Collaborative Virtual Worlds for Enhanced Collective Scientific Understanding

Research & Development Team:

Michael J. Jacobson, Charlotte Taylor, Anne Newstead (Sydney University),
Deborah Richards, Meredith Taylor, John Porte (Macquarie University)

This project is funded by the Australian Research Council Discovery program #DP1093170.

THE UNIVERSITY OF SYDNEY

Outline

- The broader context
  - A family resemblance of theories, frameworks, and paradigms
  - Features of complex systems applicable to learning in classrooms
- Introducing our virtual world and virtual learning environment
- The V-Worlds Classroom
- Our learning activities in the 2011 study
- Qualitative data emerging from the study at LHS 2011
- The future of learning in virtual worlds
  - Globally networked virtual classrooms
  - Massive scientific collaboration inside virtual worlds (SL)
  - Agent-based modelling and computational social science

Broader context:
A family resemblance among frameworks

The primary unit of analysis is something larger than the individual:

- In cognitive science, *distributed cognition* emphasizes that cognition happens across individuals throughout parts of a system (Hutchins).
- In *philosophy of mind*, the *theory of the extended mind* suggests that the mind may spread over the artifacts and tools that it uses to think (Clark).
- *Situated cognition* emphasizes that learning and cognition are bound to particular situations, real-life contexts, communities of practice (Lave & Wenger).
- In *educational psychology*, Vygotskian theories of learning emphasize the sociocultural basis of learning and the role of knowledgeable others in supporting learning.
- In *learning technologies*, the field of CSCL emerged out of the need to move beyond studying individual learning and to focus on group learning and interactions.

Hutchin's Cockpit Example

Cockpit Example

- "A cockpit provides an opportunity to study the interactions of internal and external representational structure and the distribution of cognitive activity among the members of the crew. Through an analysis of audio and video recordings of the behaviors of real airline flight crews performing in a high fidelity flight simulator we demonstrate that the
- expertise in this system resides not only in the knowledge and skills of the human actors, but in the organization of the tools in the work environment as well. The analysis reveals a pattern of cooperation and coordination of actions among the crew which on one level can be seen as a structure for propagating and processing information and on another level appears as **a system of activity in which shared cognition emerges as a system level property**.*" (Hutchins 1995; Hutchins & Klausen 2000)*

Classrooms as complex systems

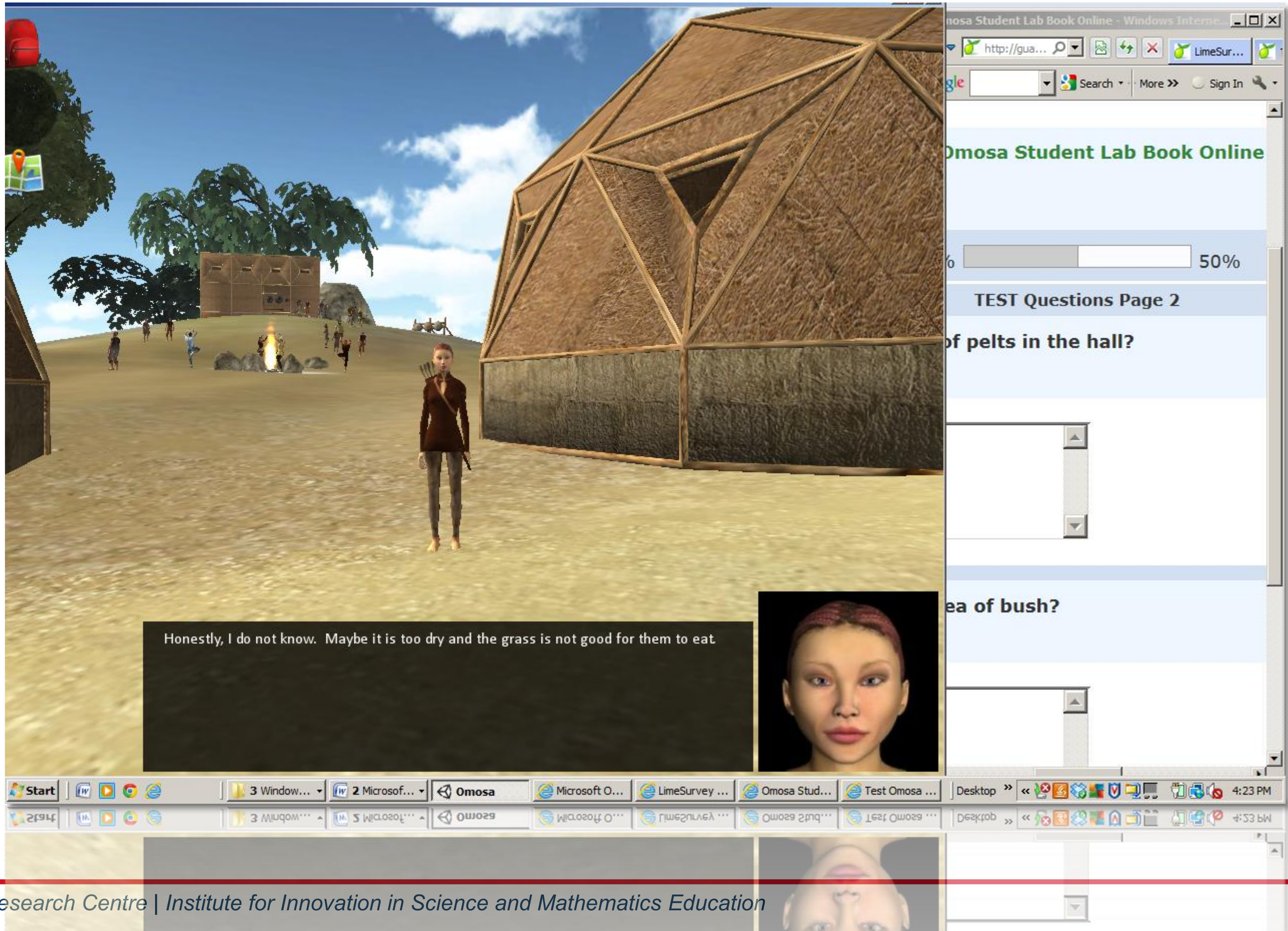
- Clancey (2008) lists five features of complex systems:
  1. emergence
  2. feedback loops
  3. open, observer-defined boundaries
  4. complex systems have history
  5. compositional networks
- Classrooms as sites of learning have many of these features! (Jacobson & Kapur 2012).

  Example: The culture of a classroom emerges from interaction of students, teachers, resources. Students respond to positive teacher feedback by learning more (amplification).The classroom need not have physical boundaries (e.g. globally networked classrooms in collaborative or virtual worlds). The classroom has a history, and is itself part of a network of classrooms (e.g., a school, a school district).

Our project

- The task was to design a virtual learning environment to support students learning scientific inquiry.
- The design involved three elements:
  - virtual world (3D)
  - student guidebooks as a overlay
  - NetLogo simulation (2D and interactive)
- The pedagogy had to be in keeping with:
  - Community of practice
    - Participation in a community of scientific inquiry
    - Learn science by virtually doing science
  - Productive failure and problem-based learning (research component)
    - Students engage in complex problems using the VWorld as an instructional anchor
    - Learning sequences of initial failure in challenge problems followed by scaffolding for successful problem solving

Omosa Virtual World:
The Virtual Learning Environment

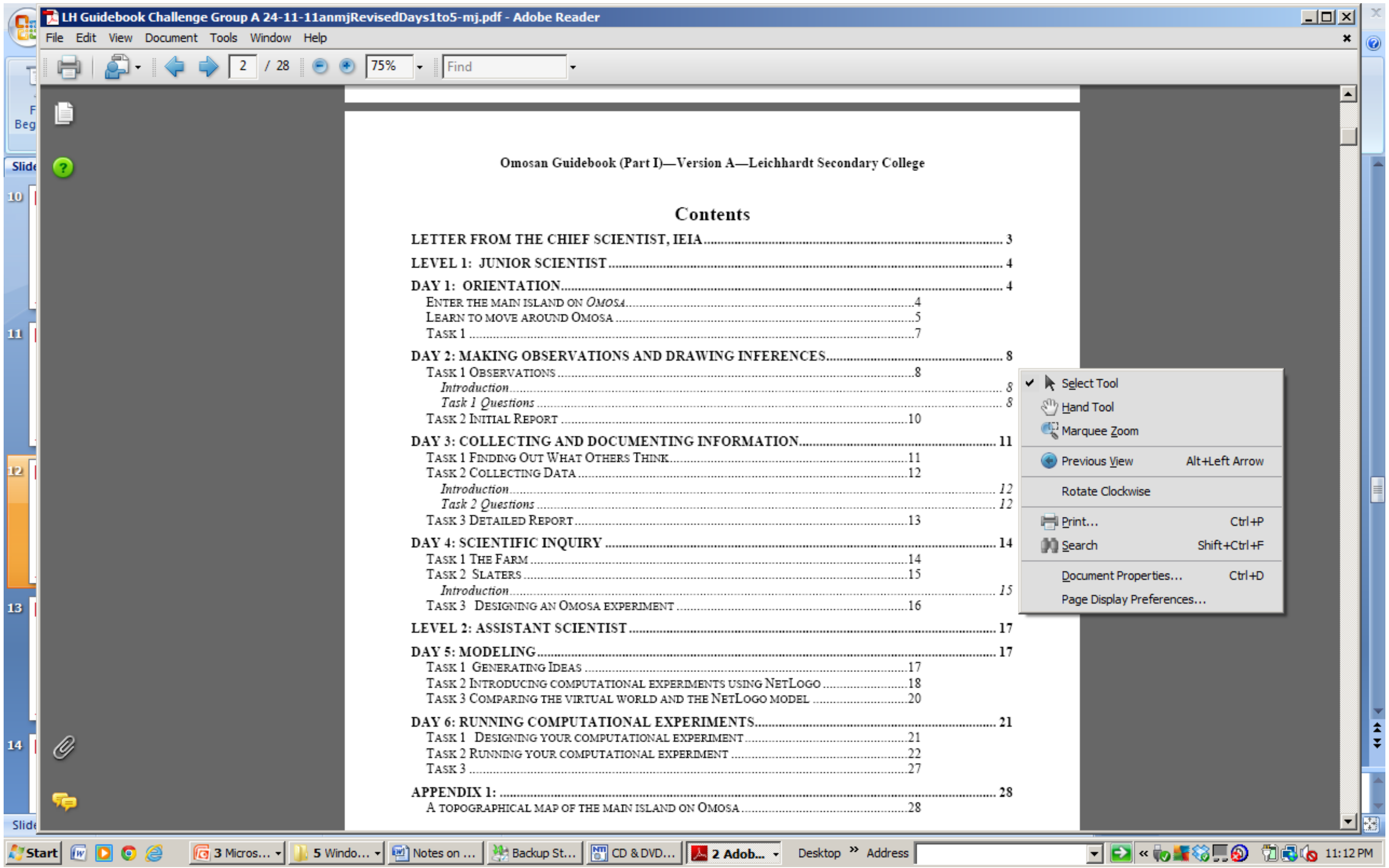


* Demonstration (live demo all going well)

*Clip also from Meredith Taylor (research programmer, Macquarie University)
http://comp.mq.edu.au/~richards/aamas12Omosa/

The first study

- Design-based research: study learning in its natural context, the classroom with iterative design revisions over time.
- Quasi-experimental design to explore "Productive failure" (Kapur 2008; Jacobson et. al. (in press)).
- Students randomly assigned to treatment groups:
  - **Challenge and guided learning**: Low task structure initially, followed by high task structure.
  - **Guided learning**: High task structure
- Students used different versions of a "guidebook" that provided the learning tasks for the virtual world
- Learning tasks were identical for the two treatment groups, just varied in the structure that was provided

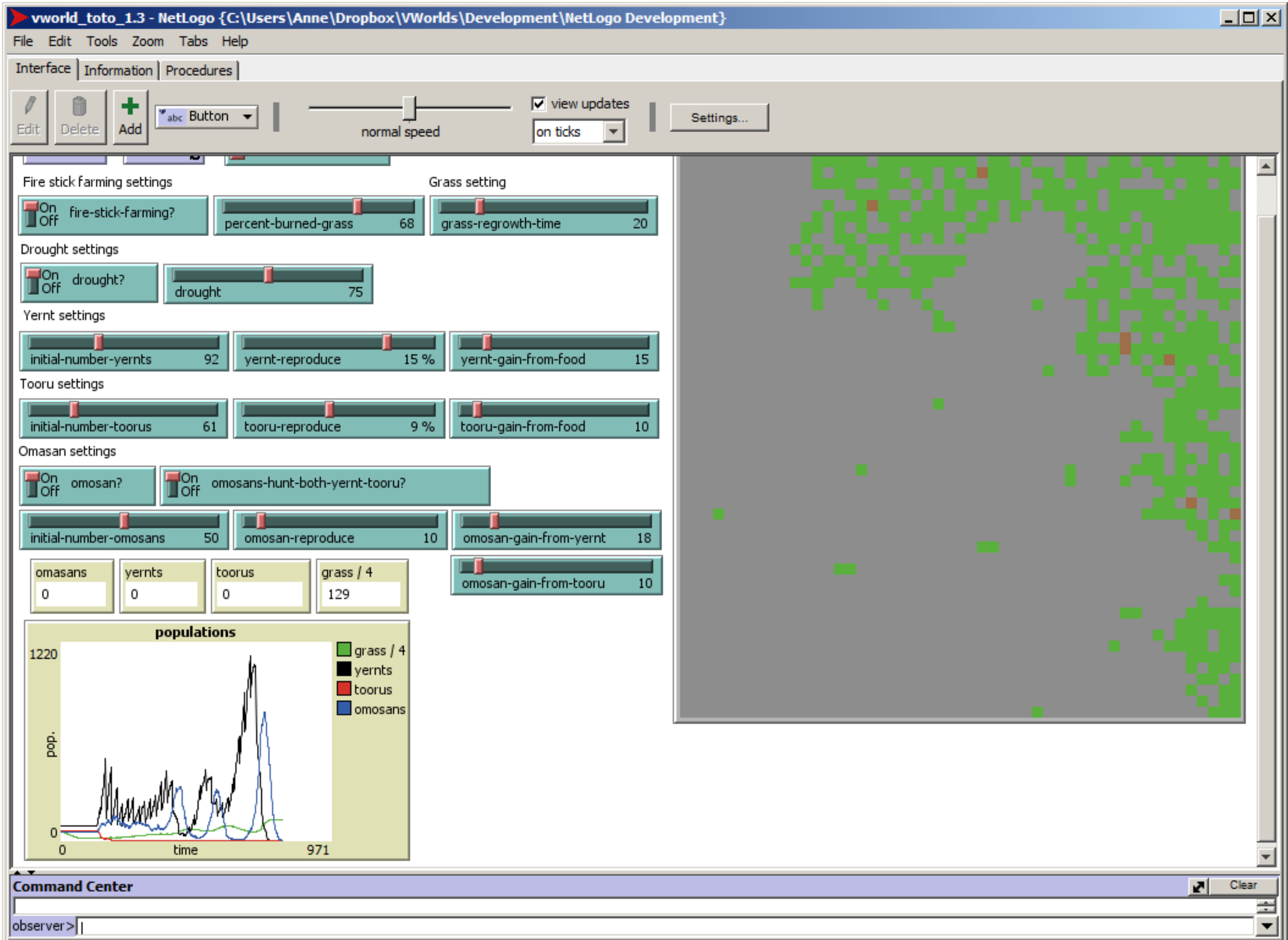


Omosan Guidebook (Part I)—Version A—Leichhardt Secondary College

Contents

The V-Worlds Classroom

Netlogo Simulation of Omosa



Scaffolding for Computational Experiments

Experiment #1 Yernt Conditions Under Fire-stick Farming

Run	Total time elapsed after run completed (months)	Population settings	Independent variables (Switches)	Readings of dependent variable (high, medium, low)	Dependent variable (average outcome)
#1	620 months	Grass: burn 30%, regrowth 60% Yernt: rep 10%, 10% gain Tooru: 2% rep, 15% gain	ALL switches off (FIRE-STICK FARMING OFF)	Time / Reading 95 / 467 (h) 55 / 280 (m) 3 / 106 (l)	= (467+280+106)/3 = 284
#2	620 months		(FIRE-STICK FARMING ON) 10%	Time / Reading 265 / 287 (h) 141 / 186 (m) 87 / 89 (l)	(287+186+89)/3 = Av=187
#3	620 months		30%	Time / Reading 424 / 233 (h) 303 / 161 (m) 107 / 71 (l)	= (233+161+71)/3 = Av = ~~278~~ 155
#4	620 months		40%	Time / Reading 401 / 197 (h) 245 / 137 (m) 153 / 40 (l)	= (197+137+40)/3 = Av = 125
#5	395 ~~620~~ months		80%	Time / Reading 129 / 103 (h) 140 / 58 (m) 395 / 0 (l) (died)	= (103+58)/2 = Av = 80.5

Teamwork in the V-Worlds Classroom

Qualitative Data

- Suvey responses and interviews
- Students said they learned about scientific design and ecosystems.
  - “I learnt about hypothesis and testing it out using different programs.” (Survey, LHS, post-test, 12.12.11)
  - “I learned more about how ecosystems work.” (Survey, LHS, post-test, 12.12.11)
- Some students preferred Netlogo simulation to Omosa Virtual World, because more interactive.
  - “You learnt more from Netlogo but Omosa World was more enjoyable” (Student interview, LHS 15.12.11)
  - “I learnt that you can do different things to solve problems. For example, modelling on NetLogo.” (Survey, LHS, post-test, 12.12.11)

Student Attitudes

- Many students enjoyed the virtual world:
  - “It was a different experience and it was nice to be able to explore as i pleased”
  - “The Omosa world was fun because it wasn't like every other experiment done at school so it lets us do things we normally don’t. Such as run around and communicate through a virtual world”

Attitudes towards teamwork: Intellectually enriching

"Its easier to complete work and you hear ideas and thoughts that would have never crossed your mind"
(Girl, selective class, post-test survey)

"I did like working in teams because different people's ideas can form into **one solid but quality idea."**
(Girl, selective class, post-test survey)

"It is helpful to have other peoples' ideas not just your own."
(Girl, selective class, post-test survey)

But

"I did not like working in teams because I prefer to work by myself"
(Girl, comprehensive class, post-test survey)

Attitudes towards teamwork: Drawbacks

"I did not like working in teams because I prefer to work by myself"

(Girl, comprehensive class, post-test survey).

"Teamwork is good. It allows leaders to stand up, bludgers to budge and the responsibility to fall on many."

(Boy, selective class, pretest survey)

"Working in groups can be fun but sometimes I feel as if I am left to do all the work. This annoys me and makes me grrrrrr..."

(Boy, selective class, pretest survey)

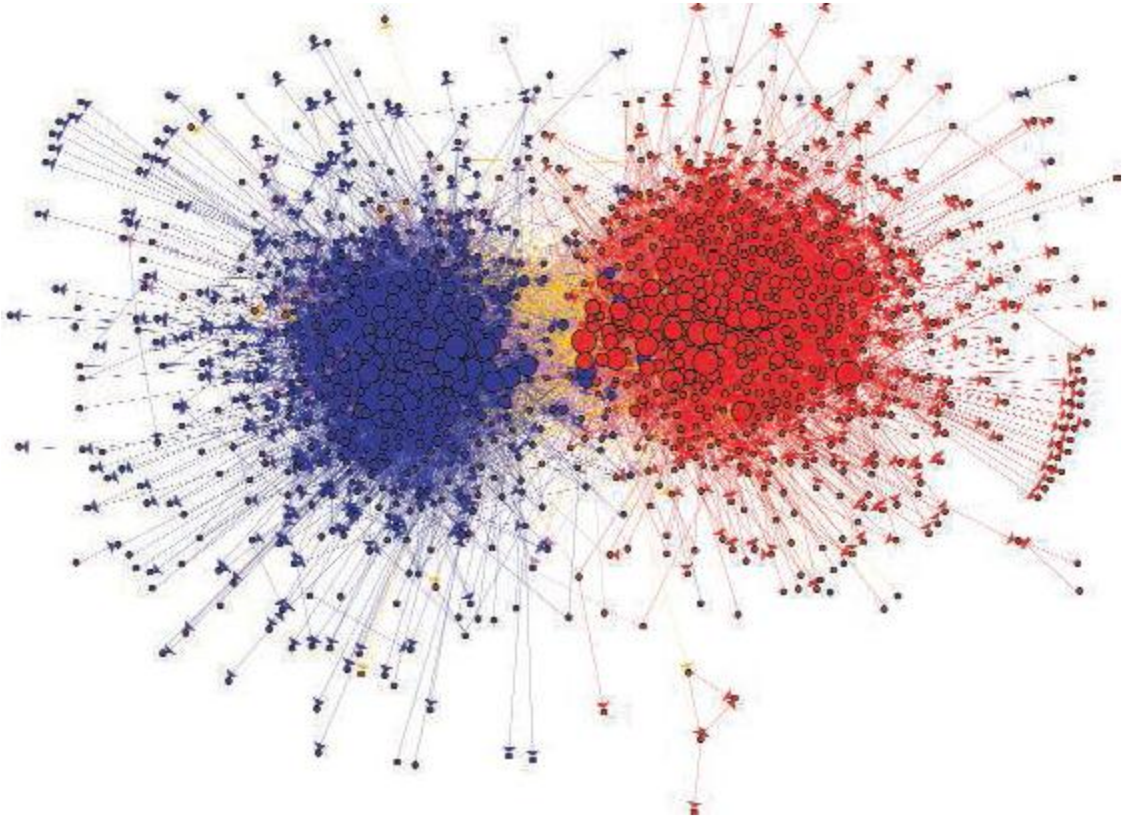
A possible future of learning in virtual worlds: Globally distributed cognition

- Long term goal: Articulate a framework for a “learning ecology” by making the virtual world and learning materials available to affiliate schools.
  - Teachers will be able to customize the learning activities
  - Hope a community of practice develops over time as teachers interact with each other and share resources and experiences
- Our first affiliate school is in Singapore!
- Baby steps toward globally distributed cognition mediated by collaborative and virtual interactions

The future of learning in virtual worlds: Scientific collaboration inside virtual worlds

Screenshot of astrophysicists meeting in Second Life from Djorgovski et. al (2009)—massive scientific collaboration around the world happening inside virtual environments such as SL and others.

ABMS and Computational Social Science



THE UNIVERSITY OF SYDNEY

Conclusion

- Virtual worlds are suitable for supporting scientific inquiry learning and research.
- Our experimental design enabled us to vary the amount and sequencing of scaffolding in the learning activities while offering all students a virtual experience.
- Our learning activities encouraged students to function like scientists and to think scientifically: to join a community of practice.
- The students in the classroom were not exactly a “group mind”, but could be conceived of parts of a complex system—the V-World Classroom-- with emergent properties.
- The students sometimes conceived of themselves as individuals, sometimes as team-members, sometimes as class members. A good framework can work across all these levels, perhaps without suggesting that one particular level is the “correct” one.
- Questions welcome!