Collaboration-Based Learning Environments using Augmented Reality

by

Sebastian Gil Parga

Submitted to the Department of Creative Technologies
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY IN CREATIVE TECHNOLOGIES

at the

AUCKLAND UNIVERSITY OF TECHNOLOGY

November 2025

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ABSTRACT

The developments of the "kinetic theory" of gases made within the last ten years have enabled it to account satisfactorily for many of the laws of gases. The mathematical deductions of Clausius, Maxwell and others, based upon the hypothesis of a gas composed of molecules acting upon each other at impact like perfectly elastic spheres, have furnished expressions for the laws of its elasticity, viscosity, conductivity for heat, diffusive power and other properties. For some of these laws we have experimental data of value in testing the validity of these deductions and assumptions. Next to the elasticity, perhaps the phenomena of the viscosity of gases are best adapted to investigation.[1]

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[1]Text from Holman (1876): doi:10.2307/25138434.

Acknowledgments

Write your acknowledgments here.

Biographical Sketch

Silas Whitcomb Holman was born in Harvard, Massachusetts on January 20, 1856. He received his S.B. degree in Physics from MIT in 1876, and then joined the MIT Department of Physics as an Assistant. He became Instructor in Physics in 1880, Assistant Professor in 1882, Associate Professor in 1885, and Full Professor in 1893. Throughout this period, he struggled with increasingly severe rheumatoid arthritis. At length, he was defeated, becoming Professor Emeritus in 1897 and dying on April 1, 1900.

Holman's light burned brilliantly before his tragic and untimely death. He published extensively in thermal physics, and authored textbooks on precision measurement, fundamental mechanics, and other subjects. He established the original Heat Measurements Laboratory. Holman was a much admired teacher among both his students and his colleagues. The reports of his department and of the Institute itself refer to him frequently in the 1880's and 1890's, in tones that gradually shift from the greatest respect to the deepest sympathy.

Holman was a student of Professor Edward C. Pickering, then head of the Physics department. Holman himself became second in command of Physics, under Professor Charles R. Cross, some years later. Among Holman's students, several went on to distinguish themselves, including: the astronomer George E. Hale ('90) who organized the Yerkes and Mt. Wilson observatories and who designed the 200 inch telescope on Mt. Palomar; Charles G. Abbot ('94), also an astrophysicist and later Secretary of the Smithsonian Institution; and George K. Burgess ('96), later Director of the Bureau of Standards.

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VR Virtual Reality

AR Augmented Reality

TEL Technology Enhanced Learning

Chapter 1

Introduction

In the Netflix animated series Cyberpunk: Edgerunners (Imaishi et al., 2022), the main character attends courses at a prestigious academy that uses advanced technology to boost education and performance. The students gather in a room with Virtual Reality Virtual Reality (VR) headsets and connect to the lesson, which is taught by a holographic (and probably powered by artificial intelligence) tutor. The episode does not show the lesson itself (the entire system fails catastrophically when attacked by malware), but the brief scene highlights the vision many people have of a futuristic classroom, one guided by advanced technology and automatization.

Forsler et al. (2024) propose the term "post-digital classroom" to identify the characteristics and trends in education present in a world beyond the adoption of digital technologies. The purpose of this classroom is not anymore to introduce new technologies to students, but to implement them as an essential factor of the learning process. The post-digital classroom is interconnected, social and global. In this scenario, learning goes beyond the physical classroom because it is based on creating relationships between concepts and developing valuable skills rather than acquiring knowledge. It is also a classroom where information is detached from the physical learning institute, and access to facts and sources is, ideally, immediate, ubiquitous and democratic.

The classroom has also become hybrid. There is little distinction between network-based lessons and the face-to-face spaces associated with schools and universities (Goodyear et al., 2004). Hybrid and blended approaches blur the distinctions between learning in an online setting and learning in a classroom. In both instances, information is at hand in the network, students can easily connect to peers and mentors, distance and time constrains are less meaningful and knowledge is presented in a multimedia format that needs a technological backbone to be created and shared (Rivoltella, 2008; Shank, 2005).

This thesis explores the use of technology in such post-digital classrooms, specifically, Augmented Reality Augmented Reality (AR) within the context of mobile computing. Moreover, this research will analyse the creation of effective learning spaces, those places where students can build, personalise and control all the activities they engage with (Gourlay & Oliver, 2016). Learning spaces are interesting tools at the disposal of students because these are spaces that can exist outside the norm of a typical classroom, they are more fluid, less structured and can easily connect to other similar spaces (Nørgård & Hilli, 2022). The proposal of this research is that AR can be used to boost the way students build and interact with their own learning

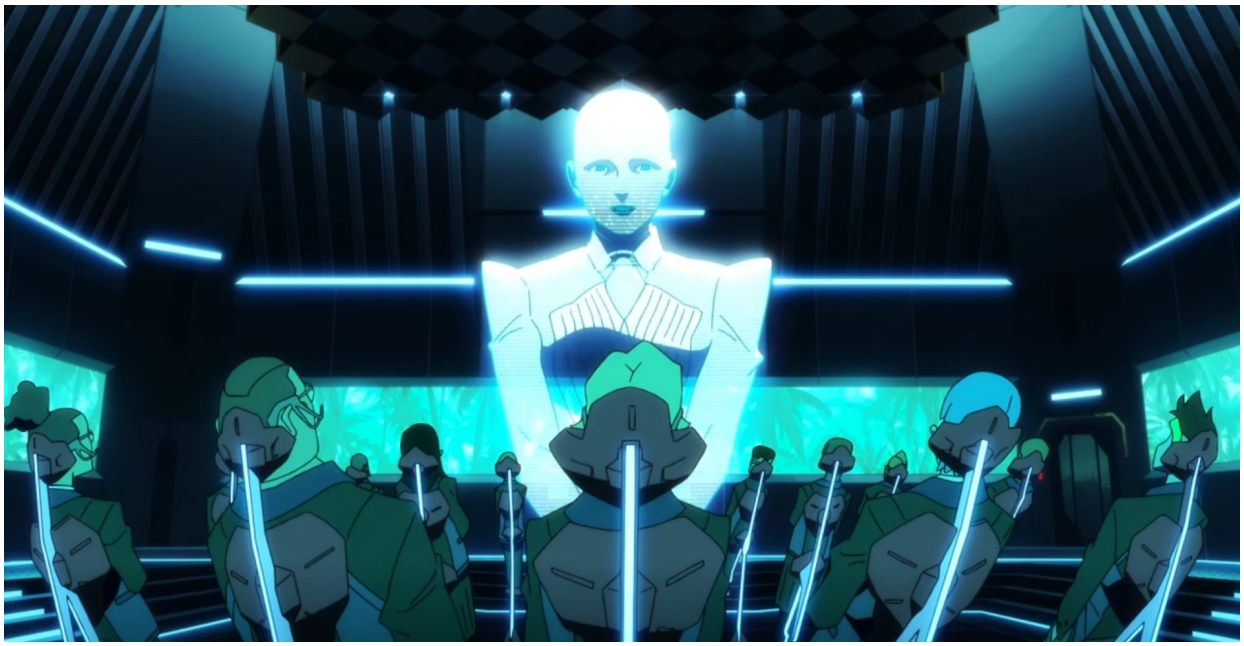

Figure 1.1: Virtual Classroom in Cyberpunk: Edgerunners

spaces and can also offer educators another option to be integrated in the construction of a lesson that capitalises the characteristics of the aforementioned post-digital classrooms.

Within the field of Technology Enhanced Learning Technology Enhanced Learning (TEL), AR and related technologies were chosen as a focus of interest because of their intrinsic relationship with space. The initial example scene of Cyberpunk: Edgerunners serves to illustrate the collective idea of what could be achieved in the future with technologies like VR and AR: the possibility of creating an entire new space, suited for the needs of the classroom or the students. It is a space that is shared, in which information and interactions flow between users and that can be controlled at will by students and teachers. In reality, the technology is not quite there yet, especially in terms of fidelity and immersion (Checa & Bustillo, 2020; Hamad & Jia, 2022). What can be explored right now is the creation of interesting synthetic environments that facilitate or allow experiences that are not possible in the common classroom. This process is limited more by the creativity and expertise of the developer rather than by the technology, and therefore can be explored easier and in more detail.

AR, compared to VR, has a more direct relationship with the *real*, physical space and with the context of the user. Instead of an isolated immersion, AR creates a connection with the environment based on image detection, data and visualizations. This natural expression of the technology is where the value of AR can be explored in relation to the creation of innovative learning spaces. The technology not only has interesting capabilities for visualization and interaction, it also allows an easier implementation of shared, social components that can be used to build activities based on cooperative simulations, sharing knowledge and the creation of communities, all crucial elements for the construction of effective learning spaces (Bligh & Crook, 2017).

The research is positioned then in the conjunction of these three fields: Learning spaces,

TEL and AR. The guiding goal is to understand how students are using technology to learn, and how AR can be used to boost that process. AR shines at creating immersive experiences that can be shared with others and that consider the physical context of the user. I want to use this collaborative space as an educational tool that takes advantage of the inherent social aspects of learning, building and sharing knowledge.

1.1 Context

1.2 Research Structure

1.2.1 Research Questions

1.2.2 Scope and Limitations

1.3 Significance and Contributions

1.4 Document Structure

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