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PlayPhysics: An Emotional Games Learning Environment for Teaching Physics

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Outline of presentation

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

Background & related work

- Game-oriented learning
  - Interactive and emotional link

  CHALLENGE: Achieving Knowledge & Understanding

- Providing Adaptable Guidance
  - Intelligent Tutoring Systems (ITSs)

    (Conati & Maclaren, 2009; Blanchard & Frasson, 2006)

- Affective Gaming (Sykes, 2006) & Student Modelling (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)

- Influencing & modulating emotion
  - Embodied Pedagogical Agent s(EPAs) (Sarrafzadeh et al., 2008; D' Mello et al., 2008; Johnson et al., 2000)
  - Games as multisensory environments
    - Acoustic & visual sources serve different purposes (Malone, 1981; Collins, 2008)
      - » Setting a mood, creating a feeling of immersion, focusing attention, conveying meaning, decreasing the learner's playing curve
  - Colours employed for self-reporting emotions and communicating and emphasising an emotion (Alsmeyer et al., 2008; Rasek et al., 2006; Nijdam, 2005)

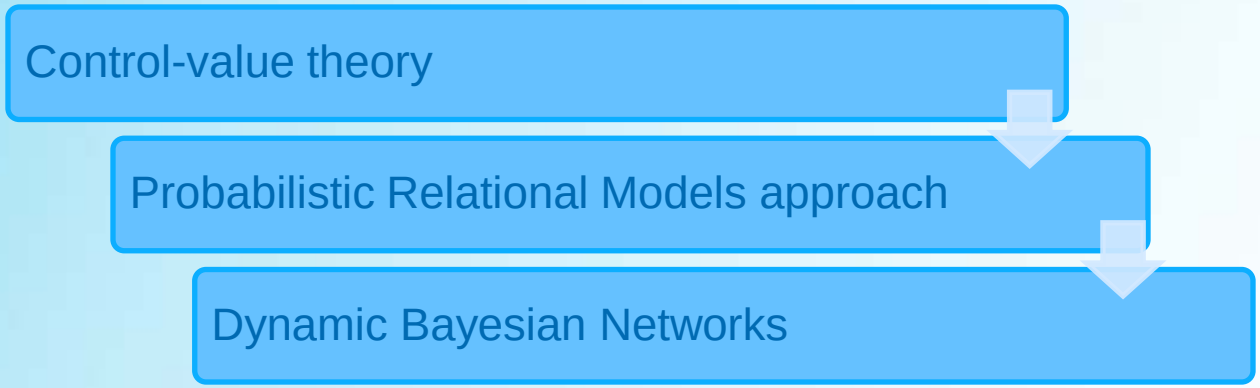
Research aims & goals

- Creating an emotional student model to reason about the learners' emotions from observable behaviour during game-play using cognitive & motivational variables
- Selecting & implementing suitable pedagogical actions that intelligently adapt game-play
- Developing & implementing PlayPhysics: An Emotional Games learning Environment for Teaching Physics

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



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
		Low	Hopelessness
	Negative (Failure)	Low	Hopelessness
		Medium	Anxiety
		High	Anticipatory relief
Retrospective/ Outcome	Positive (Success)	Irrelevant	Joy
		Self	Pride
		Other	Gratitude
	Negative (Failure)	Other	Anger
		Self	Shame
		Irrelevant	Sadness
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)

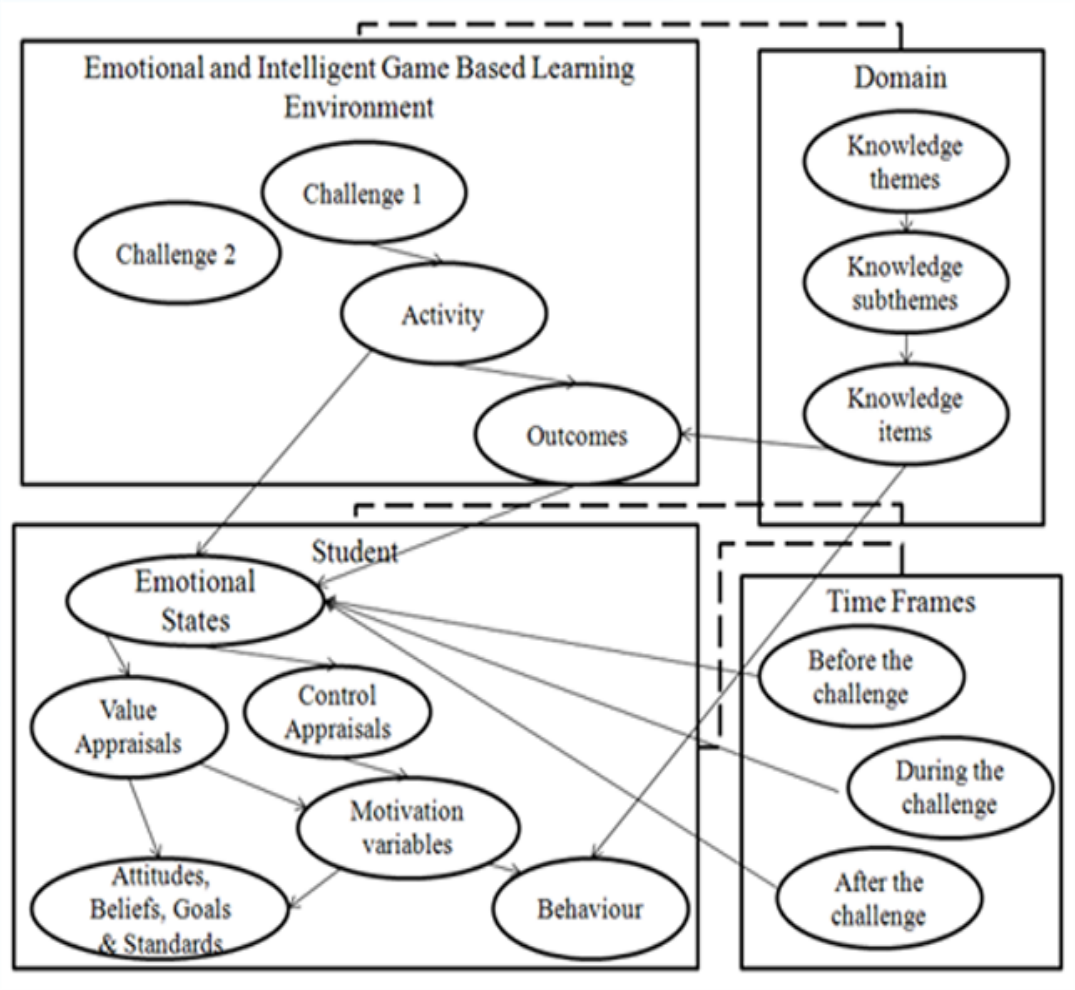


Figure 1. PRM based on the control-value theory.

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

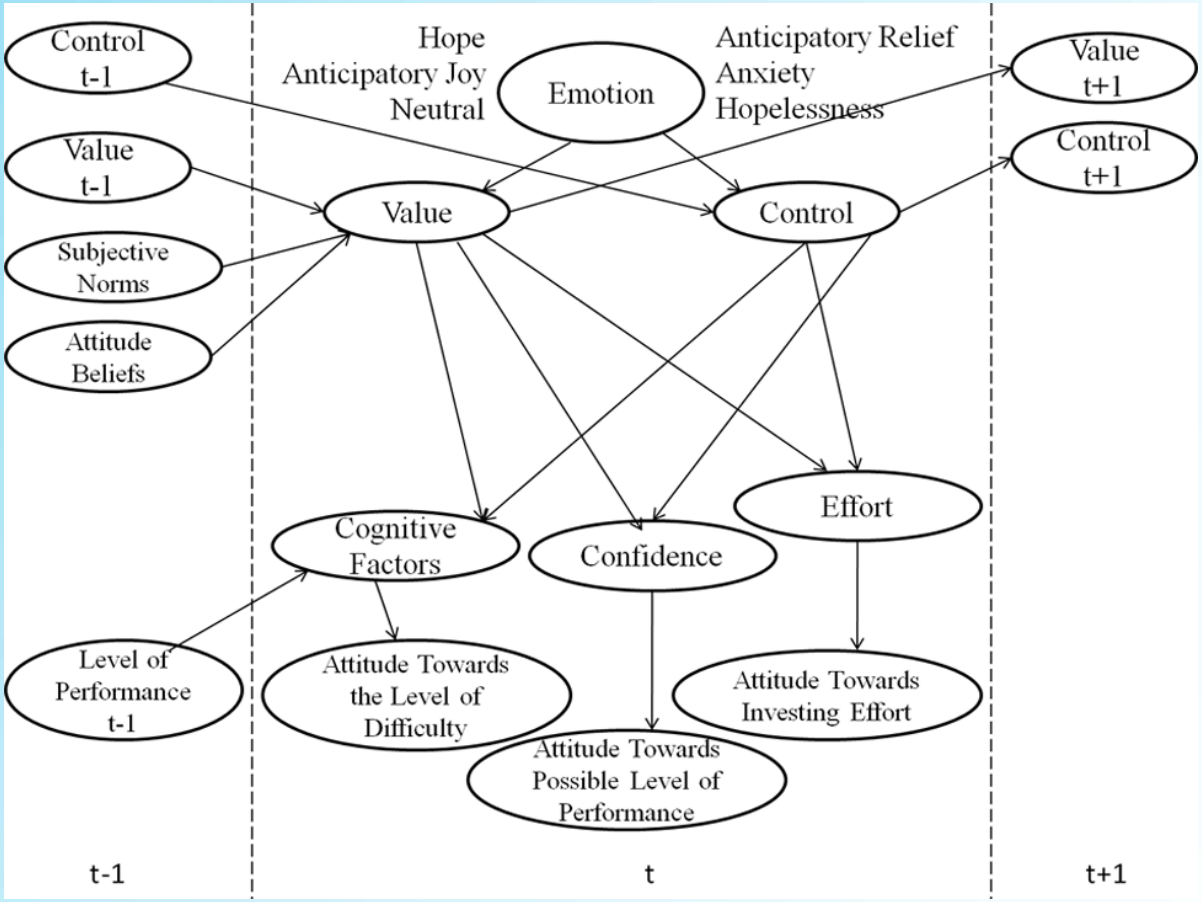
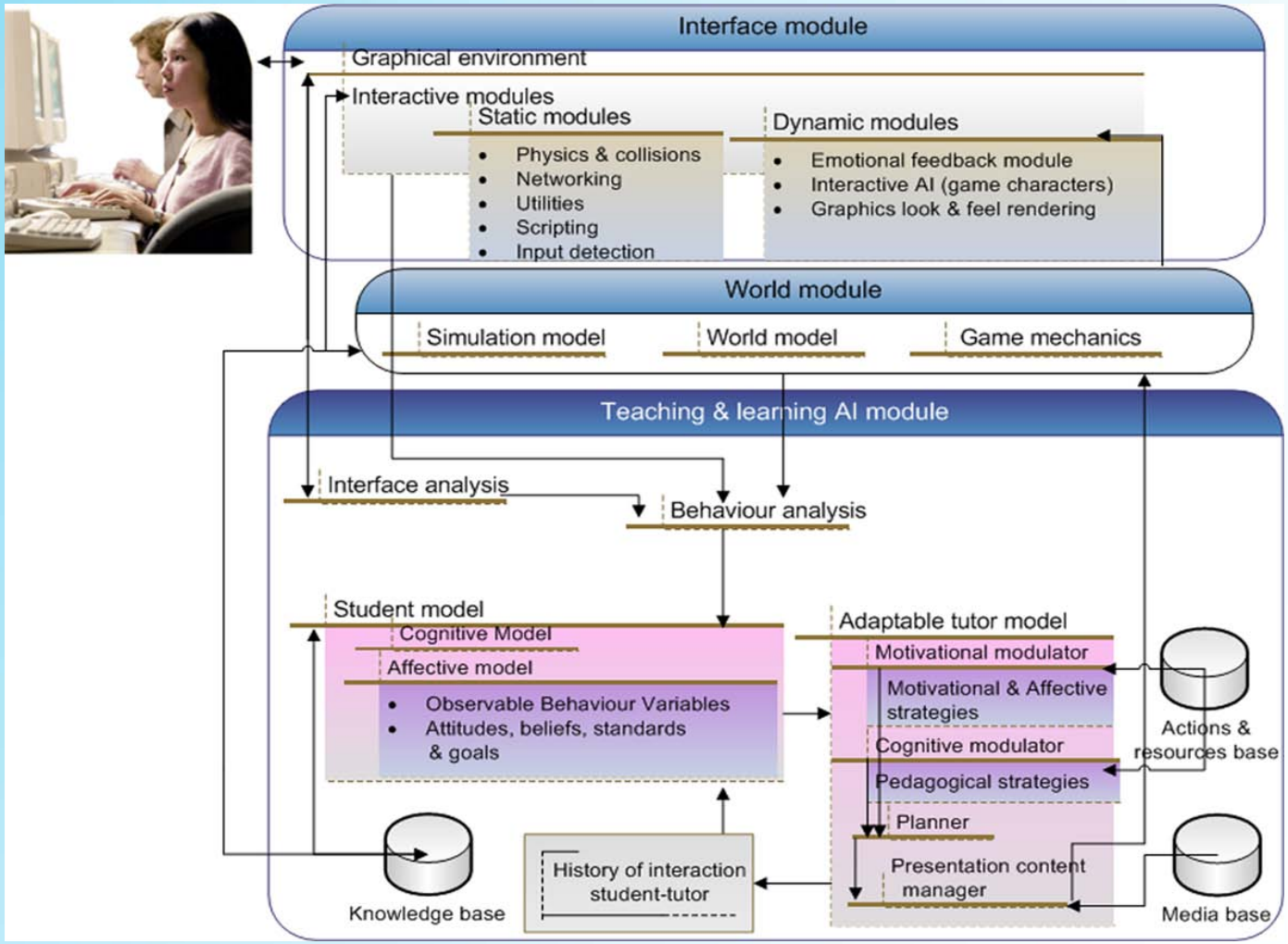


Figure 3. Prospective-outcome emotions DBN

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

Olympia architecture



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

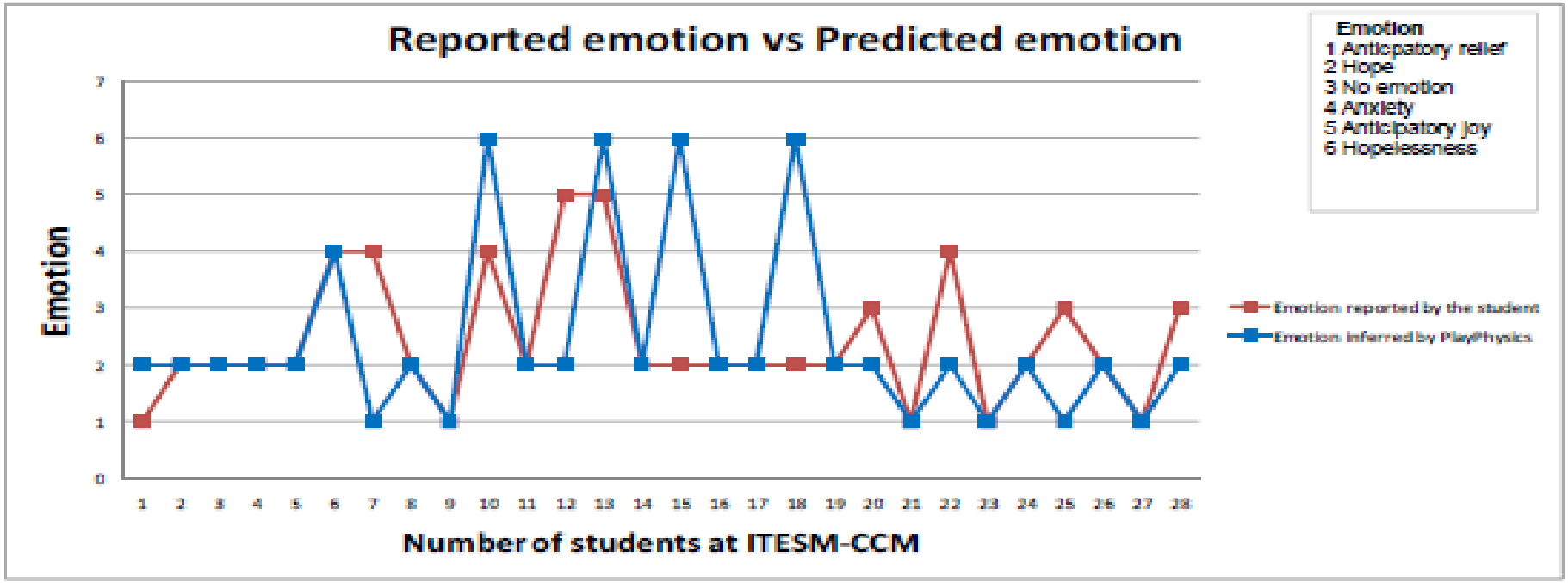
Evaluation & Results

Pre-test & Knowing result

Answering Game-dialogue

Comparison between reported emotion & inferred emotion

•Evaluation of the Prospective-outcome emotions DBN



- 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

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