Designing a Course on Serious Games Programming

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Contents

• What are **Serious Games**?
• Who is interested in Serious Games?
• Why should we teach Serious Games Programming?
• What should a Master Course on Serious Games Programming aim at?
• What are the challenges in designing the course?
Serious Games

Murratet et al. 2009

Winn 2009

Zyda 2005
What are Serious Games?

• **Serious Games** are not just for entertainment, but they are specifically designed to change behaviors and **impart knowledge** and are widely used in training situations, such as emergency preparedness, training for leadership and even citizenship.

• *These games have wide acceptance due to their challenging design and the social interactions that they generate.*

• *Research showed that games also develop mental abilities and skills such as strategy and decision making. They also promote digital competence and other key transversal competences for life and employability.*

**SEGAN:** [http://seriousgamesnet.eu/](http://seriousgamesnet.eu/)
What are Serious Games?

• **Serious games** are simulations of real-world events or processes designed for the purpose of solving a problem.
• Although serious games can be entertaining, their main purpose is to train or **educate** users, though it may have other purposes, such as marketing or advertisement.
• Serious games are not a game genre but a category of games with different purposes. This category includes some **educational games** and advergames, political games, and so on.
• Serious games are primarily focused on an audience outside of primary or secondary education.

http://en.wikipedia.org/wiki/Serious_game
What are Serious Games?

Mike Zyda’s definition:

• **Game**: a physical or mental contest, played according to specific rules, with the goal of amusing or rewarding the participant.

• **Video Game**: a mental contest, *played with a computer* according to certain rules for amusement, recreation, or winning a stake.

• **Serious Game**: a mental contest, played with a computer in accordance with specific rules that *uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives*.

What are Serious Games used for?

SGs are used for various purposes, such as:

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Simulation</th>
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<tbody>
<tr>
<td>E-learning</td>
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<tr>
<td>Training</td>
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<tr>
<td>Team-building</td>
<td>Collaboration</td>
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<tr>
<td>Collaboration</td>
<td>Social Networking</td>
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<tr>
<td>Advertising</td>
<td>Business Modeling</td>
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<tr>
<td>Business Modeling</td>
<td>Investigating ...</td>
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</table>

They are used in many industries and sectors, such as:

<table>
<thead>
<tr>
<th>Industry</th>
<th>Sector</th>
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<tbody>
<tr>
<td>Education</td>
<td>Healthcare</td>
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<tr>
<td>Business</td>
<td></td>
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<tr>
<td>Scientific exploration</td>
<td>Emergency Management</td>
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<tr>
<td>Engineering</td>
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<tr>
<td>Military Defense</td>
<td>Tourism and cultural Heritage ...</td>
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<tr>
<td>City Planning</td>
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Who is interested in SGs?

The Serious Games Industry ...

“Research Debuted at Serious Play Conference Shows Growing Acceptance, LOS ANGELES – Aug. 23, 2012:

– The serious games market is already a **multi-billion dollar industry**, growing at a slow, but steady pace as games and simulations designed for education and training purposes gain acceptance, according to research studies.

– Latin America sales are growing at the highest rate at 29.1%, followed by **Eastern Europe** and Africa at **25.7%** and 20.7%, respectively.”

Who is interested in SGs?


- **ICT 20 – 2015**: Technologies for better human learning and teaching

  *Specific Challenge: The development and integration of robust and fit-for-purpose digital technologies for learning are crucial to boost the market for and innovation in educational technologies.*

  ... apply e.g. adaptive learning, augmented cognition technologies, affective learning, microlearning, game-based learning and/or virtual environments/virtual worlds to real-life learning situations.

- **ICT 21 – 2014**: Advanced digital gaming/gamification technologies

  *Specific Challenge: Digital games and gamification mechanics applied in non-leisure contexts is an important but scattered industry that can bring high pay-offs and lead to the emergence of a prospering market.*

  ... development of new methodologies and tools to produce, apply and use digital games and gamification techniques in non-leisure contexts, as well as building scientific evidence on their benefits - for governments, enterprises and individuals.
Who is interested in SGs?

EU Research Networks ...

- Games and Learning Alliance – GALA: http://www.galanoe.eu/
- Making Games in Collaboration for Learning - MAGICAL: http://www.magical-project.net/
- SEGAN: http://seriousgamesnet.eu/
- Serious Games Institute - SGI: http://www.seriousgamesinstitute.co.uk/
- LUDUS: http://www.ludus-project.eu/
- ... and many more
Who is interested in SGs?

Researchers, Instructors (Game-based Learning) ...

- European Conference on Games Based Learning (ECGBL)  
  \textit{(8\textsuperscript{th} ECGBL Conf., 9-10 October, Berlin, Germany)}

- International Conference on Serious Games Development and Applications (SGDA)  
  \textit{(5\textsuperscript{th} SGDA Conf., 9-10 October, Berlin, Germany)}

- European Alliance for Innovation (EAI) Endorsed Transaction on Serious Games

- International Journal of Game-Based Learning

- Several special issues in International Journals

- Special sessions in International Conferences (ACM ITiCSE, IEEE ICALT, IEEE EDUCON)

- ...
Who is interested in SGs?

Master programs ...

• **Msc Serious Games Development**, University of Glasgow, UK: [http://www.gsa.ac.uk/study/graduate-degrees/serious-games-development/](http://www.gsa.ac.uk/study/graduate-degrees/serious-games-development/)

• **Msc Serious Games**, University of Skövde, Sweeden: [http://www.his.se/en/Prospective-student/education/master-studies/Serious-Games/](http://www.his.se/en/Prospective-student/education/master-studies/Serious-Games/)

• **Games and Meaningful Play Msc**, Michigan State University: [http://seriousgames.msu.edu/ma/](http://seriousgames.msu.edu/ma/)

• and many more...
Designing a MSc Course on Serious Games Programming
MSc in “Applied Informatics” with 4 specializations (new program of studies from the academic year 2014-15):

- Computer Systems and Network Technologies
  - Course: **Serious Games Programming**
- Computational Methods and Applications
- Business Computing
- E-Business and Innovation Technology

In each one of the first 2 semesters students choose 4 courses (1 course per semester might be selected from one of the other streams of specialization).
What are the objectives of the course?

The aim of the course is for students to acquire:

(a) knowledge of the role, the types and the features of serious games, as well as the whole process of devising a serious game,

(b) capabilities of designing and implementing serious games using contemporary tools, interfaces and programming languages,

(c) knowledge and capabilities of using/devising evaluation metrics for serious games based on the aims defined during its design.
Upon successful completion of this course students will be able to:

• **evaluate the design quality** of serious games and the degree they fulfill the initial goals

• **design serious games** taking into account various factors/design principles

• **implement simple serious games** using the object-oriented programming technique and game libraries\engines
What should the content of the course be?

In order to fulfill its goals the course must combine material taught in different courses in a MSc on (Serious) Games:

<table>
<thead>
<tr>
<th>MSc</th>
<th>Courses</th>
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<tr>
<td><em>Msc Serious Games Development</em>, University of Glasgow, UK</td>
<td>▪ Serious Game Design and Research,</td>
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<td>▪ Serious Games Development,</td>
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<td></td>
<td>▪ Game Programming</td>
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<tr>
<td><em>Msc Serious Games</em>, University of Skövde, Sweden</td>
<td>▪ Serious Games Research and Development</td>
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<tr>
<td><em>Games and Meaningful Play Msc</em>, Michigan State University</td>
<td>▪ Foundations of Serious Games,</td>
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<tr>
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<td>▪ Game Design and Development I</td>
</tr>
<tr>
<td><em>Master of Entertainment Technology</em>, Carnegie Mellon University</td>
<td>▪ Game Design</td>
</tr>
<tr>
<td><em>Game Design and Development MSc</em>, Rochester Institute of Technology, NY</td>
<td>▪ Game Design,</td>
</tr>
<tr>
<td></td>
<td>▪ Game Development Processes</td>
</tr>
<tr>
<td>Topics</td>
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</table>
| Foundations of SGs | - The **role** of serious games as tools for educating, skills acquisition and simulation in various sectors, such as education, health and business processes.  
- **Game genres** (i.e. puzzle, strategy, role-playing games).  
- **Types and features** of SGs.  
- Review of representative **examples** of serious games. |
| Designing SGs     | - **Scenario:** the world, the characters (players and bots) and their actions, the levels of the game.  
- **Content and pedagogy:** learning objectives, learning outcomes, activities.  
- **Design principles, methodologies** and **frameworks**. |
| Evaluating SGs    | - Evaluating the quality of existing serious games using **frameworks** and quality **metrics**. |
| Programming SGs   | - The game loop, game architecture and game state, interaction and event handling, rendering text, 2D graphics and animation, game math, arrays and object collections.  
- **Tools, engines** and **programming interfaces** for serious games.  
- Designing a SG using contemporary game engines and platform independent graphics libraries (such as OpenGL) and implementing it in C#, C++ or Java. |
### What programming language should be used?

<table>
<thead>
<tr>
<th>Programming Language</th>
<th>Advantages and drawbacks for Game Programming</th>
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</table>
| Java                | (+) uses a Virtual Machine: one version of the game runs on various CPUs  
|                     | (+) client or server side, interpreted, OS independent.  
|                     | (-) non-deterministic memory management  
|                     | (-) lack of 3rd party libraries  
|                     | (-) smaller community for game development |
| C++                 | (+) low level memory management  
|                     | (+) multi-platform language  
|                     | (+) client executable, no interpreter/vm required  
|                     | (+) there are plenty of SDKs/APIs/Libraries for game programming  
|                     | (-) separate compiled versions are required |
| C#                  | (+) uses a Virtual Machine: one version of the game runs on various CPUs  
|                     | (+) is a higher level language and is much easier to learn to begin with  
|                     | (+) client executable, interpreted, best for windows  
|                     | (+) there are plenty of SDKs/APIs/Libraries for game programming  
|                     | (-) XNA on Microsoft platforms like Windows and Xbox 360 |
It depends on the requirements of the game

- Single Player/ multiplayer?
- 2D/3D?
- Memory management?
- OS independent/ browser games

Ok! **But which language should be better used in the course?**

**Facts:**
- Knowledge of Object-Oriented Programming in any language is a prerequisite for attending the course
- Students that have no background can attend the OOP course offered in the undergraduate curriculum

**Concerns/criteria:**
- Which language better supports the teaching/learning of game programming?
- Free and user-friendly programming environment?
- Available resources (good textbook, open source projects, community, libraries, SDKs)?
- Acceptance in games industry and skills for employability?
What teaching approach will be applied?

Designing and implementing a serious game is complex.

Teaching SGs programming is challenging!

How will be students supported?
**Hands-on activities for applying theory**

- Evaluating the design and quality (in terms of fulfilling its goals) of a SG using one of the available design frameworks.
- Revising a SGs design framework for applying it in a specific type of SGs (i.e. health SGs).
- Designing a SG for a specific purpose and writing a report for the choices made using one of the available design frameworks.

**Usage of educational software**

- Creating the prototype of a game using educational software, such as GameMaker, GreenFoot, or even Scratch.

**Learning through open-source SG projects**

- Study and document the source code of SGs
Case study: the CMX MMORPG for programming

CMX is an educational game that aims to introduce students to computer programming, to help them get acquainted with the way computer programs are structured and also allow them to engage in algorithmic logic.

The following aspects of CMX will be studied:
- Design framework
- Software architecture and technical/programming issues
- Learning Analytics
- Evaluation Framework

http://users.uom.gr/~malliarakis
Case study: CMX Design Framework
The CMX Design framework includes concepts that need to be represented within any educational game that aims to teach computer programming. It is abstract enough to be employed by future designers and developers and detailed enough to act as a solid guide without allowing many arbitraries.
Case study: Learning Analytics Framework

The educational score the player gets in the game’s progression is dependant on:

a) the player’s success percentage during the assessments ($S^{CS}$),
b) how many errors the player made ($E^{CS}$),
c) how active the player is ($A^{CS}$),
d) how frequently the player visits the game, ($F^{CS}$),
e) how collaborative the player is, ($C^{CS}$).
Case study: Evaluation Framework

Each axis represents a specific aspect that needs to be assessed in order to determine the overall game’s efficiency.
Conclusions

| SGs are important | • Industry  
|                   | • Research  
|                   | • Education  
| We consider teaching SGs Programming important | • Foundations of SGs  
| | • Analysis  
| | • Design  
| | • Implementation  
| | • Evaluation  
| A MSc Course on SGs Programming was designed | • MSc on Applied Informatics  
| | • Computer Systems and Network Technologies specialization  
| Teaching the aforementioned aspects of SGs Programming in a single course is challenging | • Active learning  
| | • Learning through projects  
| | • Case studies  
| | • Experiences, Ideas?  

|
Textbooks


