



PA199 Advanced Game Design

Lecture 9
Serious Games and Virtual Environments

Dr. Fotis Liarokapis

29th April 2019

Serious Games



Essential Game Elements



- Huizinga (1950)
 - Free activity, outside “ordinary” life, not “serious”
 - Absorbs the player
 - No material interest or profit
 - Distinct Boundaries of time and space
- Caillois (1961)
 - Free (voluntary), separate (time and space)
 - uncertain, unproductive, governed by rules, make-believe
- Salen and Zimmerman (2003)
 - A system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome



Serious Games - A Definition



- Describes computer games that are not limited to the aim of providing entertainment that allow for collaborative use of 2D/3D spaces but are also used for different purposes in a number of application domains



Anderson, E.F., McLaughlin, L., Liarokapis, F., Peters, L., Petrakis, P., de Freitas, S. Developing serious games for cultural heritage: a state-of-the-art review, *Virtual Reality*, Springer, 14(4): 255-275, 2010. (ISSN: 1359-4338)



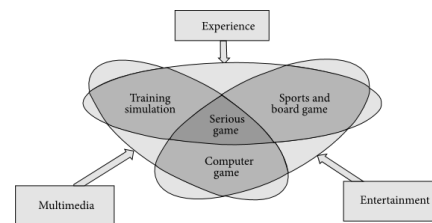
Serious Games - Another Definition



- Bergeron, (2006): “a serious game is an interactive **computer application**, with or without a significant hardware component, that: has a challenging goal, is **fun** to play and/or engaging, incorporates some concept of scoring, and imparts to the user a **skill**, **knowledge**, or **attitude** that can be applied in the real world.” (pg. xvii)



And Another Definition



Laamarti, F., Eid, M., El Saddik, A. An Overview of Serious Games, *International Journal of Computer Games Technology*, Article ID 358152, 2014.



Milestones in the History of SG



Year	Serious game	Application
1970	Serious Games book by C. Abt	Academic book
1972	Magnum's Odyssey	Education
1973	The Oregon Trail	Education
1980	BattleZone	Training
1981	The Bradley Trainer	Training
1982/1983	Pole Position/Atari VCS 2600 console	Training
1996	Marine Doom	Military
2002	America's Army	Military
2003	DARWARS	Military
2005	VBSI	Military
2006	BLAT	Interpersonal communication
2009	VBS2/Game After Ambush	Military
2012	X-Plane 10	Training

Laamarti, F., Eid, M., El Saddik, A. An Overview of Serious Games, International Journal of Computer Games Technology, Article ID 358152, 2014.



Advantages of Games



- Motivation/Engagement
- Interactivity
- Mechanic is the Learning
 - To beat the game is to learn the message/skill
 - But only when done right, very difficult
 - Beyond content to problem solving/systems learning
- Adaptive to the Learner
- Real-Time Assessment
 - Analytics/Data/Log Files



Simulations and Games



- Squire (2003) examples of uses:
 - Manipulate otherwise unalterable variables
 - Enable students to view phenomena from new perspectives
 - Observe systems behavior over time
 - Pose hypothetical questions to a system
 - Visualize a system in three dimensions
 - Compare simulations with their understanding of the system



Goals of Serious Games



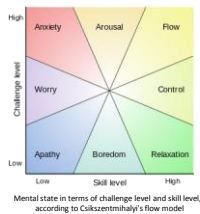
- Flow (Csikszentmihalyi)
 - Balancing challenge
 - See next slides
- Scaffolding
- “Transfer” Knowledge
- System Understanding
- Attitude/behavior change



FLOW



- FLOW is the mental state of operation in which a person performing an activity is fully immersed in a feeling of energized focus, full involvement, and enjoyment in the process of the activity
 - Characterized by complete absorption in what one does



[https://en.wikipedia.org/wiki/Flow_\(psychology\)](https://en.wikipedia.org/wiki/Flow_(psychology))



FLOW Components



- Six factors are encompassing a FLOW experience:
 - Intense and focused concentration on the present moment
 - Merging of action and awareness
 - A loss of reflective self-consciousness
 - A sense of personal control or agency over the situation or activity
 - A distortion of temporal experience, one's subjective experience of time is altered
 - Experience of the activity as intrinsically rewarding, also referred to as autotelic experience

[https://en.wikipedia.org/wiki/Flow_\(psychology\)](https://en.wikipedia.org/wiki/Flow_(psychology))



Serious Games Taxonomy

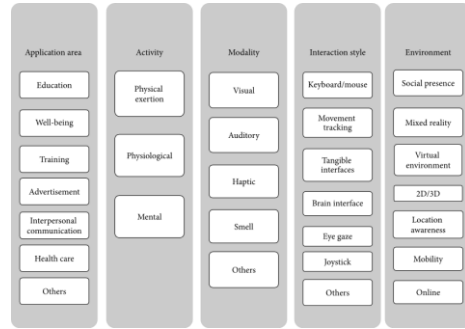


Serious Games Taxonomy
by Ben Sawyer, President, Digital Hill

SECTOR	GENRE						
	Games for Health	Advergames	Games for Training	Games for Education	Games for Science & Research	Production	Games as Work
Government & NGO	Public Health Education & Mass Casualty Response	Political Games	Employee Training	Inform Public	Data Collection/ Planning	Strategic & Policy Planning	Public Diplomacy, Opinion Research
Defense	Rehab & Wellness	Recruitment & Propaganda	Soldier Support Training	School House Education	War Games & Planning	War planning & weapons research	Command & Control
Healthcare	Cybertherapy/ E-ergaming	Public Health Policy & Social Awareness Campaigns	Training Games for Health Professionals	Games for Patient	Visualization/ Epidemiology	Biotech manufacturing & design	Public Health Response Planning & Logistics
Marketing & Communications	Advertising Treatment	Advertising: Marketing with games, product placement	Product Use	Product Information	Opinion Research	Machinima	Opinion Research
Education	Inform about disease/ risk	Social issue games	Train teachers/ Train workforce skills	Learning	Corporate Science & Recruitment	Documentary	Teaching Distance Learning
Corporate	Employee Health Information & Wellness	Customer Education & Awareness	Employee Training	Continuing Education & Certification	Advertising/ Visualization	Strategic Planning	Command & Control
Industry	Occupational Safety	Spies & Recruitment	Employee Training	Workforce Education	Process, optimization, simulation	Nano/Bio-Tech Design	Command & Control



Another Taxonomy



Laamarti, F., Eid, M., El Saddik, A. An Overview of Serious Games, International Journal of Computer Games Technology, Article ID 358152, 2014.



Prensky's Classification



Content	Learning activities	Possible Game Styles
Facts	Questions, memorization	Game show, competitions
Skills	Imitation, coaching, practice	Role-play, adventure
Judgment	Reviewing cases, asking questions, making choices	Role play, strategy
Behaviours	Imitation, feedback, practice	Role playing games
Theories	Logic, experiment, questioning	Simulation, game creation
Reasoning	Problems, examples	Puzzles
Process	Analysis, deconstruction, practice	Strategy, adventure
Procedures	Imitation, practice	Timed, reflex games
Creativity	Play	Puzzles, invention games
Language	Imitation, practice, immersion	Role play, reflex games
Systems	principles, tasks, simulation	Simulation games
Observation	Observing, feedback	Concentration, adventure
Communication	Imitation, practice	Role playing, reflex games



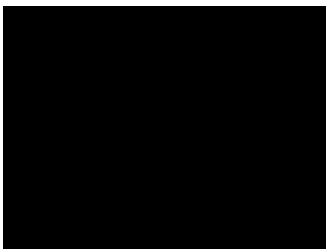
More Than Just Games



- A trend towards the development of more complex, serious games, which are informed by both pedagogical and game-like, fun elements
 - Application area of game engines and online virtual environments



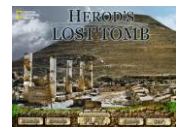
Early Example of Serious Games



Serious Games Forms

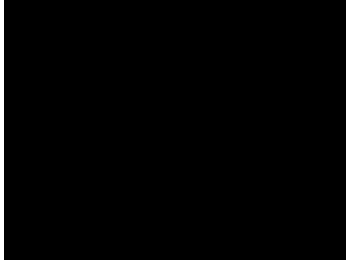


- Serious games can exist in the form of:
 - Simple web-based solutions
 - Online virtual environments
 - More complex 'mashup' applications
 - 'Grown-up' computer games
 - Mixed reality games
 - Mobile applications





Typical Example



Serious Games State-of-the-Art



- The state-of-the-art in Serious Game technology is identical to the state-of-the-art in Entertainment Games technology
 - They share the same technical infrastructure



Serious Games Uses



- Learning & Education
- Health Sciences
- Advertising
- Training
- Science and Research
- Art/Statement
- Journalism



Serious Games Strengths



- The main strengths could be generalised as being in the areas of:
 - Communication
 - Visual expression of information
 - Collaboration mechanisms
 - Interactivity
 - Entertainment



Requirements Gathering



- Need to work with Subject Matter Experts (SME's) to define learning/training content versus simply creating gameplay out of thin air
 - Game designers must work with instructional designers
 - Developers must effectively become SME's themselves



Challenges



- Access to SME's
- Access to environments
- Access to equipment
- Finding SME's fully knowledgeable in training content
- Creating SGs without simply creating a simulation





Serious Games Views



- Entertainment is more important!
 - While pedagogy is an implicit component of a SG it should be secondary to entertainment
- Education and pedagogy is more important!
 - Design methodologies for the development of games incorporating pedagogic elements



Anderson, E.F., McLoughlin, L., Liurokapis, F., Peters, C., Petridis, P., de Freitas, S. Developing serious games for cultural heritage: a state-of-the-art review. *Virtual Reality*, Springer, 34(4): 255-275, 2010. (ISSN: 1359-4338)



Engagement / Fun



- ... with what & why?
- In Traditional Teaching:
 - Engagement with Content is Primary
- In Entertainment Games:
 - Engagement with Tasks are Primary
- To a Professional Educator:
 - Learning is Predictable
- To a Professional Game Developer:
 - Fun is Predictable



Serious Game Design



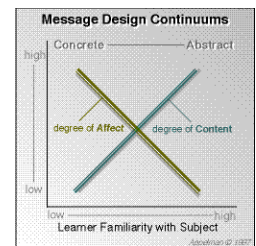
- The Context and Needs determine objectives
- The Learning Objectives need to be stated
- The Player Motivation needs to be defined
- The Ideal Learning Environment for this context, objectives, and desired outcomes must be defined
- The Learning Environment must dictate % game play and % authentic simulation



Affective/Cognitive Balance



- Affective presentation (game) effective when content knowledge is low and content density is also low
- As content knowledge goes up then content density may rise but authenticity and functionality (Sim) must also rise



The Player Experience



- Cognition – changes in cognitive and affective domains
- Metacognition –all that the player is aware of including:
 - Vision, audio, olfactory, kinesthetic, and haptic senses, plus an awareness of time, objects, & content
- Choice – perception of:
 - Degree of control, and access to variables and information during game play
- Action – perception that they can do things such as:
 - Interact with objects and elements within the game, have control of objects, elements, and own identity, have mobility to move through the environment, manipulate control interface to effect change



Game Structure



- Content
 - The story, the context, the amount of information available, the degree of concreteness or abstraction of the content, the authenticity, and its variability
- Environment
 - The virtual spaces and boundaries, the objects within these spaces and their functionality capabilities, plus any time limits imposed by the game
- Affordances
 - The abilities made for the player to change, manipulate, the objects, information, environment, their identity & capabilities, and/or to seek alternative information



Experiential Mode Triage



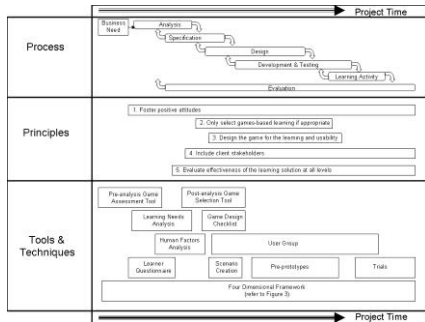
Four Dimensional Framework

Four Dimensional Framework	
Learner Specifics Profile Role Competencies	Pedagogy Associative Cognitive Social/Situative
Representation Fidelity Interactivity Immersion	Context Environment Access to learning Supporting resources

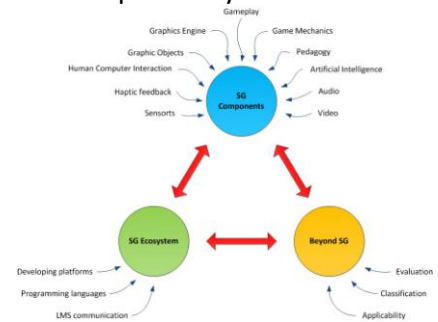
Four elements that can be used as design and evaluation criteria for the creation of serious games



Exploratory Game-Based Learning Model



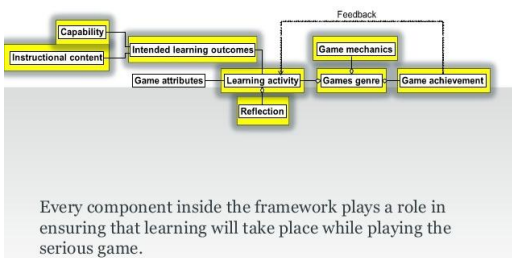
Serious Games Multidimensional Interoperability Framework



<http://seriousgamesociety.org/index.php/2014-07-11-14-15-51/evpon/134-media/388-serious-game-interoperability-the-good-the-better-is-the-optimal>



Conceptual Framework

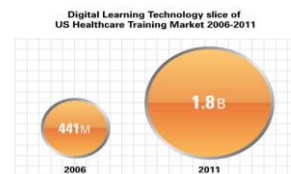


Every component inside the framework plays a role in ensuring that learning will take place while playing the serious game.

<http://www.slideshare.net/AmiYusoff/sgames2010-v3>



Serious Games Markets



Source: *Ambient Insight*, May 2009
ambientinsight.com

2007 Self-Paced E-Learning: \$13.6 Billion
5-year annual growth rate: 22%

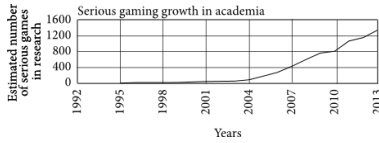
2006 Real-Time Collaboration-Based Learning: \$2.6 Billion
5-year annual growth rate: almost 35%

Real-time Collaboration-based Learning is fastest growing learning technology in US





Academic Impact



Serious games growth in the research field based on surveyed papers in ACM digital library and IEEE Xplore

Laamarti, F., Eid, M., El Saddik, A. An Overview of Serious Games, International Journal of Computer Games Technology, Article ID 358152, 2014.



Gamification

- Gamification is the application of game-design elements and game principles in non-game contexts
- Gamification commonly employs:
 - Game design elements
 - Organizational productivity
 - Flow
 - Learning
 - Employee recruitment and evaluation
 - Ease of use and usefulness of systems
 - Physical exercise
 - Etc

<https://en.wikipedia.org/wiki/Gamification>



Gamification Framework



<http://www.kickframe.com/blog/2014/11/4/gamification-framework>



Gamification vs Serious Games

Game Thinking, Broken down by design goal.

	Game Thinking	Game Elements	Game Play	Just for Fun
Game Inspired Design	●			
Gamification	●	●		
Serious Game / Simulation	●	●	●	
Game	●	●	●	●

<http://www.gamified.uk/gamification-framework/differences-between-gamification-and-games/>



Case Studies



Serious Games in Health

Triage Trainer,
TruSim, TSB,
VEGA Group,
Birmingham,
SGI



Preview
St Georges,
JISC,
SGI

Second Health
NPL, Imperial,
SGI



NanoMedicine
Playgen,
SGI

<http://www.seriousgamesinstitute.co.uk/>



NanoMedicine Video



Triage Trainer Case Study

- The game is set at the scene of an explosion in a busy high street
 - Player's job is to prioritise the multiple casualties for treatment
 - Trainees must follow set protocols to make decisions



<http://www.trisim.com/?page=CaseStudy>



Triage Trainer Video



RomaNova Case Study

- Serious game taking place in a replica of the antique city of Rome
- Aim is to teach history to young audiences
 - By means of an original engaging experience where the player is immersed in a crowd of virtual Romans



Doukakis, A., Liarokaps, F., Petridis, P., Miasoulis, G. Serious Games for Cultural Applications. Intelligent Computer Graphics 2011, Studies in Computational Intelligence, Plemenos, D., Miasoulis, G. (Eds.), Springer-Verlag, Volume 374/2012, 97-115, 2011. (ISBN: 978-3-642-15689-2)

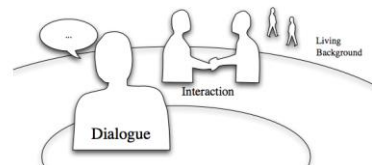
Learning in Roma Nova

- Levels of detail and levels of simulation for:
 - Crowd modelling
 - Animation techniques for cultural heritage
 - Pedagogical embedded conversational agents
- Seeking to advance information transfer through immersive 'living background'



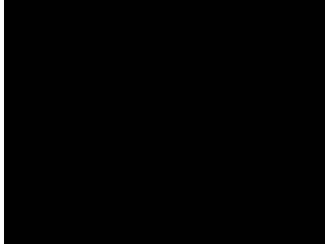
Level of Interaction Framework

- The LoI is a framework designed to model the interactions between the player and virtual characters, in a serious games perspective





Roma Nova Video



Online Virtual Environments



Virtual Environments (VEs)



- VEs are synthetic representations of reality
 - Focused on the experience that the users of these worlds have
 - Can be used by distributed groups of large numbers of players, and are immersive and interactive
- Many types exist
 - Focus is on Online Virtual Environments
 - Sometimes called 'Collaborative Virtual Environments'



Virtual Environments Experience



- Sensory Feedback – information about the virtual world is presented to the participant's senses
 - Visual (most common)
 - Audio
 - Touch
 - Smell
- Interactivity – the virtual world responds to the user's actions
 - Computer makes this possible
 - Real-time



Walking Experiment at UNC – Chapel Hill



Online VEs



- New ways of exploring web-based applications
 - Evolution of telecommunication technologies, web-services and software engineering
- Great range of different online virtual environments
 - More than 100 different ones



Collaborative Virtual Environments



- “Collaborative Virtual Environments (CVEs) are online digital places and spaces where we can be in touch, play together and work together, even when we are, geographically speaking, worlds apart...
- In CVEs we can share the experience of worlds beyond the physical” [Churchill/Snowdon/Munro 2001]



Key Components



- Graphic engines
- Displays
 - Monitors, HMDs, etc
- Interaction devices
 - Keyboard, mouse, trackers, etc
- Processing Systems
- Data Network



Types of VEs



- High realism online virtual gaming platforms
 - Custom, more experimental prototypes
 - Online game engines
- Alternative online virtual environments
 - Second Life, Active Worlds, OLIVE platform, etc



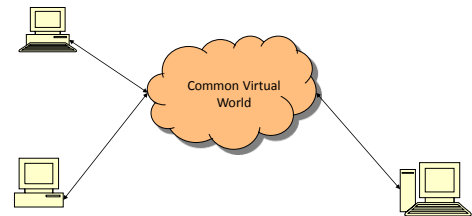
Typical Issues



- Some common research issues include:
 - What is the best virtual environment
 - What is the level of realism and interaction required
 - How best to design activities and experiences for learners



Basic Architecture



Current Challenges



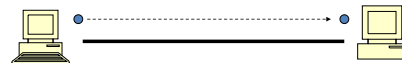
- Network Bandwidth/Latency
- Heterogeneity
- Distributed Interaction (real-time)
- Resource Management - Scalability



Networking Concepts



- Latency
 - Amount of time to transfer a bit of data from one point to another
 - Latency has a direct impact on interaction inside the virtual world
 - The designer cannot really reduce latency
 - It is possible to hide it or reduce its impact





Networking Concepts .



- Latency - causes:
 - Physical limitations: speed of electromagnetic waves in the transmission material
 - Approximately 8.25 msec per time zone
 - Delays introduced by the endpoint computers
 - Delays introduced by the network itself
 - Routers



Networking Concepts ..



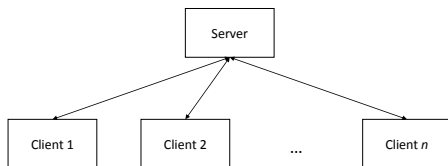
TCP	Small number of users Limited data requirements Typically client-server configuration
UDP	Higher data requirements Used both in client-server and peer-to-peer configurations.
IP Broadcasting	Small peer-to-peer Net VEs with high data requirements and time sensitive delivery.
IP Multicasting	Large peer-to-peer NetVEs, be careful with routers.



Architectures



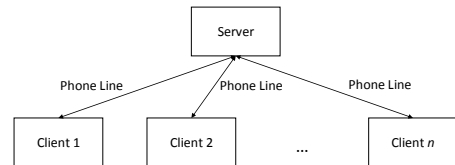
- Client-Server Systems
 - Logical architecture



Architectures .



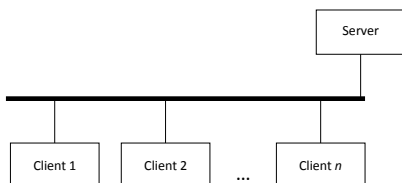
- Client-Server Systems
 - Physical architecture with phone lines



Architectures ..



- Client-Server Systems
 - Physical architecture on a LAN



Architectures ...



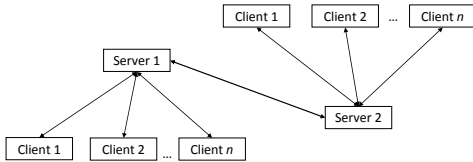
- Client-Server Systems
 - The Server can become a bottleneck.
 - What are the advantages? The server can decide::
 - Which clients should receive a message.
 - What protocol to use with different clients.
 - Sub-sample messages to slow users.
 - Keep statistics



Architectures



- Multiple-Server Architectures



Architectures



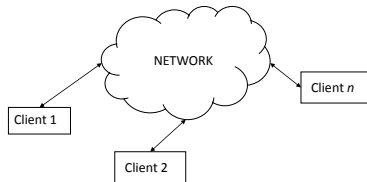
- Multiple-Server Architectures
 - Several servers have the following advantages:
 - System scales better
 - Communication between clients attached to different servers takes longer
 - Key issue: how to assign clients to servers?



Architectures



- Peer-to-peer



Architectures



- Peer-to-peer
 - “Network” will be:
 - Broadcast
 - One or multiple multicast groups
 - In the case of multicast groups:
 - Area of Interest Management: assign different users to different multicast groups, based on some criteria



Technology Comparison



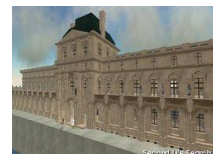
Technology	Speed (Kbps)	Min # players	Max # players
Modem	56	1	6
DSL	1500	39	163
T-1	1500	39	163
10BT	10,000	263	1085
100BT	100,000	2630	10851



Second Life – An example



- A typical illustration of online virtual environments is Second Life
 - 13 million registered accounts worldwide
- An open source approach exists
 - OpenSim





Second Life Video



Case Studies

<https://www.youtube.com/watch?v=3QK9BMR9yM>



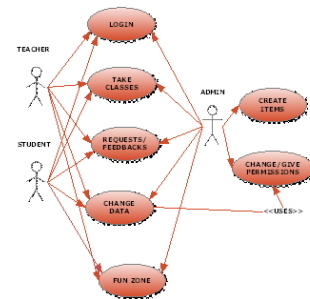
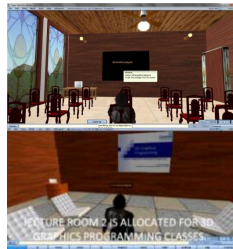
OpenSim Case Study



Virtual Learning Environment



- Online Virtual Learning Environment
 - OpenSim
 - Open source
 - Creates dynamic online VEs
 - Allows customisation
 - Supports different database systems
 - Aim:
 - Teach computer graphics University UG students



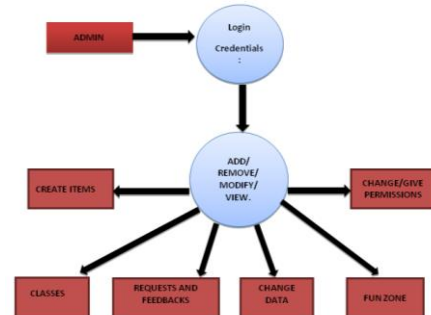
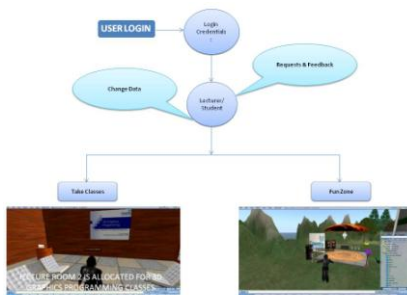
Jaligama, V, Lianelagis, F. An Online Virtual Learning Environment for Higher Education, Proc. of the 3rd International Conference in Games and Virtual Worlds for Serious Applications (VS-Games'11), IEEE Computer Society, Athens, Greece, 4-6 May, 2012, 207-214, 2011. (ISBN: 978-0-7695-4419-9)



User-System Interaction

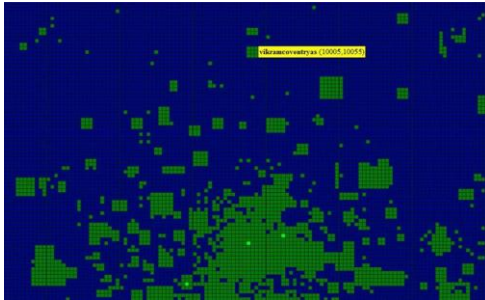


Administrator Privileges





Online VE Location



Modelling



Virtual Fun Zone



Online Teaching



- A 2nd year computer science undergraduate module has been ported into our online virtual learning environment
 - Called '3D Graphics Programming' and introduces 3D computer games graphic programming fundamentals to the students
- The theoretical part covers issues such as textures, global illumination and the simulation of physical phenomena



Online Virtual Classroom



User Evaluation



- Two-stage evaluation with 20 participants was performed and qualitative and quantitative feedback was recorded
 - Participants ranged from students to business professionals
 - Evaluation lasted for approximately 1 hour per participant
- All end-users had some experience with computer games, console games or online virtual environments



Qualitative Evaluation



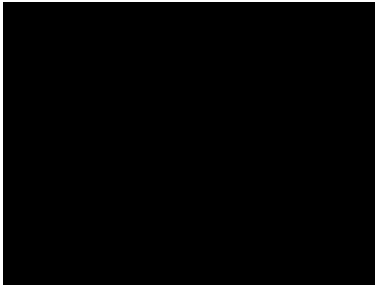
- On the positive side, most participants noted that the platform is quite enjoyable and has a lot of potential for remote learning
- On the negative side, some participants did not like the idea of spending some time to familiarise with the platform



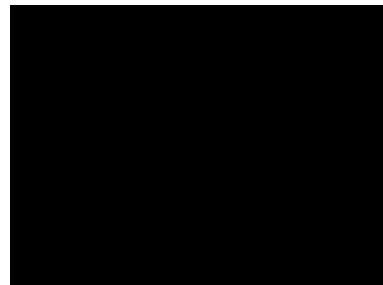
Feedback



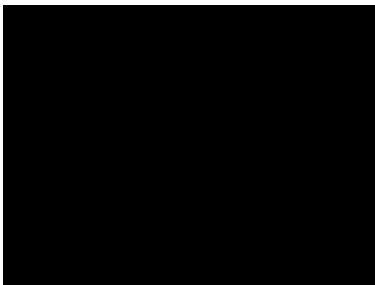
Video 1



Video 2



Video 3



Videos



- http://www.youtube.com/watch?v=rZ5vzsNugVQ&feature=mfu_in_order&playnext=1&videos=_6TNubnTOTO
- http://www.youtube.com/watch?v=HI7nrORinrg&feature=mfu_in_order&list=UL
- <http://www.youtube.com/watch?v=NGf9BTGsAB8>
- http://www.youtube.com/watch?v=a5itQRi7Sog&feature=mfu_in_order&list=UL



VS-Games Conferences



- VS-Games 2009, Coventry, UK
 - <http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=5116537>
- VS-Games 2010, Braga, Portugal
 - <http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=5458389>
- VS-Games 2011, Athens, Greece
 - <http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?reload=true&punumber=5962074>



IEEE VS-Games 2018



- Dates:
 - Submission: 30th April 2018
 - Conference: 5-7 September 2018
- Location: Würzburg, Germany
- Website: <https://vsgames.org/2018/>



Conclusions



- Serious games are becoming more and more popular
 - Expected to get 'serious' profits in the games industry
- Computer graphics technology is the same
 - For games and serious games
- More research is required in many areas
 - HCI, personalisation and pedagogy



Bibliography



- de Freitas, S. & Maharg, P. (Eds) (2011) Digital Games and Learning. London and New York: Continuum Press
- de Freitas, S. & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? Computers and Education, 46 (3): 249-264
- Michael, D. & Chen, S. (2006) Serious Games: Games that Educate, Train and Inform. Boston, MA: Course Technology PTR
- Salen, K & Zimmerman, E. (2003) Rules of Play, MIT Press
- Bergeron, B. (2006) Developing Serious Games, Thomson



Questions

