PhD Thesis – Abstract
Exploring Mixed Reality in Distributed Collaborative Learning Environments

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- **Date**: 15th January 2016
- **Location**: School of Computer Science, The University of Essex, UK.
- **Outcome**: Pass (UK PhDs have just two outcomes; Pass or Fail)

**Abstract**

Society is moving rapidly towards a world, where technology enables people to exist in a blend of physical and virtual realities. In education, this vision involves technologies ranging from smart classrooms to e-learning, creating greater opportunities for distance learners, bringing the potential to change the fundamental nature of universities. However, to date, most online educational platforms have focused on conveying information rather than supporting collaborative physical activities which are common in university science and engineering laboratories. Moreover, even when online laboratory support is considered, such systems tend to be confined to the use of simulations or pre-recorded videos. The lack of support for online collaborative physical laboratory activities, is a serious shortcoming for distance learners and a significant challenge to educators and researchers.

In working towards a solution to this challenge, this thesis presents an innovative mixed-reality framework (computational model, conceptual architecture and proof-of-concept implementation) that enables geographically dispersed learners to perform co-creative teamwork using a computer-based prototype comprising hardware and software components.

Contributions from this work include a novel distributed computational model for synchronising physical objects and their 3D virtual representations, expanding the dual-reality paradigm from single linked pairs to complex groupings, addressing the challenge of interconnecting geographically dispersed environments; and the creation of a computational paradigm that blends a model of distributed learning objects with a constructionist pedagogical model, to produce a solution for distributed mixed-reality laboratories.

By way of evidence to support the research finding, this thesis reports on evaluations performed with students from eight different universities in six countries, namely China, Malaysia, Mexico, UAE, USA and UK; providing an important insight to the role of social interactions in distance learning, and demonstrating that the inclusion of a physical component made a positive difference to students’ learning experience, supporting the use of cross-reality objects in educational activities.