

Reviewing the State of Ubiquitous Computing in Education

Elijah Nicpon

Georgia Institute of Technology School of Computer Science

CS 4605 - Mobile & Ubiquitous Computing

Dr. Clint Zeagler

12 July 2023

1. Introduction

More than a decade after Abowd published *What next, Ubicomp?* (2012), wherein he asserts that “Ubicomp is dead!”, I sat down in a class called Mobile & Ubiquitous Computing at the very school he published the paper. As ironic as that sounds, Abowd main his attention-grabbing assertion based on the premise set by Weiser’s infamous article, *The Computer for the 21st Century* (1991), specifically citing, “The most profound technologies are those that disappear...” This essay seeks to analyze that disappearance, specifically how improvements in technology have woven themselves into the very fabric of the educational domain.

2. The State of Ubicomp as it pertains to Education

Laru’s 2015 IEEE publication divides the development of educational use of ubiquitous computing into 4 stages: (i) Mobility and PDA(s), (ii) Wireless Internet Learning Devices, (iii) Introduction of Social Mobile Media, and (iv) a ubiquitous future. To gain a deeper understanding of the state of ubicomp in education, I have elected to examine two particular technologies. The first is a hardware solution, the smartboard, and the second is a software solution, the Learning Management System, or LMS.

2.1 Smartboards

My first experience with ubiquitous computing was in kindergarten (2007-2008). To this day, I vividly remember my class’s trip to the school’s library, where we each received an egg-shaped Promethean ActiVote to interact with the aptly-named Promethean ActivBoard. While I can’t remember what we were supposed to be learning that day, I remember the awe on my classmate’s faces as their responses populated columns on the board. In the year to follow, our elementary school



became a showroom for various Promethean products, and by the time I reached 1st grade, there was one in nearly every classroom in the district.

These products took over so quickly because they truly disappeared into the classroom walls, often mounting directly to pre-existing whiteboards so teachers wouldn't even need to re-arrange their classrooms. In countless studies, smart boards were found to increase engagement and retention in students from preschool to high school (Mun, 2016), (Davidovitch, 2017), (Zhang, 2018).

2.2 Learning Management Systems

It wasn't until I began dual enrollment at Georgia State University that I experienced my first *true* Learning Management System, (hereinafter referred to as "LMS"), through iCollege, a Desire2Learn Brightspace solution. Features like discussion forums and the integration of instant messaging increase engagement and allow for deeper understanding and clarity (Aljawarneh, 2019).

Meanwhile, my high school began to implement an LMS of its own, and it mostly consisted of teachers complaining that they were mandated to host at least one assignment on a system that they received little to no training on, and also took a disproportionately large amount of our county's budget. This reveals a critical necessity in the successful implementation of an LMS: properly training instructors (Cabral, 2012).

However, merely being onboarded onto my high school's LMS made a significant difference when the COVID-19 pandemic began. While the use of LMSs increased during quarantine, causing an increase in the availability of education in rural areas (Jamoral, 2023), many issues prevailed, as discussed in "Drawbacks."

One final point that cannot be overlooked is security. As the amount of sensitive information uploaded to LMSs continues to grow, the importance of creating and adhering to security standards increases as well (Aljawarneh, 2019).

3. Drawbacks

Unfortunately, such rapid advancement in technology isn't without its costs. As solutions are implemented hastily at nationwide scales, the environment often pays the cost. Gutterman's paper, *'Chromebook Churn' report highlights problems of short-lived laptops in schools (2023)*,

quantifies the amount of e-waste that has been created as the first round of laptops distributed by schools reach the end of their short lifespans, often below 4 years. While this particularly detrimental example was largely rushed and by proxy amplified by the COVID-19 pandemic, we must remain steadfast in putting the environment first by creating repairable and recyclable solutions that can be used for years to come.

Further, while LMSs have organized classrooms around the world, the pandemic reminded us that we aren't quite ready to replace in-person learning. A study in Lebanon found a "significant correlation between student satisfaction and prevalence of depression, anxiety, and stress" (Fawaz, 2020), and a study on social workers in California through the pandemic revealed extreme difficulties in connecting with and diagnosing students (Melero, 2021).

4. Reflection & The Future of Ubicomp in Education

One common theme I noticed during the process of writing this paper was the desire to increase student *engagement*. For the past few decades, technologies like TVs, projectors, and monitors have had an inherent advantage over analog solutions both in their ability to draw attention with lights and sounds, and simply by being a new, fascinating technology. However, while seeing the iPad cart (or for older generations, the TV cart) getting wheeled into an elementary school classroom may have been met with cheers 10 years ago, as more children are raised in closer proximity to these technologies, this novelty factor wears off, which calls for a new generation of constant research and development of engaging educational tools. In this sense, Ubicomp is not dead in the educational realm, and constantly developing new ways to educate future generations will be paramount in the advancement of the human race.

5. Conclusion

Ubiquitous computing has permanently transformed the way students learn and think. Products like the Promethean lineup and the rise of the LMS integrated so well into the classroom environment that Weiser's prediction came to fruition: they truly disappeared. While, as with most new technologies, there were significant growing pains along the way, ubiquitous computing has made education more engaging, accessible, and fun for students at all levels, and is most certainly here to stay.

References

- Abowd, G. D. (1999). Classroom 2000: An experiment with the instrumentation of a living educational environment. *IBM Systems Journal*, 4, 508–530.
<https://doi.org/10.1147/sj.384.0508>
- Abowd, Gregory D. (2012). What next, ubicomp? *Proceedings of the 2012 ACM Conference on Ubiquitous Computing*. <https://doi.org/10.1145/2370216.2370222>
- Aljawarneh, S. A. (2019). Reviewing and exploring innovative ubiquitous learning tools in higher education. *Journal of Computing in Higher Education*, 1, 57–73.
<https://doi.org/10.1007/s12528-019-09207-0>
- Cabral, P. (2012). LMS in higher education: analysis of the effect of a critical factor ‘faculty training.’ *World Academy of Science, Engineering and Technology*.
<https://repositorio.ul.pt/handle/10451/25027>
- Davidovitch, N., & Yavich, R. (2017). The Effect of Smart Boards on the Cognition and Motivation of Students. *Higher Education Studies*, 1, 60.
<https://doi.org/10.5539/hes.v7n1p60>
- Fawaz, M., & Samaha, A. (2020). E-learning: Depression, anxiety, and stress symptomatology among Lebanese university students during COVID-19 quarantine. *Nursing Forum*, 1, 52–57. <https://doi.org/10.1111/nuf.12521>
- Guterman, L. (2023, April 18). ‘Chromebook Churn’ report highlights problems of short-lived laptops in schools. US Public Interest Research Group - Education Fund.
<https://pirg.org/edfund/resources/chromebook-churn-report-highlights-problems-of-short-lived-laptops-in-schools/>
- Jamoral, R. (2023). Cyberspace Migration Learning Encounters of Filipino University Students in Rural Areas. *Ubiquitous Learning: An International Journal*, 1, 69–83.
<https://doi.org/10.18848/1835-9795/cgp/v16i01/69-83>
- Laru, J., Naykki, P., & Jarvela, S. (2015). Four Stages of Research on the Educational Use of Ubiquitous Computing. *IEEE Transactions on Learning Technologies*, 1, 69–82.
<https://doi.org/10.1109/tlt.2014.2360862>
- Marinagi, C., Skourlas, C., & Belsis, P. (2013). Employing Ubiquitous Computing Devices and Technologies in the Higher Education Classroom of the Future. *Procedia - Social and Behavioral Sciences*, 487–494. <https://doi.org/10.1016/j.sbspro.2013.02.081>

- Melero, H., Hernandez, M. Y., & Bagdasaryan, S. (2021). Field Note—Social Work Field Education in Quarantine: Administrative Lessons From the Field During a Worldwide Pandemic. *Journal of Social Work Education, sup1*, 162–167.
<https://doi.org/10.1080/10437797.2021.1929623>
- Mun, S. H., & Abdullah, A. H. (2016). A review of the use of smart boards in education. *2016 IEEE 8th International Conference on Engineering Education (ICEED)*.
<https://doi.org/10.1109/iceed.2016.7856056>
- Virtanen, M. A., Haavisto, E., Liikanen, E., & Kääriäinen, M. (2017). Ubiquitous learning environments in higher education: A scoping literature review. *Education and Information Technologies, 2*, 985–998. <https://doi.org/10.1007/s10639-017-9646-6>
- Weiser, M. (1991). The Computer for the 21st Century. *Scientific American, 3*, 94–104.
<https://doi.org/10.1038/scientificamerican0991-94>
- Zhang, Y. (2018). Investigating K-12 teachers' use of electronic board in the classroom in the Central South of United States. *Education and Information Technologies, 1*, 825–841.
<https://doi.org/10.1007/s10639-018-9800-9>