Gaming Learning Analytics: Contributing to the Serious Games Ecosystem

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Serious Games Market

2014-2019 Global Market Forecasts for Game-based Learning and Simulation-based Learning

- Ambient Insight separates Game-based Learning revenues and Simulation-based Learning revenues.
- There are distinct pedagogical differences between Game-based Learning and Simulation-based Learning.
- Our definitions are based on the definitions developed by Alessi and Trollip.

### Global Revenues by Learning Product Type

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Simulation-based Learning</td>
<td>$3,823.29</td>
<td>$8,307.95</td>
<td>16.8%</td>
</tr>
<tr>
<td>Game-based Learning</td>
<td>$1,841.41</td>
<td>$4,954.12</td>
<td>21.9%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$5,664.70</strong></td>
<td><strong>$13,262.55</strong></td>
<td><strong>18.5%</strong></td>
</tr>
</tbody>
</table>

***Does not include hardware

2014-2019 Worldwide Five-year Growth Rates by Seven Learning Technology Product Types

ALL RIGHT, KIDS! Raise your hand if you like algebra! Hmmm. Now, raise your hands if you like Angry Birds! I see. What if I were to tell you that Angry Birds had been surpassed in the App Store — by a game that involves solving algebra equations? Because that’s what DragonBox did.

https://www.wired.com/2012/06/dragonbox/
Educational

You don't have to be a genius to understand the world of science. Explore the life and work of Nobel Laureates. These games and simulations, based on their achievements, will teach and inspire you while you learn.
RAGE Project presentation

07/10/2016
Game Learning Analytics

• **Learning Analytics** Improving education based on data analysis
  – Data driven
  – Evidence-based education

• **Gaming Learning Analytics** is a specific case when all interaction data is used in serious games for improving the learning process supported by the games
  – Educational games not as “black boxes”
  – In games is called Telemetry or Game metrics

• **GLA allows for new business models for serious games**
  – Serious game as a service

Uses of Gaming Learning Analytics in educational games

- Game testing – game analytics
  - Is the game reliable?
  - How many students finish the game?
  - Average time to complete the game?

- Game deployment in the class – tools for teachers
  - Real-time information for supporting the teacher
  - Knowing what is happening when the game is deployed in the class
  - "Stealth" student evaluation

- Formal Game evaluation
  - From pre-post test to evaluation based on game learning analytics??
It is GLA feasible for a SME?

• Game Learning Analytics imposes new requirement on already struggling Game developers
  – Not many of the SME that develop games are collecting and exploiting learning analytics data
  – GLA requires different technology and expertise
  – When done it is very “game dependent”

But there are new specifications and developments that could systematize the work
H2020 RAGE project

- RAGE will deliver advanced technology and know-how to support the European Applied Games industry build-up and job creation
  - February 2015, 4 years, 19 partners, 9M
- Creating a new serious games ecosystem by making available a set of reusable technology components for developing advance serious games easier, faster and more cost-effectively
- Open source gaming learning analytics framework
  - provide all the required services (e.g. game tracker, learning analytics server, visualization of analytics information)
  - easy inclusion of gaming learning analytics techniques in the new games
User Data Analytics Outline

• Collecting and assessing game-based user data
  – the collection and aggregation of data
  – the interpretation of the data to support further intervention
• Solid data protection and authentication procedures
  – Data anonymization when possible
• Generalization of the approach
  – Applicable to different kind of games
• Use of standards
User Data Analytics Approach
Collecting data: xAPI application profile for serious games with ADL

- We can collect the relevant data in a standard format using xAPI
- Creation of an xAPI serious games profile with ADL
- This will simplify the analysis and visualization of data (e.g. dashboards)

xAPI profile for serious games developed with ADL

• Definition of a general interaction model for applying Game Learning Analytics with serious games
  – Completion (A level/stage/puzzle or completion percentage)
  – In-game choices (player selections in the game)
  – Meaningful variables (i.e. Score, Coins …)
  – Meaningful actions (i.e. ask for help, …)
  – Custom interactions (Game-specific interactions)

• Definition of an xAPI application profile for serious games
  – Implementation of our general model in xAPI
Countrix: Demo Quiz Game

- Available at Google play

![Image of Countrix app interface]
# Architecture and Technologies

The architecture and technologies diagram illustrates the interaction between various components of the system. Here is a breakdown of the key elements:

## Client
- **Players**: Engage with games and analytics.
- **Devs, Students, Teachers**: Access A2 Frontend for development and learning.
- **Admins**: Manage A2 Frontend for security and resource management.

## A2
- **Authentication and Authorization**: Uses JWT (JSON WEB TOKEN) for secure user interactions.
- **Users**: Include roles, resources, permissions, and applications.

## Applications
- **Applications 1 to N**: Represent various applications that interact with the backend.
- **Collector**: Gathers data from sessions and results.
- **Kafka Queue**: Facilitates data flow between components.

## Analytics Backend
- **Visualization**: Utilizes tools like Kibana for data visualization.
- **Games Sessions**: Tracks user interactions and sessions.
- **Results**: Store and display analytics results.

## Topology
- The topology diagram highlights the network and system architecture, showing how different components are interconnected.

The diagram emphasizes the importance of security, user accessibility, and the flow of data within the system.
H2020 Beaconing project

- BEACONING stands for ‘Breaking Educational Barriers with Contextualised, Pervasive and Gameful Learning’
  - Started in January 2016, 15 partners, 9 countries, 6M
- Global goal is learning ‘anytime anywhere’
  - Exploitation of technologies for contextual pervasive games and use of gamification techniques
  - Enriching the Gaming Learning Analytics data model with the contextual, geolocalized and accessibility information
- Large pilots in real settings with content providers
  - Formal and informal learning across virtual and physical spaces
- LA is a key element in the games and pilots evaluation
- Using RAGE infrastructure and extending it for these new requirements and applications
Other initiatives:
IMS Global

http://www.imsglobal.org/
Apereo & OpenDashboards

https://www.apereo.org
Testing RAGE Analytics with a previously existing game

First Aid Game - Proof of concept
Integrated Assets Demo

Game Client Tracker 2.1a,
Server Side interaction storage & analytics 2.1b,
Server Side Authentication & Authorization 2.4a,
Server Side Dashboard & Analytics
About the game

- The **goal** of the game is that students learn how to correctly react under emergency situations and apply **first aid**. (Based on ILCOR 2011)
- Three situations:
  - Choking
  - Chest pain
  - Unconscious
- Game already **validated** and manually tested in **actual schools**
- Game rebuilt with uAdventure
- Include analytics using RAGE tracker based on xAPI specification
Connecting the game with RAGE Analytics

- Choose between three available activity trackers:
  - C# Tracker, Java Tracker
  - Unity 3D tracker
- Developer registers the Game in RAGE, and a Tracking Code is generated.
- For each group of players, teachers can now configure a new Class in RAGE.
- Once the teacher starts the Class, data collection and analytics begins.
Analytics for teachers and developers

- Different data will be used and presented to different stakeholders
  - **Teacher** has access to all the data from **their classes**
  - **Developer** have **anonymized** access to data from **all classes**
  - Visualizations for each stakeholder can be chosen at game setup time

<table>
<thead>
<tr>
<th>teacher</th>
<th>developer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learner activity over time</td>
<td>Most used xAPI verb</td>
</tr>
<tr>
<td>Questions answered correct/failed</td>
<td>Times interacted with GameObjects, most/less used</td>
</tr>
<tr>
<td>Full game progress and each single level completion</td>
<td>Min, average, and max time to complete levels or even full game</td>
</tr>
<tr>
<td>Relation between videos seen/skipped</td>
<td>Times each video has been seen</td>
</tr>
</tbody>
</table>
¡More than 20 different analysis and visualizations have been created!
Visualizations configuration

Game Example Game

Analytics Setup

Visualization selection

Visualizations

Visualization templates describe families of graphics and plots; a Visualization Template, when, combined with fields from an Index Pattern, fully describes a visualization, which can then be populated with data.

Add new visualizations template:
Choose File: No file chosen
Submit visualizations template

Or use this visualization:

<table>
<thead>
<tr>
<th>Visualizations</th>
<th>Teacher</th>
<th>Developer</th>
</tr>
</thead>
<tbody>
<tr>
<td>AlternativeSelectedCorrectIncorrectPerQuestionId-Gmn</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>CompletablesCompletedperTarget</td>
<td></td>
<td>✔️</td>
</tr>
<tr>
<td>AccessibleAccessedperTargetId</td>
<td></td>
<td>✔️</td>
</tr>
</tbody>
</table>
Real-time analytics: Alerts and Warnings

- Identify situations that may require teacher intervention
- Fully customizable alert and warning system for real-time teacher feedback

**Inactive learner**: triggers when no traces received in #number of minutes (e.g. 2 minutes)

**> 50% incorrect answers**: after a minimum amount of questions answered, if more than half of the students that need attention

View for an specific student (name anonymized)
From RAGE to BEACONING

- Reuse of our previous experience in serious games with eAdventure
- Include learning analytics in the game design
- Simplify the full life cycle: from authoring to deployment and application
Conclusions

• Game Learning Analytics has a great potential from the business, application and research perspective

• Still complex to implement GLA in SG
  – Increases the (already high) cost of the games
  – Requires expertise not always present in SME

• New standards specifications and open software development could greatly simplify GLA implementation and adoption
REFERENCES
