Adding features of educational games for teaching Physics

Karla Cristina Muñoz Esquivel [1], Julieta Noguez[2], Paul Mc Kevitt[1], Luis Neri[2], Victor Robledo-Rella[2] & Tom Lunney[2]

University of Ulster, Magee [1]
Tecnológico de Monterrey, Campus Ciudad de México[2]

E-mail: munoz_esquivel-k@email.ulster.ac.uk, jnoguez@itesm.mx, p.mckevitt@ulster.ac.uk, {neri, vrobledo}@itesm.mx, tf.lunney@ulster.ac.uk

19th October

Outline

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  - GUI design
  - Design & student model
  - Evaluation
- Conclusion & future work

Background & related work

- Understand the coherent structure underpinning Physics
- Virtual laboratories (VLs) provide significant learning experiences (Reilly, 2008)
  - Link objects & events (Virtual Learning Environments - VLEs) with real world concepts & phenomena
- Open Learning Environments
- Positive effects are attained by enhancing Human Computer Interaction (HCI) (Conati, 2008; D'Mello, 2008)
- Educational games more easily attain students' attention (Conati, 2002)

Aims & objectives

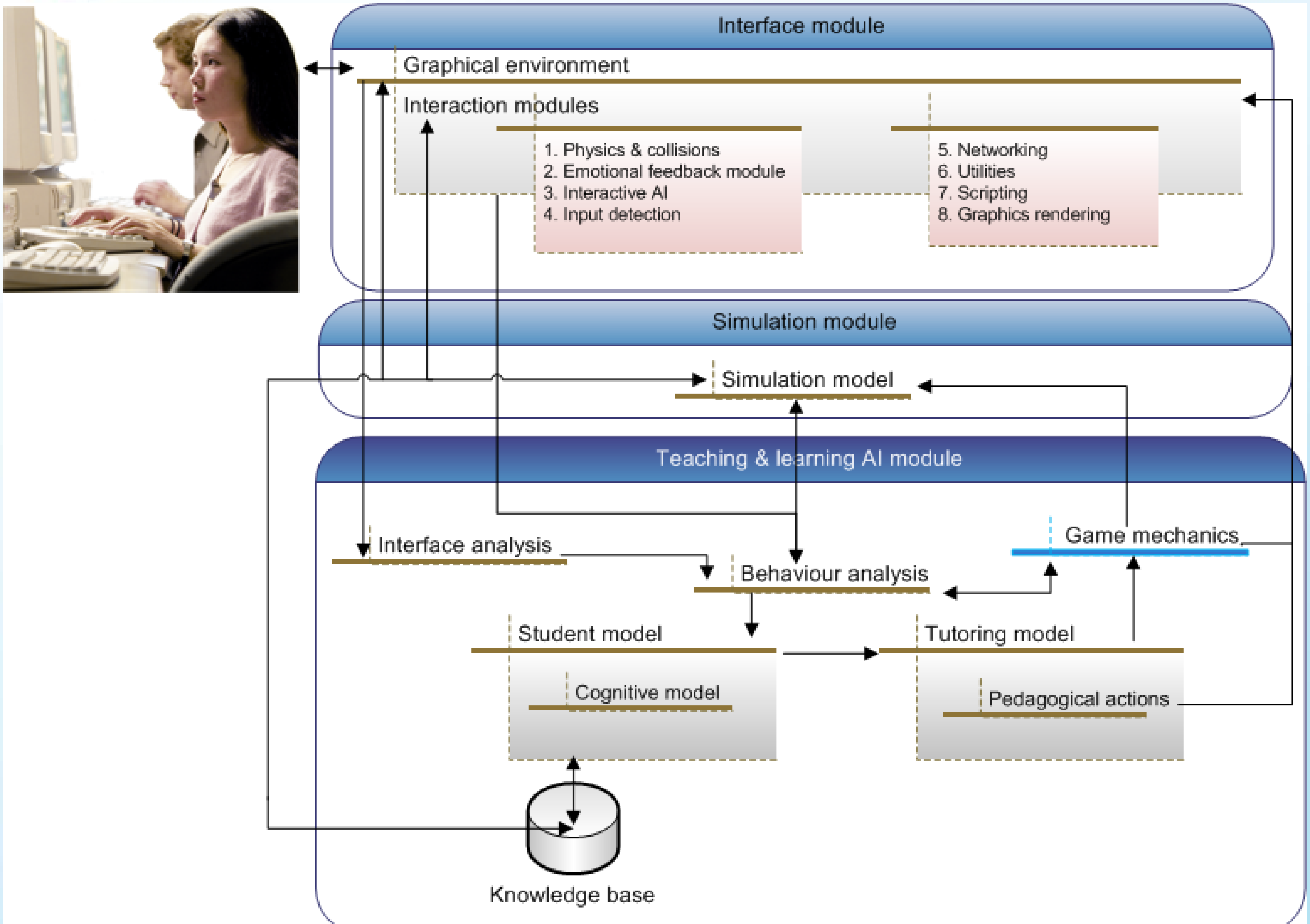
- Improve student understanding & motivation through adding features of educational games & AI techniques to VLs

- Test hypothesis in specific case study -> teaching Physics (e.g. linear momentum) at undergraduate level

- Evaluating the performance of Olympia
    - Improved Probabilistic Relational Model (PRM)
    - Tutorial videos
    - Feedback refined

Olympia architecture

- Olympia combines features of VLEs & educational games (Adams & Rollings, 2007; Sherrod, 2007; Bergeron, 2005) with Intelligent Tutoring Systems (ITSs)
- Based on research work of Noguez et al. (2007)
- Student Model is a PRM
  - infers student's cognitive state through interacting with the system


Interface module
Graphical environment
Interaction modules
1. Physics & collisions
2. Emotional feedback module
3. Interactive AI
4. Input detection
5. Networking
6. Utilities
7. Scripting
8. Graphics rendering
Simulation module
Simulation model
Teaching & learning AI module
Interface analysis
Behaviour analysis
Game mechanics
Student model
Cognitive model
Tutoring model
Pedagogical actions
Knowledge base

Case study & methodology

Design & implement traditional VL & Game VL (GVL) using Olympia for teaching linear momentum

1. Pre-phase – pre-test
2. Interaction

(Control , VL & GVL)

3. Post-phase – post-test

Analysis of results based on research work of Hake (1998)

Design & student model

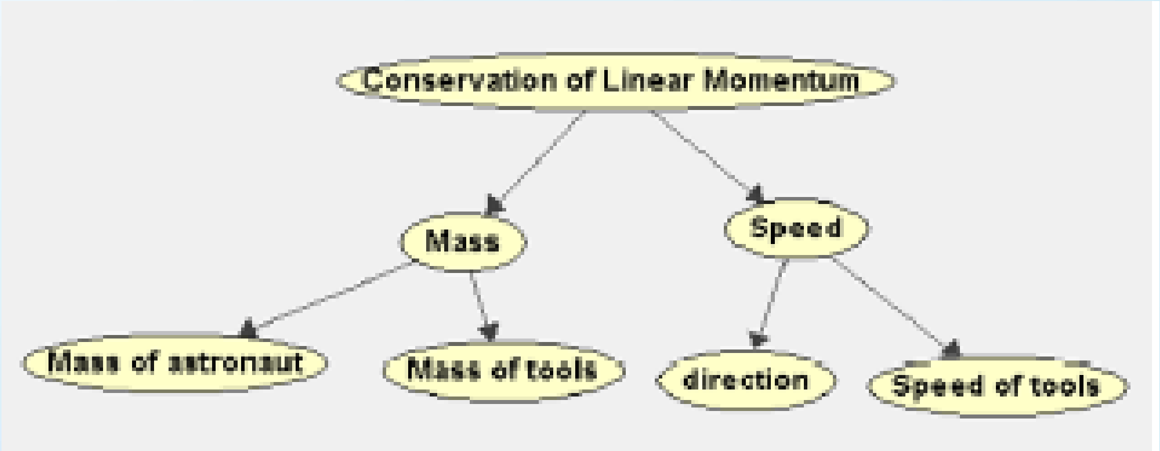
Problem selection

GUI design

Exploration parameters & assessment

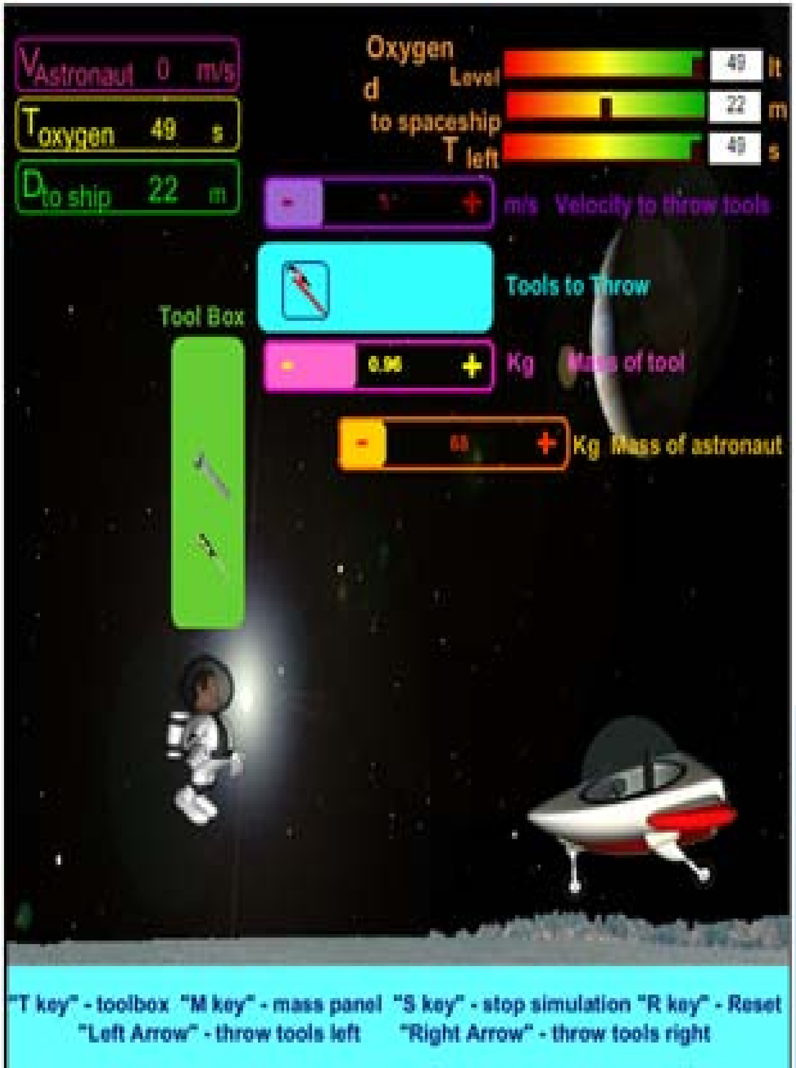
Knowledge inference

Feedback

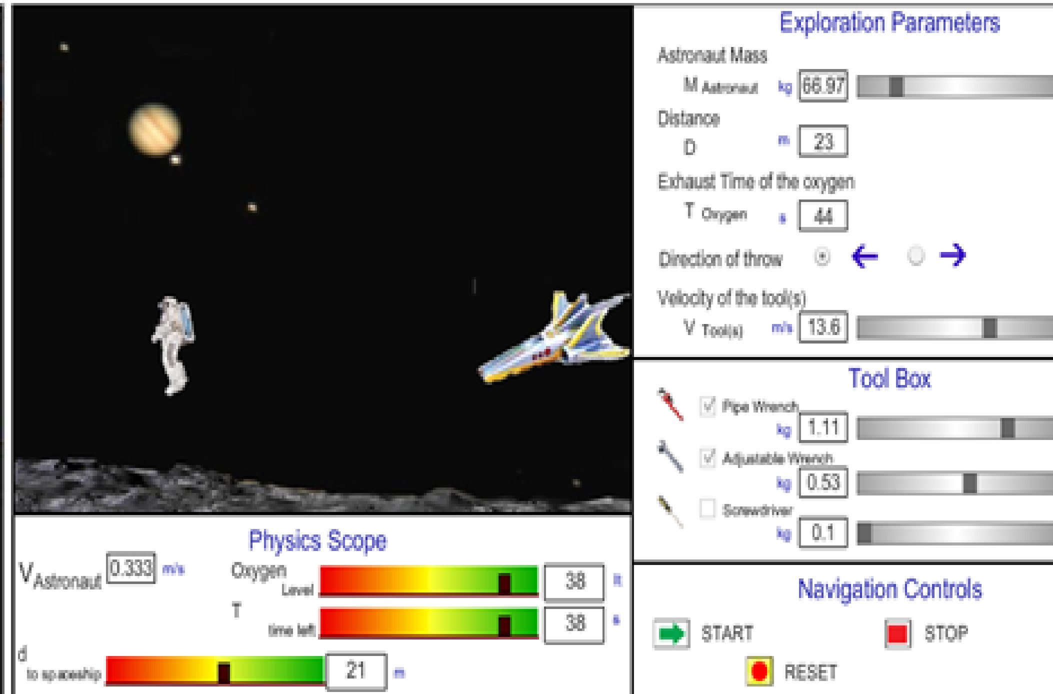


Bayesian net derived from relational student model

GUI design



VAstronaut 0 m/s
Toxygen 49 s
Dto ship 22 m
Oxygen
Level
49 lt
d
to spaceship
22 m
T left
49 s
m/s Velocity to throw tools
Tools to Throw
Tool Box
Kg Mass of tool
Kg Mass of astronaut
"T key" - toolbox "M key" - mass panel "S key" - stop simulation "R key" - Reset
"Left Arrow" - throw tools left "Right Arrow" - throw tools right



Exploration Parameters
Astronaut Mass
M Astronaut kg 66.97
Distance
D m 23
Exhaust Time of the oxygen
T Oxygen s 44
Direction of throw
Velocity of the tool(s)
V Tool(s) m/s 13.6
Tool Box
Pipe Wrench
kg 1.11
Adjustable Wrench
kg 0.53
Screwdriver
kg 0.1
Physics Scope
VAstronaut 0.333 m/s
Oxygen
Level
38 lt
T
time left
38 s
d
to spaceship
21 m
Navigation Controls
START
STOP
RESET

Evaluation

GROUP	N	Pre-Test	Post-Test	G_{rel}	G	Efficiency
VL	11	59 ±23	73 ±26	0.27±0.33	14 ±13	0.28±0.15
GVL	12	65 ±27	79 ±18	0.57±0.20	15 ±14	0.49±0.38
CONTROL	34	71 ±23	74 ±16	0.19±0.15	3 ±10	-

$$G_{rel} = \frac{(PostTest - PreTest)}{(100 - PreTest)}$$

$$G = (PostTest - PreTest)$$

Conclusion & future work

- Olympia -> teaching introductory Physics at undergraduate level
- Students using GVL have better performance than students using traditional VL
- Students using GVL are more engaged -> higher efficiency
- Additional experimentation
- Validation of best pedagogical action in the tutor model
- Provide suitable affective & pedagogical learning responses
- Implement educational games for teaching Physics

Questions