Using Gamification in Technical Higher Education: An XP Report

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The SIGCSE 2014 Puzzle Challenge
#2 Meet New People

- Badge holder = 2 dots
- 3 possible colors (Brown, Orange, Green)
- Task:
  Form groups of 3 with
  1x Brown +
  2x Green +
  3x Orange +
- Exchange contact
- Email each to sigcse14puzzle@gmail.com
A Testimonial

I want to thank you for showing that even though I’m not that good at written exams, I still can excel at other points in my study. I’d love to have a copy of my badge, as physical reminder of a course that made me eager to learn about things. Even when some of those things will never really have my interest. This course, and the way it was given, learned me a few things about what motivates me, and only for that reason it was totally worth getting up for every lecture.

Image source: http://www.bcsea.org/learn/educational-opportunities

Why Fix It If It Ain’t Broken?

- Well, it’s broken bad (at least the grammar)
- New generation of students
  - Attention span
  - Is higher education needed?
  - A technical education?!
- New understanding of students
  - International means multi-cultural
  - Aware of individual personality and skill-level
- It’s not you, it’s me
- New ambition of GamificationU (Top-20 Eng/Tech*)
  - <35% finish 3-year B.Sc. Curriculum in 4 years ...
  - ... but cannot select students

Why Gamification*?

* Making courses similar to social game universes

"Science and scholarship are much like games. [...] playing involves creating, testing and revising strategies as well as the skills necessary for progressing in the game." Mayra 2009

"51% US households own a console ... 58% Americans play ... 45% are women" ESA‘14

Gaming is challenge and reward, tension and catharsis

Game universes populated with all levels of skill

Game universes populated with all personalities

Gamification* in Higher Education = Rich Opportunity

* Making courses similar to social game universes

Gaming used to be about youths, now all generations
What is This Talk Also About?
My Personal Curiosity*


* “A Magical New Adventure” http://pbskids.org/itsmylife/blog/2010/03/miyazaki-mania.html
What Is This Talk About?

Q: What would you learn about art from the High Museum of Art’s poster?

1. Intro: Atlanta, we have a problem
2. What’s in a game?
3. Could gaming techniques work in education?
4. Our work on gamification
   1. How to gamify a course? (theory)
   2. Is gamification useful? (practice)
5. Conclusion
What’s in a name?

Over 250,000,000 active players

Social Gaming = (online) games for which social interaction helps the gaming experience

1. Mechanics
   Explore, do, learn, socialize, compete +

2. Dynamics, incl. Rewards
   Player stats, badges, others +

3. Game Content*
   puzzles, challenges, extra-projects, culture

*Romeo and Juliet

* Art class pending.
Could Work: Games Already Cater for Different Player Types

- Richard Bartle’s “Players who suit MUDs”
  - Achievers
    - Solve the challenge
  - Explorers
    - See what’s there
  - Socializers
    - There for others
  - Killers / Winners
    - Win against others

Our U: <5%
Each ~25% players
But…: (Meta-)Research on the Use of Game Elements in Education

<table>
<thead>
<tr>
<th>Study</th>
<th>Meta-study of … studies</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randel et al. (1992)</td>
<td>&gt;60</td>
<td>&gt;50% no difference if using games. &gt;30% significant improvement when using games.</td>
</tr>
<tr>
<td>Hays (2005)</td>
<td>&gt;100</td>
<td>Game <strong>design must match learning objectives.</strong></td>
</tr>
<tr>
<td>Vogel et al. (2006)</td>
<td>&gt;30</td>
<td>Games <strong>can help</strong> improve cognitive skills vs. traditional.</td>
</tr>
<tr>
<td>Sitzman (2011)</td>
<td>&gt;60</td>
<td>Playing <strong>improves confidence.</strong> Vs. traditional, better retention, declarative and procedural knowledge</td>
</tr>
</tbody>
</table>
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Our Work At GamificationU, 10+ Operational Years Since 2007

• B.Sc. Courses
  • (B) Computer Organization (4 years + ongoing)
    (previously, was rated consistently lower than others, considered tough and boring course, different type of learning—comp.systems)
  • Bachelorseminarium (5 years, evolving form)

• M.Sc. Courses
  • (M) Cloud Computing (2 year, pair teaching, new course)
  • Distributed Computing Systems (1 year + ongoing, new course)
Into Our Approach to Gamification:
1 B.Sc. Course, 1 M.Sc. Course

- Education in systems, especially parallel and distributed computing
- Technically deep, conceptually at least broad
- Scalability and elasticity are long-lasting research topics
- Emerging comp.sci. topics, such as GPUs and cloud computing
Gamification Elements

- Too many to list here
  - Scoring system is but one element
  - Badges? Only for B.Sc., some “random”

- Onboarding (dynamics)
  - Entry quiz
  - Story every lecture

- Social Learning (dynamics)
  - In-class teams
  - Self-study as team effort
  - Involve Winners and Achievers in class
  - Involve Winners and Explorers in self-study

- Different player types
  - Ladders, ranking, end-lecture quiz: mostly for Winners
  - Content unlocking (dynamics): Explorers and Achievers

Tip: Ask me, at the end, about the scoring system.

Manga cum laude
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Is This Playful (or) Education?

Q: Is gamification useful for educators?

Two thirds of our students pass after their first try.

Exam in 2012 more difficult than exam in 2011. ASO.
Self-study work in 2012 more extensive than in 2011. ASO.
We keep top students in the classroom.
We get requests for Honors Track/Challent.
etc.
Gamification, the Numbers:
Overall Participation and Success

- Increasing number of students, B.Sc. (M.Sc. designed for ~15)
- Exam results: Gamification delivers at least as traditional approach
- Scalability limit with gamification? Future work.
Gamification, the Numbers: Successful Via Alternative Paths

Successful = bonus-worthy

- A significant fraction of students take alternative paths of advancement
- Increasingly more students benefit from each alternative (warning: natural limit at 100%)
- At least one successful alternative? 45%

Q: Is it good for so many students to receive bonuses? (Hint: In-class bonus=0.5%/item)
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Gamification* in Higher Education = Rich Opportunity

* Making courses similar to social game universes

Gamification = mechanics, dynamics, content (art)

10+ operational years of experience at GamificationU

Gamified courses can deliver results at least as good as traditional approaches, but can engage students more

There’s no free lunch!

Tip: Ask me about the costs.

TODO: which mechanisms? Longitudinal studies. Etc.

Tip: Ask me, at the end, about the future work.
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Tip: Ask other findings?
Tip: Ask me about the costs.
Tip: Ask me, at the end, about the future work.
We Also Found That...

- Top students like to learn for the sake of learning (based on participation in un-marked extra-lectures).

- Mid-term performance characterizes well the top performers. This allows for an early identification of Winners and Achievers.

- Only about 10-15% of the students fit, in our experience, the profile of Winners (~5%) or Achievers. This is much less than expected (25%).

- For the gamification-based courses, a high fraction of students who have failed the first time return to take the re-examination exam. This contrasts starkly with non-gamified courses.

http://pbskids.org/itsmylife/blog/2010/03/miyazaki-mania.html
There’s No Free Lunch in Comp.Sci.
(My Personal XP)

- Gamification takes time and energy
  - One week to consider gamification elements +
  - One day per lecture for adaptation +
  - Continuous adaptation +
  - End-lecture quiz +
  - Explaining a new system to students +
  - The nitty-gritty details

- Gamification takes moral strength (did I say that?!)
  - A new system has to conquer inertia
  - An untested new system has to conquer doubt
  - Support from TUD at most limited
  - On the positive side, I really enjoyed the open and inquisitive attitude of the Dutch student
What’s Next to Study in Gamification?

- **Macro**
  - Does gamification lead to sustained improvement at TUD?
  - Which gamification element is responsible for the largest improvement at TUD?
  - Which type of learning goal gains most from gamification, at TUD?
  - Which type of student gains most from gamification?
  - Which level of student gains most from gamification?
  - How to measure? Long-term studies, etc.

- **Micro**
  - Tuning point flows
  - Tuning gamification elements
  - Measure reaction of students
The Scoring System for TI1400/TI1405

1. Course Points
10,000 for straight 10
+1,000 for each 1
+500 for each 0

2. Access Tokens
Start with 1

3. Brownie Points
+300 correct exam Q
+500 entry quiz
+50 activity in Lab/Lecture/Tutorial
+1,000 lab bonus #2
+500 lab bonus #1
+25 correct end-lecture quiz

Bonus Lab assignments
Advanced topics (GPUs, clouds)
Discuss with Lecturer

I will bake brownies for you!
(But not force you to eat them)

A1:
1. Gamification = more tracks of advancement + keeps top students involved in the classroom
2. Decoupling grading schemes = responding to “cultuur van zesjes”
3. Extra (bonus) points for Lab, Lectures, and Tutorial, through extra assignments, lecture participation and end-lecture quizzes, and team-/self-study, respectively.

A2:
1. Exam success at first try, high rate for past 4 years.
Exit Quiz (started Q3 2012–2013)

- (Yes-No-Don’t care questions) (>90% 75-90% 50-75%)
- I understand how this course was gamified
- Gamification made me more motivated
- Gamification made me think more carefully about what I like to do (where I can get bonus points)
- I enjoyed the interactive part of the lectures
- I enjoyed the exercises at the end of the lectures
Thanks from the PDS Group at TU Delft. Questions? I have one...

Q: May I help you **gamify your course**?

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P2P systems  
Big Data  
Online gaming  

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