



# **An Emotional Student Model for Intelligent Adaptation of Game-play**

Karla Muñoz , Paul Mc Kevitt & Tom Lunney  
Intelligent Systems Research Centre  
University of Ulster, Derry, Northern Ireland

External Collaboration: Julieta Noguez & Luis Neri  
Faculty of Engineering & Architecture  
Tecnológico de Monterrey, Distrito Federal, Mexico

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# Outline of presentation

- Background & related work
- Emotional Student Model
- PlayPhysics Design & Implementation
- Evaluation & Results
- Conclusion & Future Work



# Background & related work

- Game-oriented learning
  - Interactive and emotional link
  - CHALLENGE:** Achieving Knowledge & Understanding
- Following Design Principles (Malone & Lepper, 1987) & Providing Adaptable Guidance
  - Intelligent Tutoring Systems (ITSs)  
(Conati & Maclaren, 2009; Blanchard & Frasson, 2006)
- Affective Gaming (Sykes, 2006)
- Student Modelling (Wolf, 2009; Sucar & Noguez, 2008)



- **Approaches for recognising emotion**
  - **Recognising Physical effects** (Sarrafzadeh et al., 2008; D' Mello et al., 2008)
  - **Reasoning about emotion from its origin** (Jaques & Vicari, 2007)
    - OCC Model (Ortony et al., 1990)
  - **Hybrid approach** (Conati & Maclaren, 2009)
- **Recognising students' motivation** (Rebolledo-Mendez, et al., 2006) **& self-efficacy** (McQuiggan et al., 2008)
- **Control-Value theory of Achievement Emotions** (Pekrun et al., 2007)



## Research aim

- Creating an emotional student model to reason about the learners' emotions from observable behaviour during game-play using cognitive & motivational variables

# Emotional Student Model

- Student modelling involves uncertainty (Sucar & Noguez, 2008)
  - Which emotions must be recognised?
  - Which factors & features must be taken into account

## Research Approach

Control-value theory

Probabilistic Relational Models approach

Dynamic Bayesian Networks



# The Control-Value Theory

- Achievement Emotions
  - Defined according to the focus & time frame
    - Prospective-outcome, activity & retrospective-outcome
  - Domain dependent
- Appraisals of control & value are the most relevant when determining & emotion
  - Motivational, cognitive & physiological variables



Time frame/ focus on	Value appraisal	Control appraisal	Emotion
Prospective/ Outcome	Positive (Success)	High	Anticipatory Joy
		Medium	Hope
	Negative (Failure)	Low	Hopelessness
		Low	Hopelessness
		Medium	Anxiety
Retrospective/ Outcome	Positive (Success)	Irrelevant	Joy
		Self	Pride
	Negative (Failure)	Other	Gratitude
		Other	Anger
		Self	Shame
Present/ Activity	Positive	High	Enjoyment
	Positive/Negative	Low	Frustration
	None	High/Low	Boredom
	Negative	High	Anger

**Table 1.** Summary of the Control-Value Theory by Pekrun et al. (2007)



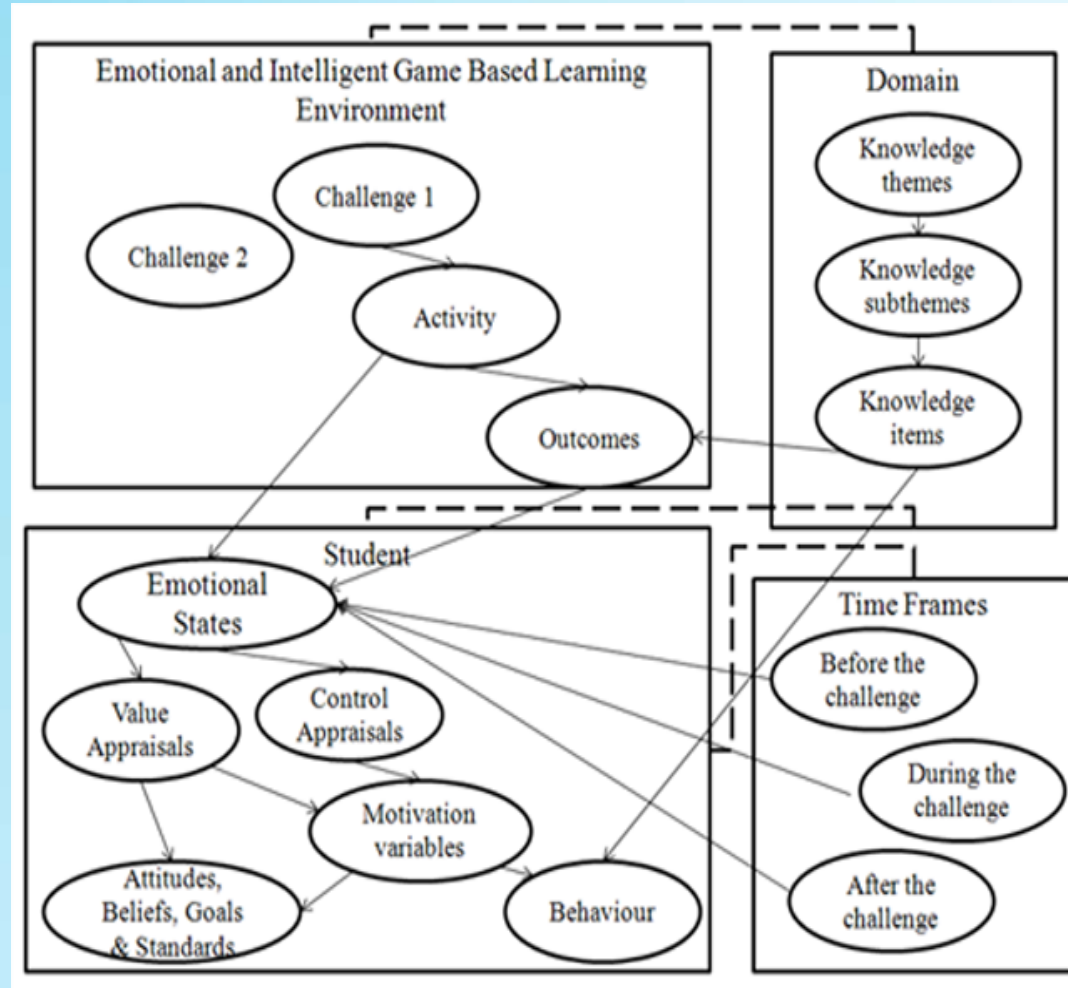


Figure 1. PRM based on the control-value theory.

**COMMANDER Damian McCarthy (NASA)**

We need that you travel to Athena station and help Captain Foster to return safely to Earth and recover control over VNUS. However, the mission is not going to be easy, since VNUS can attack you or make your mission more difficult to accomplish. Remember that VNUS still has control over the space station and all the technological equipment. To accomplish your mission it is very likely that you have to use your knowledge on the topics of vectors, the principles of linear and circular kinematics, and Newton's laws of motion for particles and rigid bodies. What do you think? Do you think you can make it?



**THE FIRST LIEUTENANT (Student)**

- Yes, I am extremely sure that I will succeed. I am very confident that I will handle the situation.
- Yes, I will succeed. I will handle the situation.
- Well... I do not know if I will succeed or fail. I will try to handle the situation.
- Well... may be I will fail, since those topics are difficult, but I will make all the possible to handle the situation anyway.
- Well... to be honest, I am afraid of failing, since those topics are very difficult, but I will give it a try.

Figure 2. Fragment of PlayPhysics game dialogue based on Ajzen theory

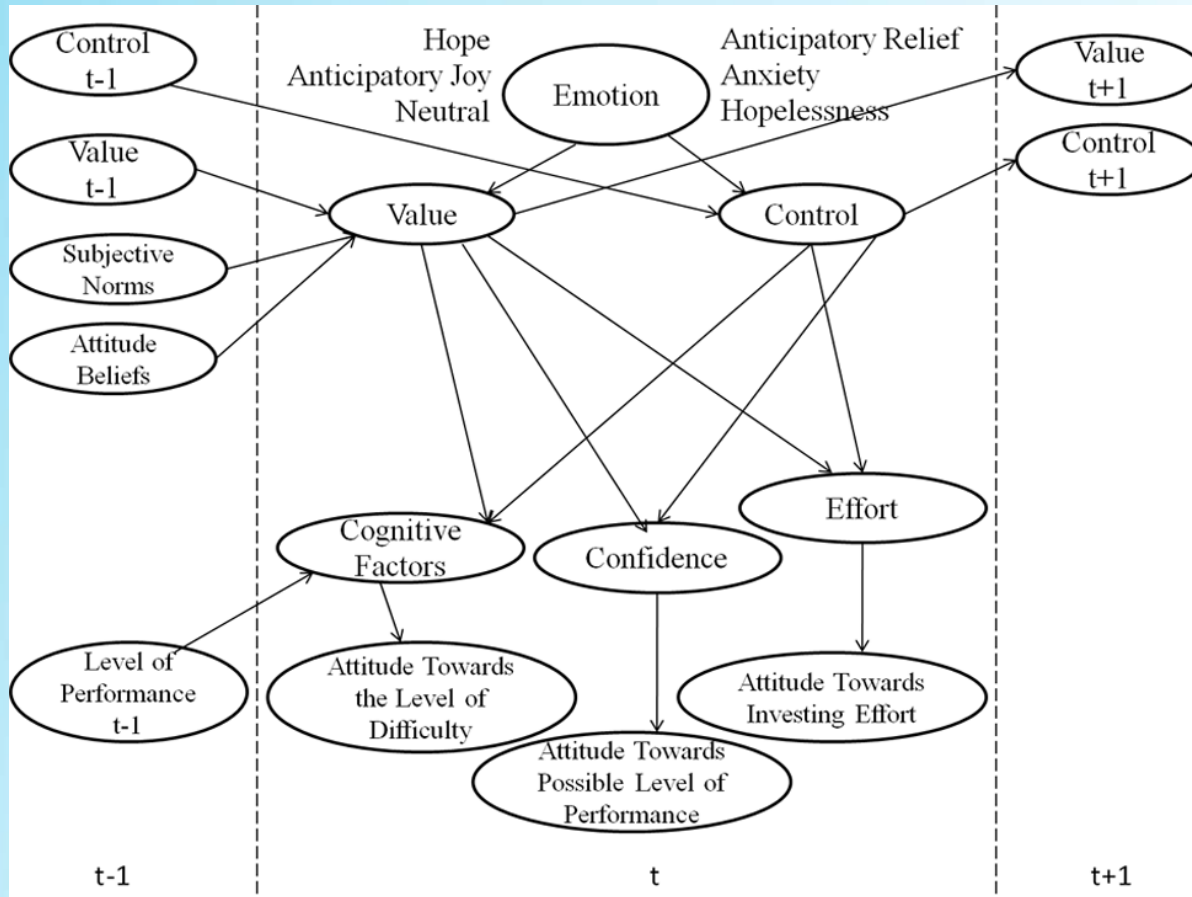


Figure 3. Prospective-outcome emotions DBN



# PlayPhysics design

- Students find it difficult to understand & apply the underlying principles of Physics
- PlayPhysics uses Olympia architecture (Muñoz et al., 2009)
- Olympia will be modified to recognise the students' emotions & provide pedagogical actions, which involve emotional responses delivered through game elements
- The most difficult topics in an introductory Physics course were identified through an online survey
  - Trinity College Dublin & Tecnológico de Monterrey .
- The story-line of PlayPhysics is a space adventure

# First Challenge

- Involves piloting a spaceship to Athena by applying knowledge about vectors, principles of linear and circular kinematics and Newton's laws for particles and rigid bodies.
- Unity Game Engine, Poser, 3D Studio Max, JSPs, Servlets & Elvira



Figure 4. PlayPhysics first challenge GUI



Figure 5. PlayPhysics Player-characters

# Evaluation & Results

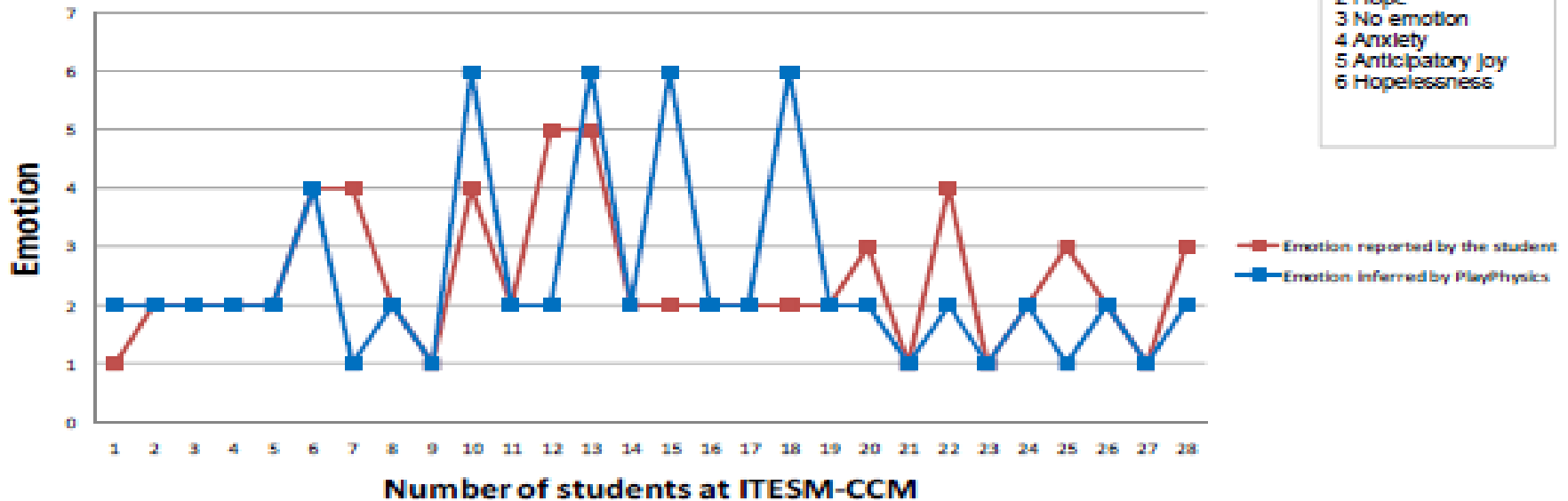
Pre-test &  
Knowing result

Answering Game-  
dialogue

Comparison  
between reported  
emotion &  
inferred emotion

- Evaluation of the Prospective-outcome emotions DBN

**Reported emotion vs Predicted emotion**





- Some students did not know how to classify the emotion that they were feeling (confidence & effort)
- Some students reported that including some diagrams in some questions of the pre-test will improve the questions' clarity
- The confidence reported by the student correlated poorly with question 5 of the game-dialogue, therefore question 2 will be used , which improves the correlation
- Some probabilities in the Conditional Probability Tables (CPTs) need improvement. Therefore the data obtained from this test will be used to adjust the probabilities
- Further tests with a larger population of students are necessary



# Conclusion & future work

- Design of an Emotional student model that reasons about emotion during game-play using cognitive and motivational variables
- A PRM approach & as a basis the Control-Value theory of achievement emotions
- The results show promise when evaluating the prospective-outcome emotions DBN. However it will be necessary to conduct further tests with a larger population of students and with the other DBNs once the implementation of the first challenge is completely finished



# Questions



<http://www.infm.ulst.ac.uk/~karlam>  
munoz\_esquivel-k@email.ulster.ac.uk