rhetorical impact of proposed wearable devices. In: Proceedings International Symposium on Technology and Society, pp. 201–202 (2013)
Ponce, B.A., Menendez, M.E., Oladeji, L.O., Fryberger, C.T., Dantuluri, P.K.: Emerging technology in surgical education: combining real-time augmented reality and wearable computing devices. Orthop. **37**(11), 751–757 (2014)
Russell, P., Mallin, M., Youngquist, S., et al.: First "Glass" education: telementored cardiac ultrasonography using Google Glass - a pilot study. Acad. Emerg. Med. **21**(11), 1297–1299 (2014)
Salamin, A.D.: Using Google Glass to enrich printed textbooks in a blended learning environment to meet digital natives' expectations. In: Bastiaens, T., (ed.) Proceedings of E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2014, pp. 1741–1748 (2014)
Silva, M., Freitas, D., Neto, E., Lins, C., Teichrieb, V., Teixeira, J.M.: Glassist: using augmented reality on Google Glass as an aid to classroom management. In: Proceedings - 2014 16th Symposium on Virtual and Augmented Reality, pp. 37–44 (2014)
Suarez, A., Ternier, S., Kalz, M., Specht, M.: GPIM: Google glassware for inquiry-based learning. In: Rensing, C., de Freitas, S., Ley, T., Muñoz-Merino, P.J. (eds.) EC-TEL 2014. LNCS, vol. 8719, pp. 530–533. Springer, Heidelberg (2014)
Thomas, J.: Library to lend Google Glass. the student life (2014). http://tsl.pomona.edu/articles/2014/2/14/news/4709-library-to-lend-google-glass. Accessed 13 July 2014
Thorp, E.O.: The invention of the first wearable computer. In: Proceedings of the 2nd IEEE International Symposium on Wearable Computers, pp. 4–8 (1998)
Tully, J., Dameff, C., Kaib, S., et al.: Recording medical students' encounters with standardized patients using Google Glass: providing end-of-life clinical education. Acad. Med. **90**(3), 314–316 (2015)
Vallurupalli, S., Paydak, H., Agarwal, S.K., Agrawal, M., Assad-Kottner, C.: Wearable technology to improve education and patient outcomes in a cardiology fellowship program - a feasibility study. Health Technol. **3**(4), 267–270 (2013)
Weppner, J., Hirth, M., Lukowicz, P., Kuhn, J.: Physics education with Google Glass gphysics experiment app. In: ACM International Joint Conference on Pervasive and Ubiquitous Computing, pp. 279–282 (2014)
Woodside, J.M.: Wearable technology acceptance model: Google Glass. In: Slykhuis, D., Marks, G., (eds.) Proceedings of Society for Information Technology & Teacher Education International Conference 2015, pp. 1800–1802 (2015)