Improving online training through personalised learning experiences

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Drawing by Paul Rumsey
(www.paulrumsey.co.uk/)

About Me

- Professor of Computer Science at Essex University, Director of Creative Science Foundation
- Worked in avionics (aircraft electronics) before joining university system
- Specialist in robotics and artificial intelligence (founded Robotics at Essex in late 80's, Intelligent Environments in late 90's)
- Current research focused on Mixed-Reality, Intelligent Environments and Immersive Education
- Part of organizational team for numerous conferences, workshops, journals (eg founded Intelligent Environment series – www.intenv.org)

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•Parkland of 200 acres
•Royal Charter in 1965
•12,240 students
•27% post graduates
***•40% overseas** (130 countries)*
•Ranked 9th in UK for research
•Ranked 2nd for student satisfaction

Overview of Talk

- Overview of 3 research projects that advance online training capabilities.
  - ACSeS (Adaptive Course Sequencing System) – no video
  - PVM (Pedagogical Virtual Machine) – video
  - BReaL (Blended Reality Lab) – video [UPDATE]

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ACSeS (Adaptive Course Sequencing System)

Acknowledgement:
Special thanks to **Abdulkareem Alzahrani** for his excellent PhD work that this presentation is based on.

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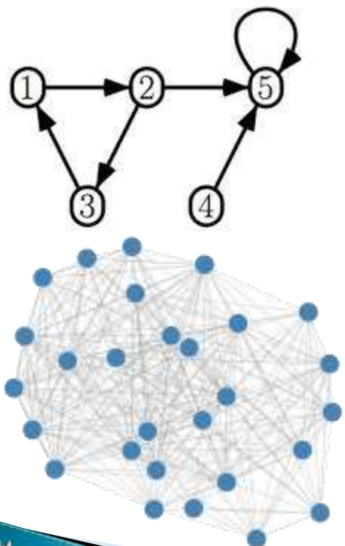
Starting Point

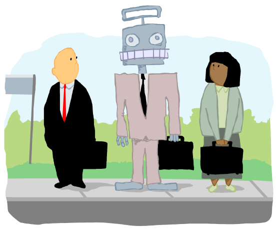


- The sequence students follows learning objects can effect their learning experience and outcomes.
- Most current methods rely on the course designer providing a domain model and rules to guide the student through the learning objects.
- However, this method can be time consuming for course designers and not as adaptive as it might be for individual students.
- We set out to explore if we could improve on current methods .

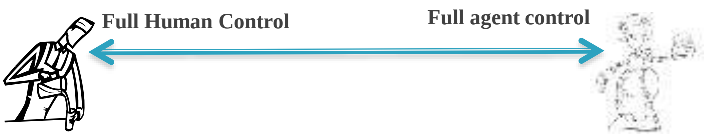
ACSeS Aims

- To enhance online learning by providing students with intelligent tutoring systems that guided a student in a way that more closely resembled real teachers.
- In particular, to explore whether **adjustable autonomy** ideas (from intelligent environments) could enable a more personalised delivery of learning object sequences to the students.

What is autonomy?

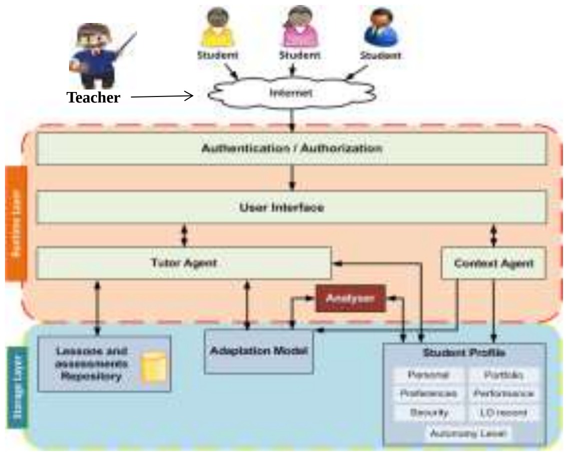


- "*independence*", "*self-government*" etc
- In artificial Intelligence its all about who creates the rules (machines, or people); and rules are what give rise to intelligent behaviour
- We had a project where we had a control to vary how smart a smart home was!
- The Autonomy (Intelligence) continuum



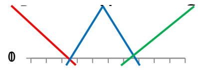
- Wondered if we could apply this to intelligent tutors (based on rationale that learners may benefit from having different levels of help)
- .

ACeSS Architectural Model



ACeSS uses fuzzy rule to build an adaptive and dynamic sequence by:

- Assessing the students pre-knowledge.
- Allowing the student to choose the learning objects (s)he prefers to learn (with or without guidance).
- Collecting student behaviour to enrich the adaption rules.



4.6/**1.4** 6/**1.8**

Autonomy Levels (from agents perspective)

Full autonomy interface

The agent takes full responsibility for guiding student between learning objects.

If the learning unit01 mark is good AND the learning unit02 mark is poor AND learning unit03 mark is poor..... THEN Study learning unit02.

Partial autonomy interface

The agent recommends a learning object but the student can chose it, or any other learning object. The system records and learns from the students choices

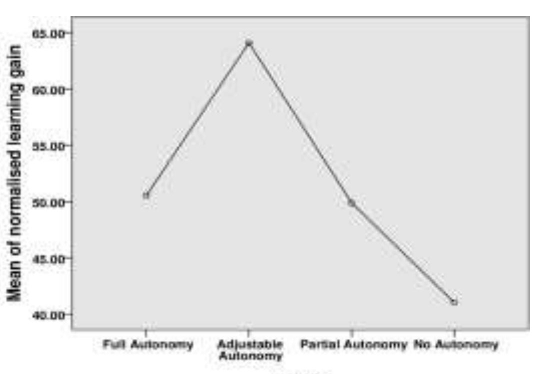
No autonomy interface

The student choses the learning sequence The agent makes no recommendations but learns from the students choices.

Rules – The teacher can access the adaption engine and create new rules, edit the existing rules or re-weight them.

1st Evaluation (teacher generated rules)

Used existing Microsoft Excel online training course, of 12 learning objects, operated by King Abdulaziz University.

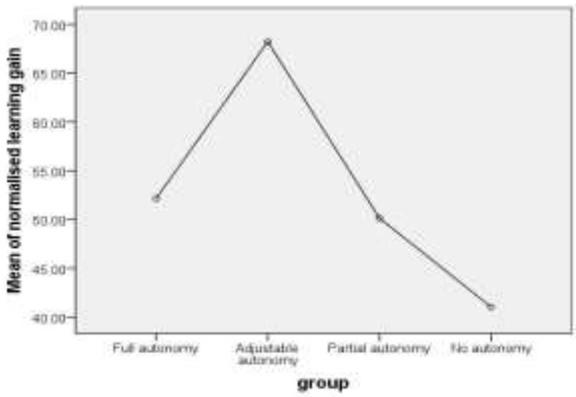


- 1320 students randomly divided into four groups of 330 students each.
- Teachers created 93 rules
- Tests showed no statistical advantage to any group (but enough variance between students to ensure differing pathways)

3^12= 531441

2nd Evaluation (student generated rules)

Used existing Microsoft Excel online training course, of 12 learning objects, operated by King Abdulaziz University.



- 234 students divided in 4 groups.
- Machine learning generated some 1614 rules (extracted from both experiments).
- The main advantage is no teacher time is required to create the rules.

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$3^{12} = 531441$

PVM (Pedagogical Virtual Machine)

Acknowledgement:
Special thanks to **Malek Alrashidi** for his excellent PhD work that this presentation is based on.

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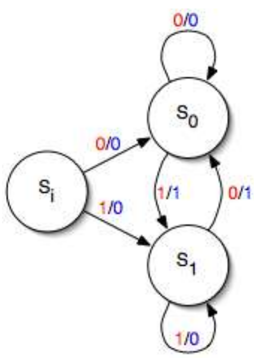
Starting Point

- When conducting lab based computer engineering learning, much of the important system functionality is hidden making learning more difficult.
- The same is true of pedagogical processes.
- Can augmented-reality be used to reveal these hidden processes in a way that improves learning?

PVM Aims

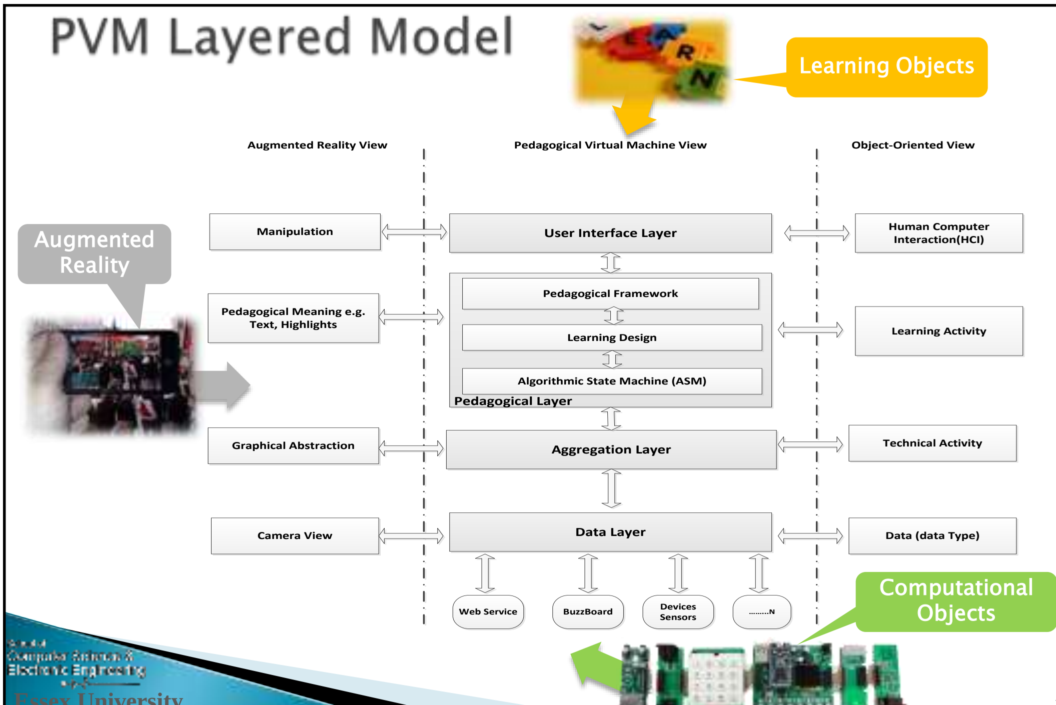
- To embed pedagogical processes into the technology being learnt, so to reveal the hidden computational and learning processes to the student & teachers.
- In particular, to harness concepts of **objectifying** & **virtualisation** as a means to unify pedagogical and computational thinking to improve learning and teaching.

Some Unifying Principles of PVM



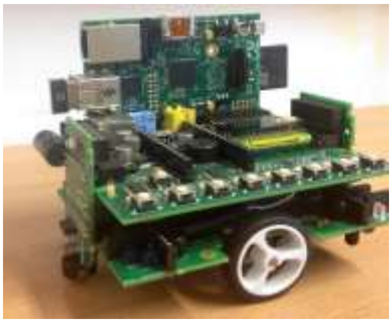
- Users a classic layered model (like 7 layer network model)
- Regards bottom layer as <u>computational objects</u>
- Regards top layer as <u>learning objects</u>
- Uses <u>virtual machine</u> principles to expose hidden pedagogy mechanisms
- Uses <u>virtual reality</u> to expose hidden computational mechanisms
- Uses Algorithmic State Machine (ASM) as formalism for representing relationships between objects (learning deign & computational design)

PVM Layered Model



Example

- Set students an exercise to design a Behaviour Based Robot that finds and follows an edge (a wall)
- Teacher might decomposes into small learning objects, such as:
  - Get robot to move
  - Get robot to detect an obstacle
  - Get robot to move tangential to object
- Pedagogical information & progress analysed and presented from PVM via AR Pad
- Students can use any development tool
- Easier to appreciate via video



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BReaL (blended reality lab)

- Update -

Acknowledgement:
Special thanks to **Anasol Pena Rios** for her excellent PhD work that this presentation is based on.

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SF-Prototyping Inspiration

SFP's are short stories that inspire future products

"iPods were effectively small cocoons; something like a comfortable armchair enclosed within a sound-proof egg-like structure packed with sophisticated but largely invisible technology that included immersive mixed reality and sophisticated AI. When participating in a movie (the industry had long dropped the word "watching" which describing these new immersive movies) the immersive reality technology aimed to make the participant feel as though they were truly part of a fictional physical world."

See www.creative-science.org

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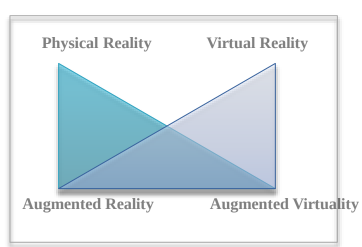
Starting Point

- Currently, its difficult to offer students science & engineering lab work online.
- Current laboratory options for online learners include:

Virtual Environments

- Simulations / Virtual laboratories
- Remote labs / Virtual presence
- Physical labs

Real Environments



Milgrams Reality Continuum

- Are there better ways of mixing or blending the virtual & physical together?

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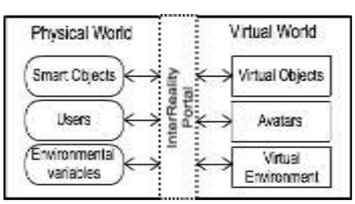
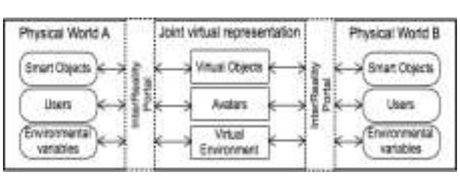
BReaL Aims

- To enhance online learning by providing Computer Engineering students with a lab experience that more closely mirrors that of a regular university campus.
- In particular, to use blended or mixed-reality to enable online students:
  - to build systems comprising both software and **hardware** components
  - to work cooperatively in groups on constructionist activities, independently of geographical location)
  - to build systems from local components that run globally.

Blended-Reality Space



Local

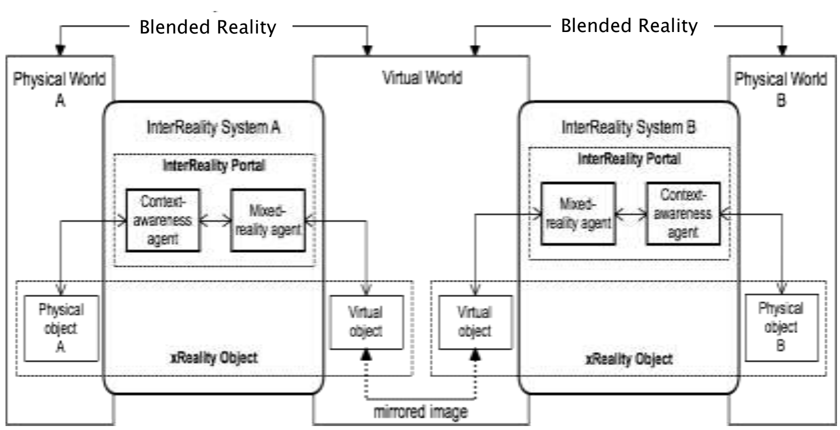


Extended

- Components of a **blended-reality** space are:
  - The physical world;
  - The virtual world;
  - The Inter-reality Portal – HCI which maintains a virtual counterpart of physical world
- **Smart objects** - physical/digital objects augmented with sensing, processing and network capabilities.

Xreality objects = Smart objects + virtual representation updated & maintained in real time

Architectural Model



Uses Unity-3D game engine running on SmartFoxServer 2X Free Community Edition license which allows 100 concurrent users)

Implementation

Inter-reality Portal (can also use smart glasses or a normal screen)

3D Virtual Interface

www.FortiTo.com

xReality objects

Experimental Evaluation

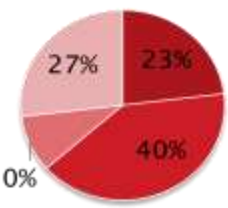
- Essex University, UK
- Anglia Ruskin University , UK
- San Diego State University, USA
- Leon Institute of Technology, Mexico
- Shijiazhuang University, China
- Shanghai Open University, China
- Monash University, Malaysia
- Khalifa University of Science, Technology and Research, UAE

27 males

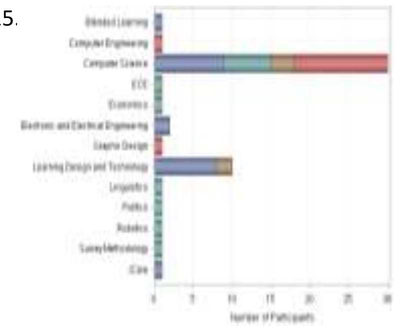
25 females

8 countries

took place with 52 students between March to May 2015.



Level of Studies



Subject of Studies

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Some insights from the evaluation data

- 88% found the prototype easy to use
- 76% found blended-reality principles simple to understand.
- 95% said they enjoyed working with other students in this environment
- 90% cited their experience as fun
- 92% participants regarded the BReaL Lab as an option that presents advantages over traditional laboratories
- 80% they would be very likely to use the technology if it was available to them in their schools and universities.
- Instructors' views on prototype were positive and confirmed that students who participated were enthusiastic and interested in understanding the functioning of the prototype.
- The shortcomings of the system were seen as some constraints on the mixing of realities, interface design issues (eg no speech channel), worries about Internet reliability, and social interaction issues (eg cultural differences).

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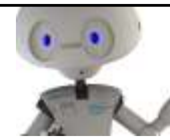
And Finally



Published by Tsinghua University Press 2016

- SF-Prototyping was used as inspiration of BReaL project

- Also now being evaluated as way of teaching Chinese Science & Engineering students English

Shijiazhuang University Students learning, English, Innovation & Computing

"Using Science-fiction Prototyping as a Means to Motivate Learning of STEM Topics and Foreign Languages" *http://victor.callaghan.info/publications/2014_IE14%28UsingScience-fictionPrototyping%29.pdf*

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That's it!

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Forthcoming Book
The Singularity Hypothesis: A Pragmatic Perspective Springer edited volume in The Frontiers Collection. (*The Singularity – a point where AI transcends the limitations of peoples brains*)

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