

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

© 2025 Sebastian Gil Parga. This work is licensed under a [CC BY-NC-ND 4.0](#) license.

Authored by: Sebastian Gil Parga
School of Future Environments, Department of Creative Technologies
November 30, 2025

Certified by: Stefan Marks
Associate Professor, Thesis Supervisor

Certified by: Jairo Gutierrez
Professor, Thesis Supervisor

Collaboration-Based Learning Environments using Augmented Reality

by

Sebastian Gil Parga

Submitted to the Department of Creative Technologies
on November 30, 2025 in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY IN CREATIVE TECHNOLOGIES

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

Thesis supervisor: Stefan Marks

Title: Associate Professor

Thesis supervisor: Jairo Gutierrez

Title: Professor

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

Contents

<i>List of Figures</i>	6
<i>List of Tables</i>	7
1 Introduction	8
1.1 Context	8
1.2 Research Structure	8
1.2.1 Research Questions	8
1.2.2 Scope and Limitations	8
1.3 Significance and Contributions	8
1.4 Document Structure	8
References	10

List of Figures

1.1 Virtual Classroom in Cyberpunk: Edgerunners	9
-----------------------------------------------------------	---

List of Tables

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 (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.

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



Figure 1.1: Virtual Classroom in Cyberpunk: Edgerunners

References

- Forsler, I., Bardone, E., & Forsman, M. (2024). The Future Postdigital Classroom. *Postdigital Science and Education*. <https://doi.org/10.1007/s42438-024-00488-y>
- Imaishi, H. (, Kaneko, Y. (, Pondsmith, M. (, Sztybor, B. (, & Ôtsuka, M. ((2022, September). Cyberpunk: Edgerunners (episode 1).