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INTELLIGENT SYSTEMS RESEARCH CENTRE

PlayPhysics:

An emotional games learning environment for teaching physics

Karla Cristina Muñoz Esquivel, B.Sc.(Hons.), M.Sc.

Intelligent Systems Research Centre
School of Computing & Intelligent Systems
Faculty of Computing & Engineering

Supervisors: Prof. Paul Mc Kevitt & Dr. Tom Lunney
External Collaborating Professor: Dr. Julieta Noguez (ITESM-CCM)

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http://isrc.ulster.ac.uk

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Outline of presentation

- Aims & objectives
- Literature review
  - Key research problems
- Project Proposal
  - Hypotheses
  - Methodology and evaluation
  - Requirements analysis
  - Software analysis
- Relation to other work
- Potential unique contributions
- Project Plan
- Publications
- Thesis Outline
- Conclusion

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Aims & objectives

- Enhance student's learning, understanding & motivation
- Optimise learner's mental state
- Incorporate new generation ITS
- Affective user modelling and prediction of learner's affective state
- Identify learner's personality traits
- Show affect & create game based learning environment to enhance learning and motivation
- Select suitable pedagogical, affinity & motivational strategies
- Enhance Olympia architecture (Muñoz et al., 2009a,b)
- Design, implement & test PlayPhysics

Literature review

- Virtual Learning environments (VLEs) & Educational Games
  (Noguez & Huesca, 2008; Bergeron, 2005)

- New Generation Intelligent Tutoring Systems (ITSs)
  (Du Boulay & Luckin, 2001)

  - Autotutor (D'Mello et al., 2008a)
  - Easy with Eve (Sarrafzadeh et al., 2008)
  - EMASPEL (Neji & Ben Ammar, 2007)
  - ERPA (Chalfoun et al., 2006)
  - PrimeClimb (Conati & Maclaren, 2009)

- Affective & educational applications
  - Synthetic Characters & pedagogical agents
    (Herman the Bug, COSMO, SmartKom, BEAT, Oz Project, Fear Not!, Aini, Mirage)
  - Affective robots (Leite & Pereira, 2007; Miwa et al., 2001)
  - Machines with common sense recognising affect
    (Li et al., 2007; Liu & Singh, 2004)
  - Multimodal storytelling, game generation & affective game design
    (Ma & Mc Kevitt, 2006; Nelson & Mateas, 2007; Zammitto, 2005)

- Knowledge Representation
  - Production rules & Declarative Knowledge (Woolf, 2009)
  - Plan recognition & machine learning techniques
    (Dynamic Bayesian Belief Networks, Influence Diagrams, Markov Decision Processes & Decision Trees)
  - Conceptual Primitives, conceptual syntax rules, semantic frames

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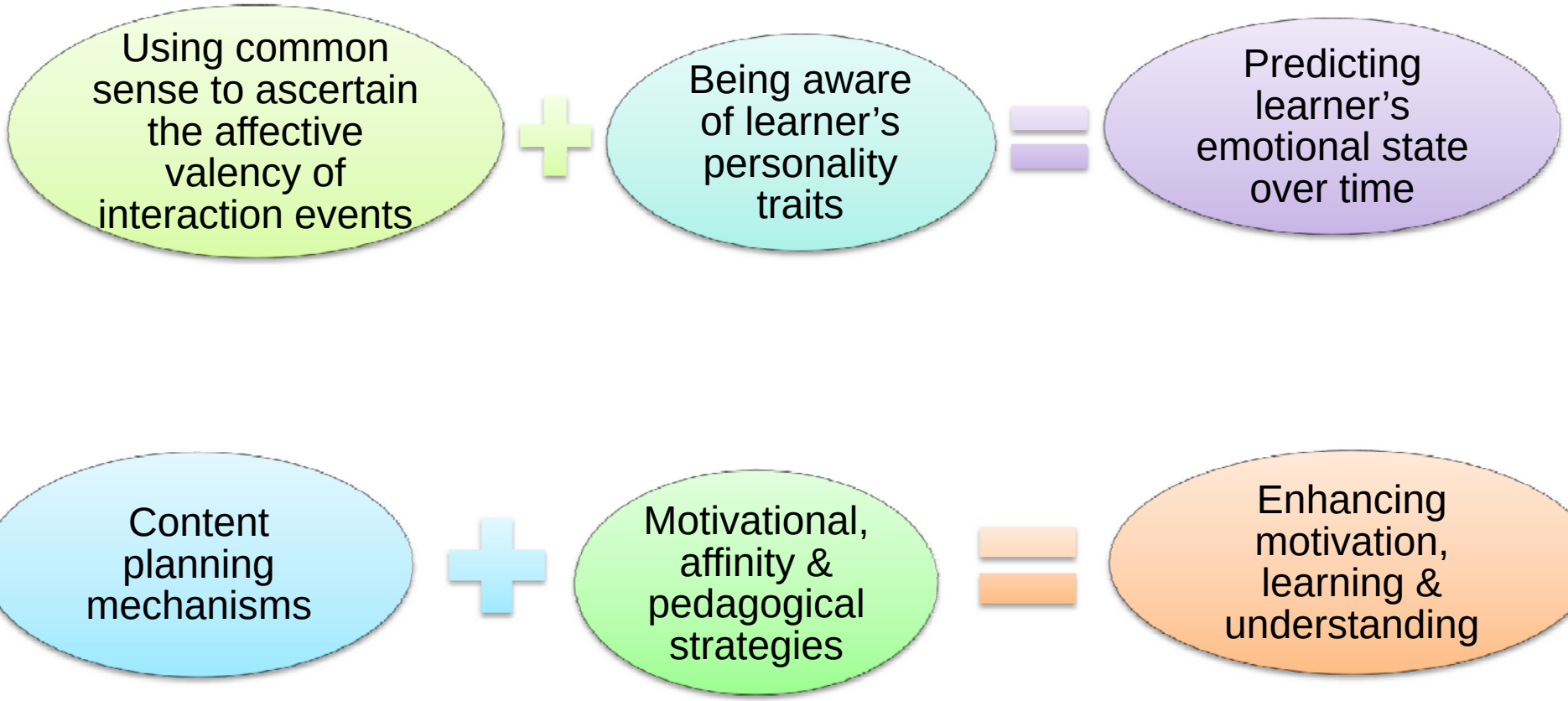
Key research problems

- Achieve learning goals, support curriculum & adaptability
- Guide student performance over time
- Identify & capture interaction data
- Achieve flexible & effective student, domain & virtual world representations
- Predict the student's emotional state & personality traits
- Select & implement motivational, affinity & pedagogical strategies
- Express affect & select suitable media to communicate the teaching message

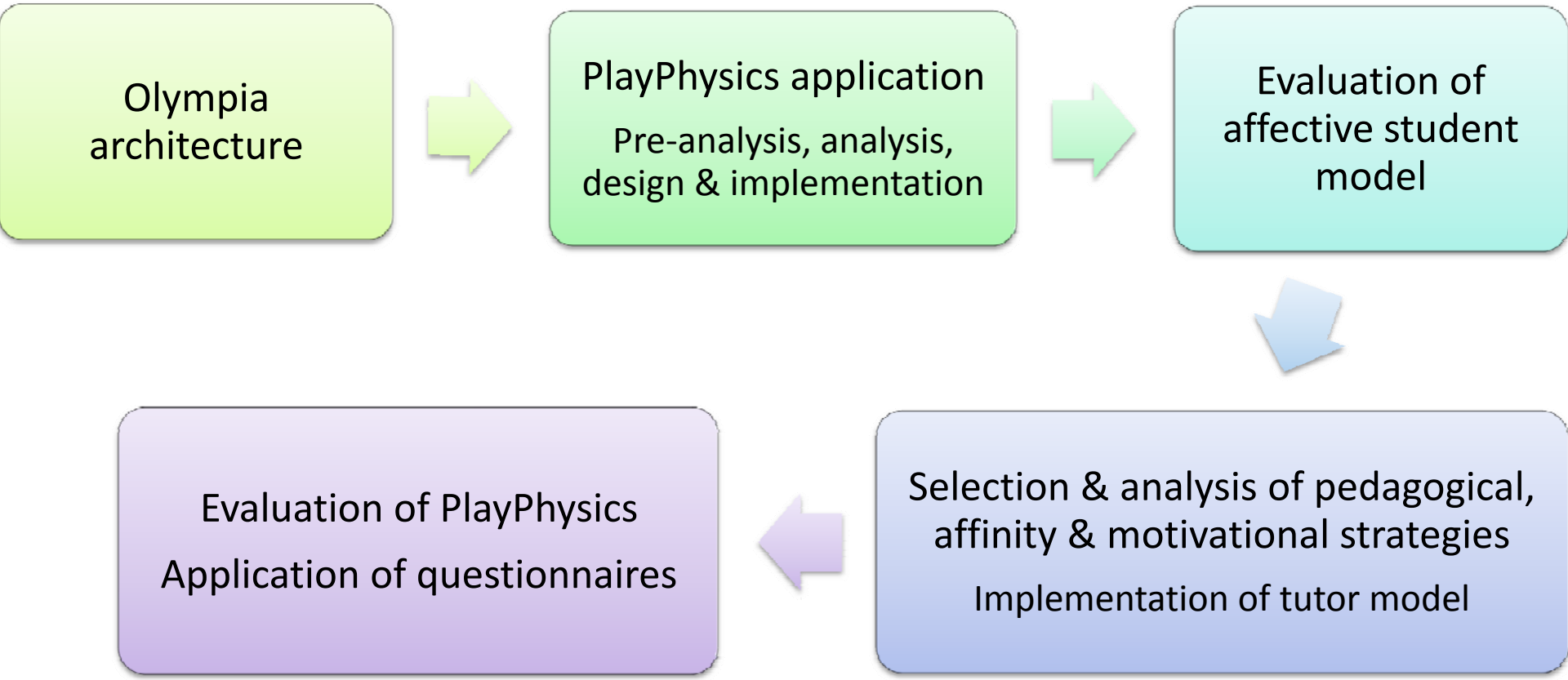
Project proposal

- Enhance student's learning, understanding & motivation
- Incorporate new generation ITS
- Two approaches to recognise learner's affective state
  - Identifying the physical effects
  - Predicting emotion from its origin
- Enhance Olympia architecture (Muñoz et al., 2009a,b)
- Design, implement & test PlayPhysics

Hypotheses


Using common sense to ascertain the affective valency of interaction events
Being aware of learner's personality traits
Predicting learner's emotional state over time
Content planning mechanisms
Motivational, affinity & pedagogical strategies
Enhancing motivation, learning & understanding

Methodology and evaluation



Requirements analysis

- *Motivating the learning of Physics* (e.g. online survey)
  - FIDGE model
  - According to Myers & Briggs - ESTJ & ESTP
  - According to DGD1:
    - ESTJ - Challenge, strategic and puzzle games
    - ESTP -Open games
  - Students mainly casual game players
  - Establish preferred methods of feedback

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Software analysis

- ConceptNet
- Torque Game Engine & Torque Game Builder
- Unity Game Engine
- 3D studio Max & Maya
- Audacity
- Elvira & Hugin Lite
- C++, C#, PHP, Java & MySQL
- Psyclone
- Haptek Automated Personalities SDK

Interface module

Graphical environment

Interactive modules

Static modules

1. Physics & collisions
5. Networking
6. Utilities
7. Scripting
4. Input detection

Dynamic modules

2. Emotional feedback module
3. Interactive AI (game characters)
8. Graphics look & feel rendering

World module

Simulation model

World model

Game mechanics

Teaching & learning AI module

Interface analysis

Short-term memory

Current interaction events

Behaviour analysis

Common-sense base

Student model

Cognitive model

Affective model

Personality traits
Emotion

Adaptable tutor module

Motivational modulator

Affinity strategies
Motivational strategies

Cognitive modulator

Pedagogical strategies

Planner

Presentation content manager

Actions & resources base

Long-term memory

History of interaction student-tutor

Knowledge base

Media base

Relation to other work

Application	Research Reference	Tutoring modelling		Education technologies		Online	Detection of personality aspects	Feedback resource			Recognised affective features		Approach affect recognition		
		ITS[1]	IA[2]	Educational game	VLE[3]			Game modulation	Game Characters	EPA[4]	Moods	Emotions	Identifying physical effects	Predicting emotion from its origin	Using common sense and the interaction events
ESTEL	Chaffar & Frasson (2004)	✓	×	×	✓	✓	✓	×	×	×	✓	×	×	×	×
ERPA	Chalfoun et al. (2006)	✓	×	×	✓	✓	✓	×	×	×	×	✓	×	✓	×
EMASPEL	Neji & Ben Ammar (2007)	×	✓	×	✓	✓	×	×	×	✓	×	✓	✓	×	×
Easy with Eve	Sarrafzadeh et. al (2008)	✓	×	×	✓	✓	×	×	×	✓	×	✓	✓	×	×
AutoTutor	D'Mello et. al (2008a)	✓	×	×	✓	×	×	×	×	✓	✓	×	✓	×	×
MOCAS	Chalfoun & Frasson (2008)	×	✓	✓	✓	✓	×	×	×	✓	-	-	-	-	×
Prime Climb	Conati & Maclaren (2009)	✓	×	✓	✓	×	✓	×	×	✓	×	✓	✓	✓	×
PlayPhysics	Muñoz et. al (2008- 2011)	✓	×	✓	✓	✓	✓	✓	✓	×	×	✓	×	✓	✓

Potential unique contributions

- Representations of interaction events & student employed to predict learner's mental state
- Provision of coordinated, integrated & affective multimodal output
- Intelligent planning mechanisms deployed to select affinity, motivational and pedagogical strategies
- Olympia architecture
- PlayPhysics: An Integrated learning environment that facilitates learning
- State of the art of ITSs, Educational Games, Virtual Learning Environments & Affective Computing

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Project Plan

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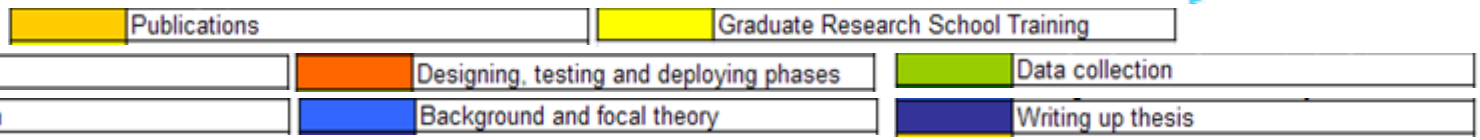

Activities	2008	2009				2010				2011		
	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep
Literature Review: Background and focal theory												
Graduate Research School Training												
100 Day Review report and viva												
39th Annual Conference, Frontiers in Education (FIE)												
Preparing a survey to find functional and non-functional requirements and justify the execution of the research												
Applying the survey												
International Symposium of Electronic Arts (ISEA 09)												
Selecting the tools to develop the web application												
Selecting the tools to develop the 3D design of the educational game												
Selecting the tools to manage and produce sound												
Selecting the tools and methodologies to recognise aspects of emotion												
Selecting the tools and methodologies to recognise aspects of personality												
Selecting the AI tools to implement the enhanced student and adaptable tutor model												
Testing the viability of the research work by carrying a pilot study												
Designing PlayPhysics												
Confirmation report and viva												
2nd year poster presentation												
Applying for ethical approval												
Developing and Implementing PlayPhysics												
Testing and deploying the PlayPhysics												
Experimentation over the subject sample												
Data collection and analysis												
IEEE Transactions on Learning Technologies - Journal Transactions on education												
3rd year presentation												
Writing up thesis												
Submission of thesis												

Publications

- Muñoz, K., Noguez, J., Mc Kevitt, P., Neri, L., Robledo-Rella, V. & Lunney, T. (2009) Adding Features of Educational Games for Teaching Physics, *In: Frontiers in Education, The 39th IEEE International Conference, San Antonio, Texas, USA,18th -21st October 2009*. USA: IEEE Press.

- Muñoz, K., Mc Kevitt, P., Noguez, J., Lunney, T. (2009) Combining Educational Games and Virtual Learning Environments for Teaching Physics with the Olympia Architecture. *In: International Symposium of Electronic Art, ISEA 09, Waterfront Hall, Belfast, Northern Ireland, 23rd - 30th August 2009.*

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Thesis Outline

0. Prelims. Title page, Table of Contents, List of Figures, List of Tables, Acknowledgements, Abstract, List of Acronyms and Note-on-access-to-contents.

CHAPTER-1: Introduction.

CHAPTER-2: Literature review.

CHAPTER-3: Theoretical contribution.

CHAPTER-4: Olympia architecture and PlayPhysics design and implementation.

CHAPTER-5: Evaluation of PlayPhysics.

CHAPTER-6: Conclusion.

7. Appendices.

8. References.

Conclusion

- Predict learner's emotional state using common sense, Dynamic Belief Networks & recognising learner's personality traits
- Include a new generation ITS
- Select & implement the most suitable pedagogical, affinity & motivational strategy using intelligent planning mechanisms and diverse game features
- Contribute to state of the art: ITSs, Educational Games, Virtual Learning Environments & Affective Computing
- Olympia architecture
- PlayPhysics is an emotional games learning environment for teaching introductory Physics

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Questions