Using Gamification in Technical Higher Education: An XP Report
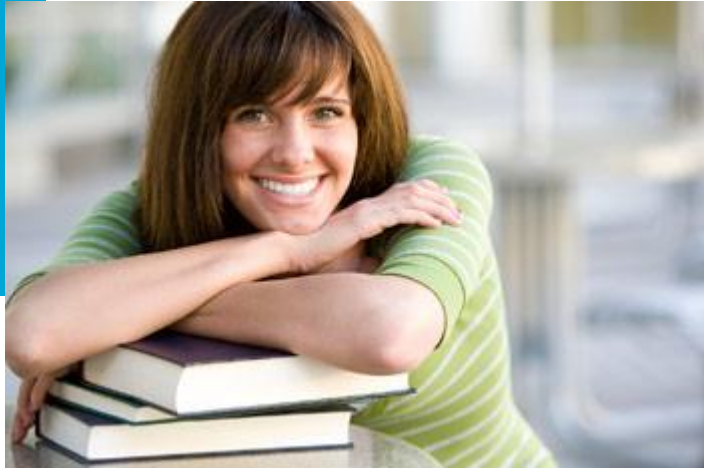
Alexandru Iosup and Dick Epema
Delft University of Technology, the Netherlands

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

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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.

A. Iosup and D. Epema, An Experience Report on Using Gamification in Technical Higher Education, ACM SIGCSE'14. http://goo.gl/V97zSw

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

+

Social Gaming in a Museum

"*51% US households own a console …*
58% Americans play … 45% are women"ESA'14

Take-Home Message

Gamification* in Higher Education = Rich Opportunity

* Making courses similar to social game universes

Gaming used to be about youths, now all generations

Gaming is challenge and reward, tension and catharsis

Game universes populated with all levels of skill

Game universes populated with all personalities

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What is This Talk Also About?
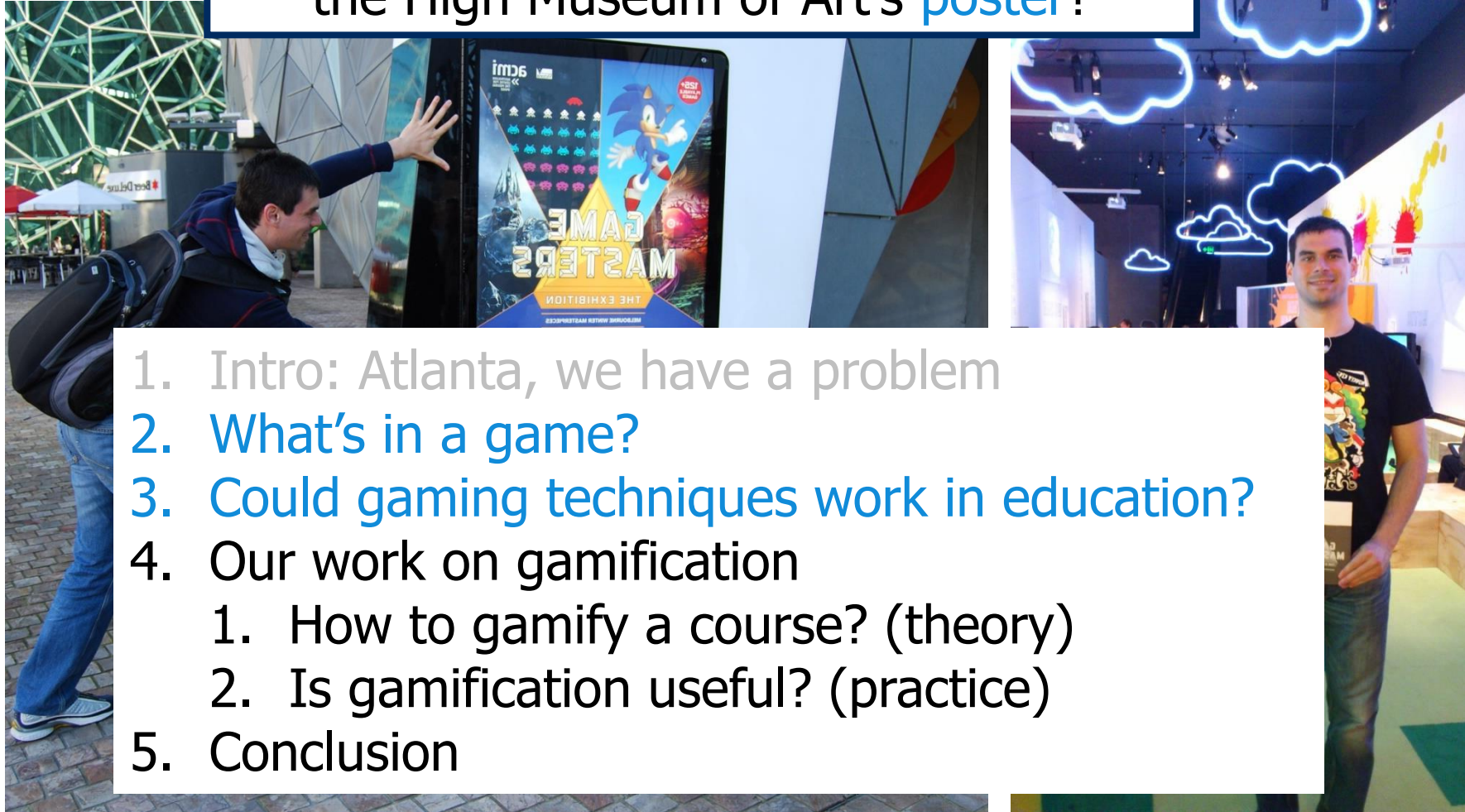# My Personal Curiosity*

A. Iosup and D. Epema, On the
Gamification of a Graduate Course
on Cloud Computing, Poster
ACM/IEEE SC 2013.

A. Iosup and D. Epema, An Experience
Report on Using Gamification in
Technical Higher Education, ACM
SIGCSE'14. http://goo.gl/V97zSW /
http://www.pds.ewi.tudelft.nl/~ios
up/gamification-higher-
education14sigcse_sub.pdf

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* "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

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What's in a name?

Over 250,000,000 active players

Social Gaming =

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

Romeo and Juliet

1. **Mechanics**
Explore, do, learn, socialize, compete
+
2. **Dynamics, incl. Rewards**
Player stats, badges, others
+
3. **Game Content***
puzzles, challenges, extra-projects, culture

* Art class pending.

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Could Work: Games Already Cater for Different Player Types

- Richard Bartle's "Players who suit MUDs"

- **Achievers**
  - Solve the challenge
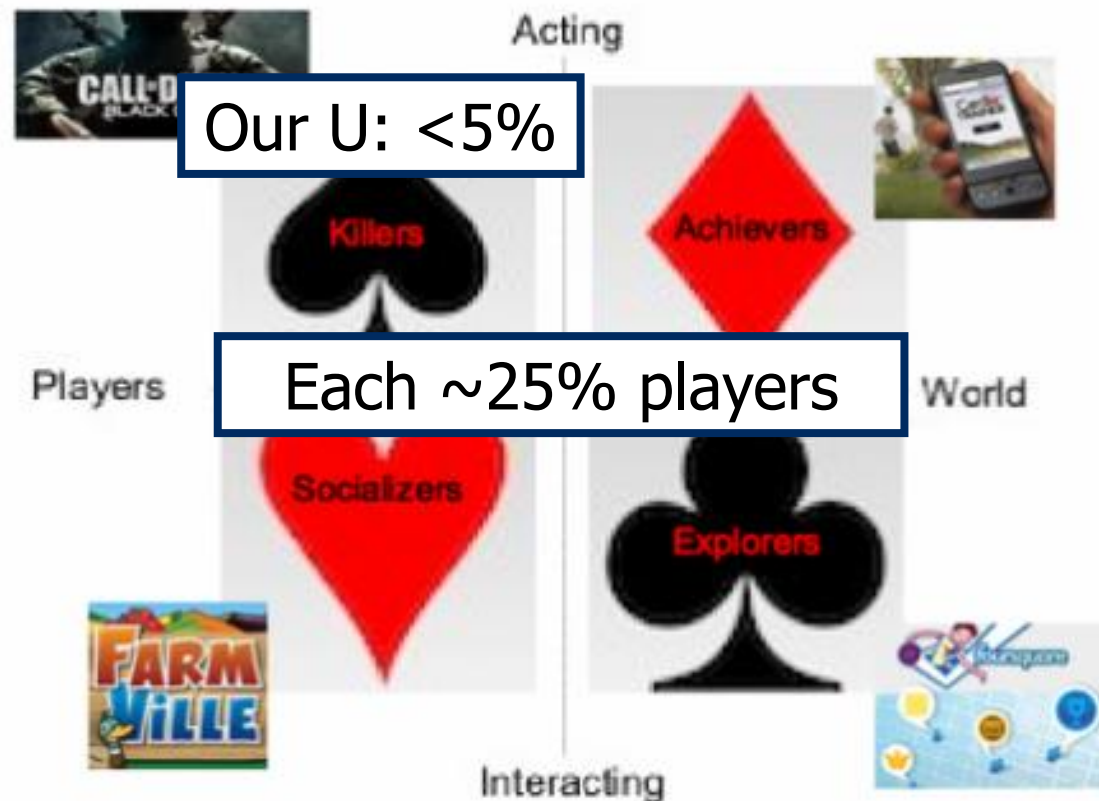
- **Explorers**
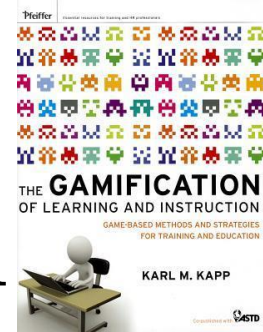 - See what's there

- **Socializers**
  - There for others

- Killers / **Winners**
  - Win against others

Our U: <5%

Each ~25% players

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But…: (Meta-)Research on the Use of Game Elements in Education

Study	Meta-study of … studies	Findings
Randel et al. (1992)	>60	>50% no difference if using games. >30% significant improvement when using games.
Hays (2005)	>100	Game design must match learning objectives.
Vogel et al. (2006)	>30	Games can help improve cognitive skills vs. traditional.
Sitzman (2011)	>60	Playing improves confidence. Vs. traditional, better retention, declarative and procedural knowledge

What Is This Talk About?
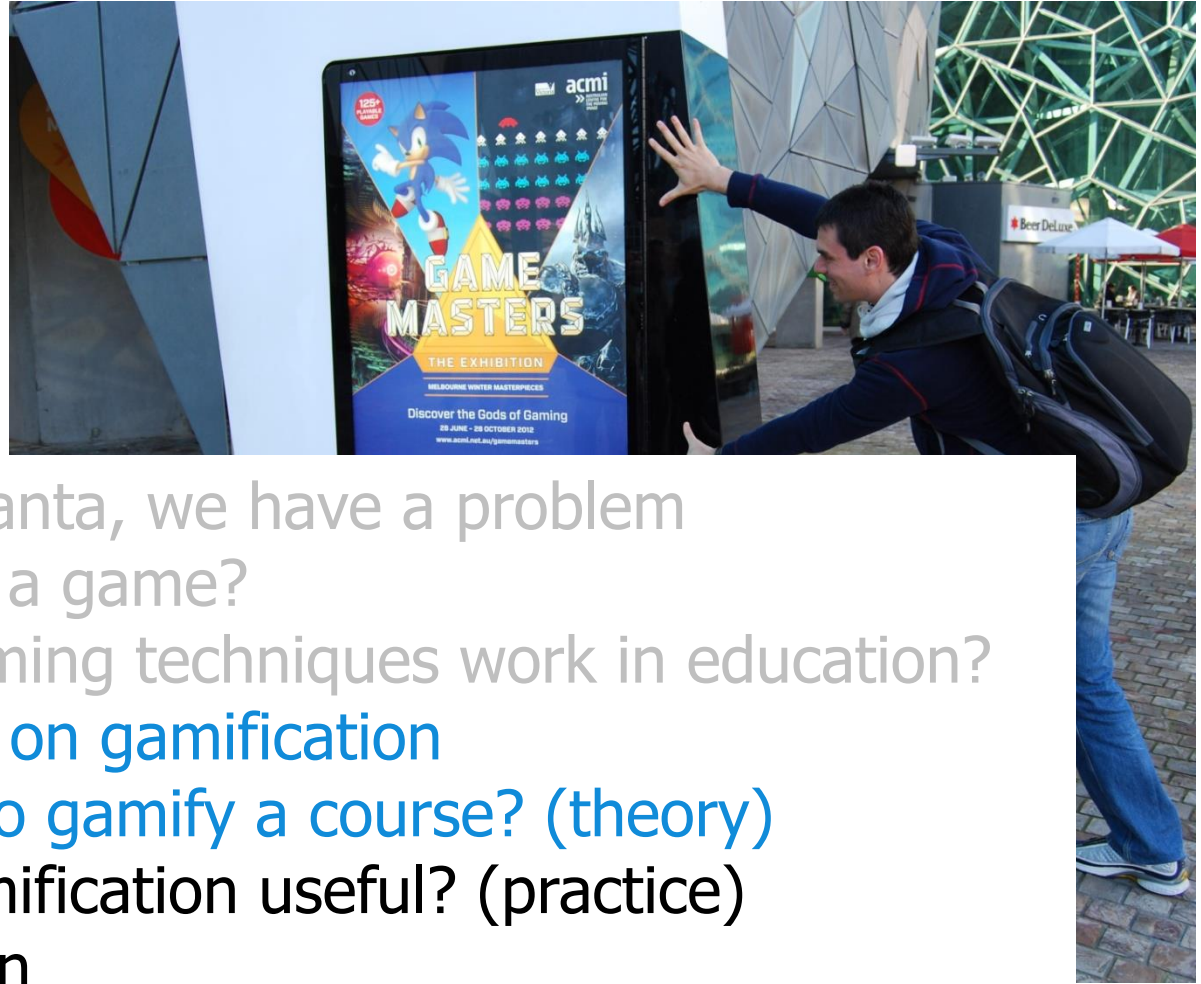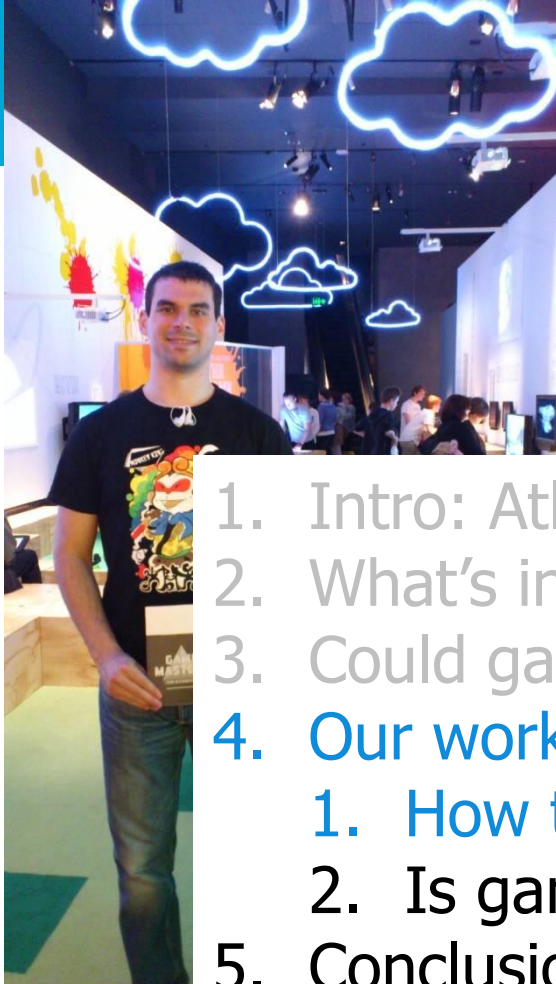
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Our Work At GamificationU, 10+ Operational Years Since 2007

- 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

BSc-CO, 6EC (168h)	MSc-CC, 5EC (140h)
Digital Logic and Data Representation	Overview of cloud computing
Computer Architecture and Organization	Scheduling and Resource Management
Interfacing and I/O Strategies	Data Centers and Energy Efficiency
Memory Architecture	Multi-tenancy concepts, incl.virtualization
Functional Organization	Cloud programming models
Multiprocessing	Case studies
Performance Enhancements	Guest lecturer
Directions in Computing	

- 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

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Gamification Elements

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

    Manga cum laude

- 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.

What Is This Talk About?
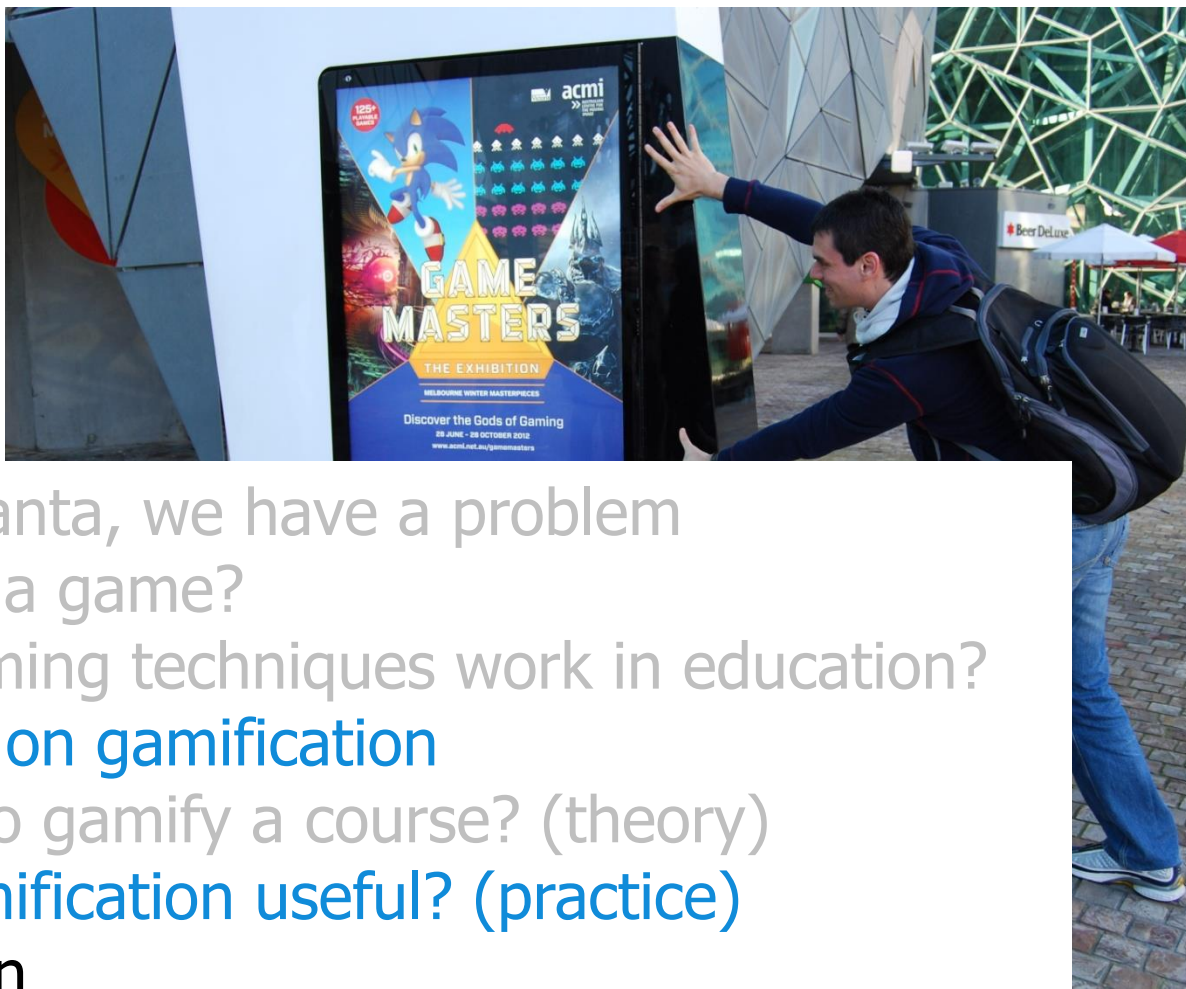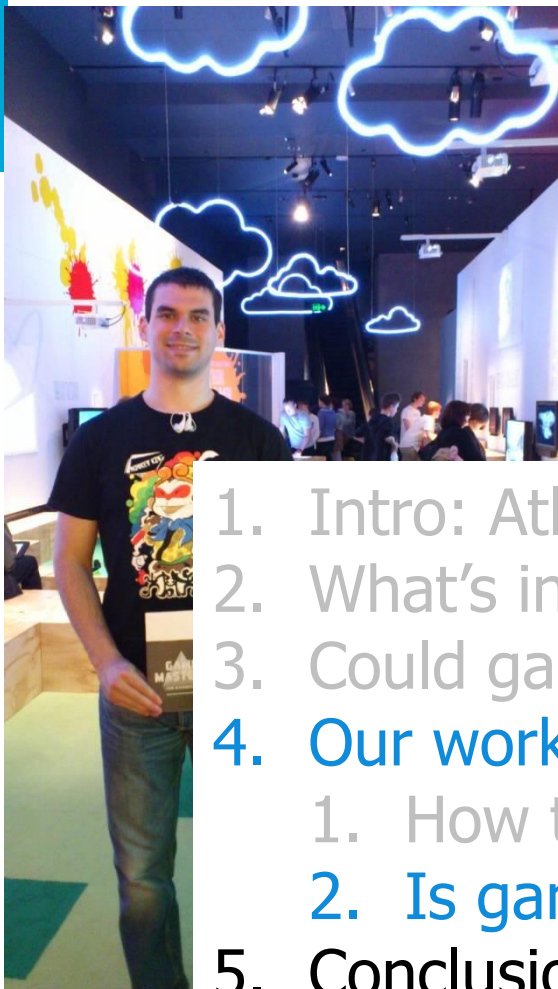
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Is This Playful (or) Education?

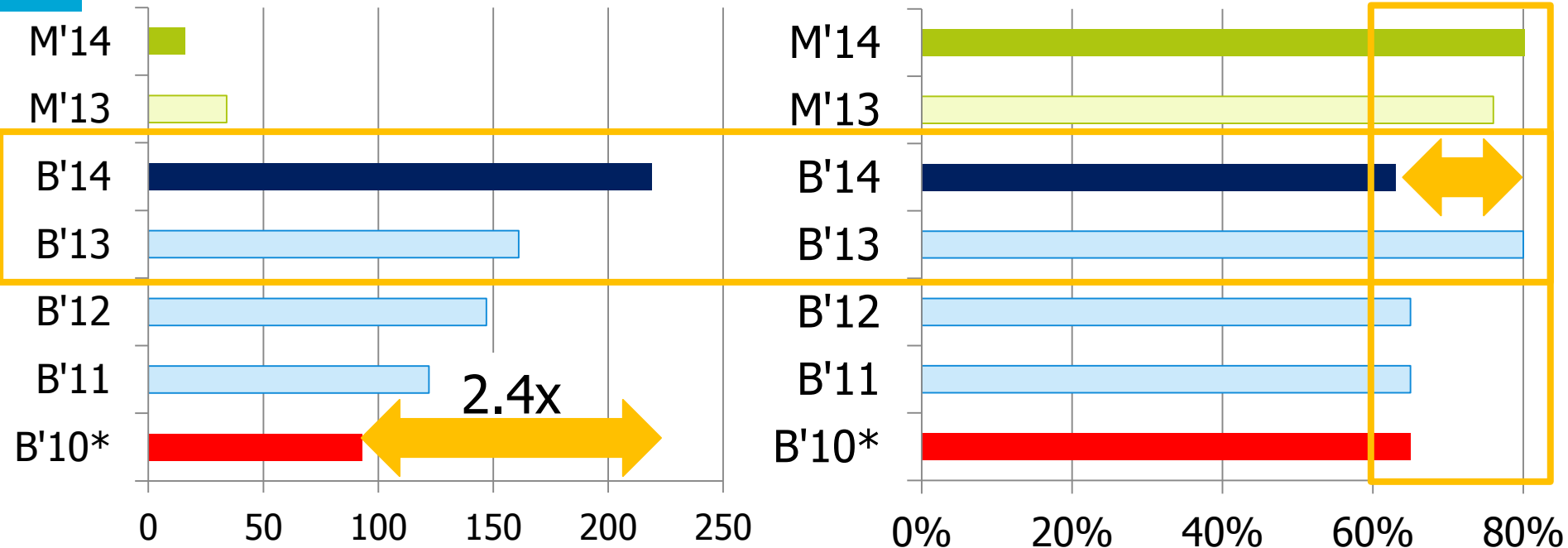Q: Is gamification useful for educators?

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.

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Gamification, the Numbers:
Overall Participation and Success

Participants in-class, count

M'14	
M'13	
B'14	
B'13	
B'12	
B'11	
B'10*	

2.4x

0 50 100 150 200 250

Final exam, passed 1st try [%]

M'14	
M'13	
B'14	
B'13	
B'12	
B'11	
B'10*	

0% 20% 40% 60% 80%

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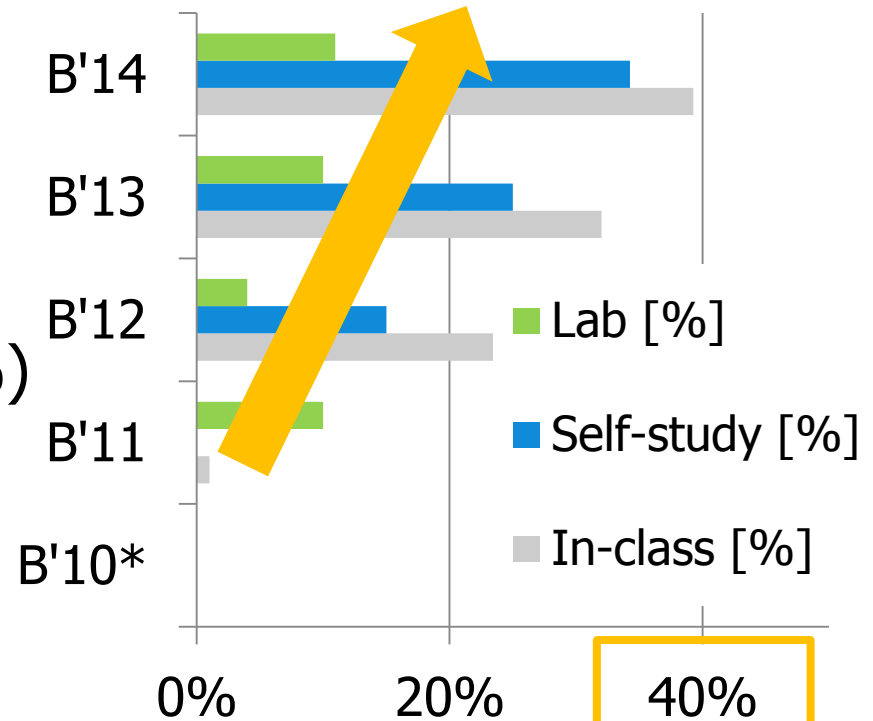- Scalability limit with gamification? Future work.

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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)

Students With Alternative Paths, Successful [%]
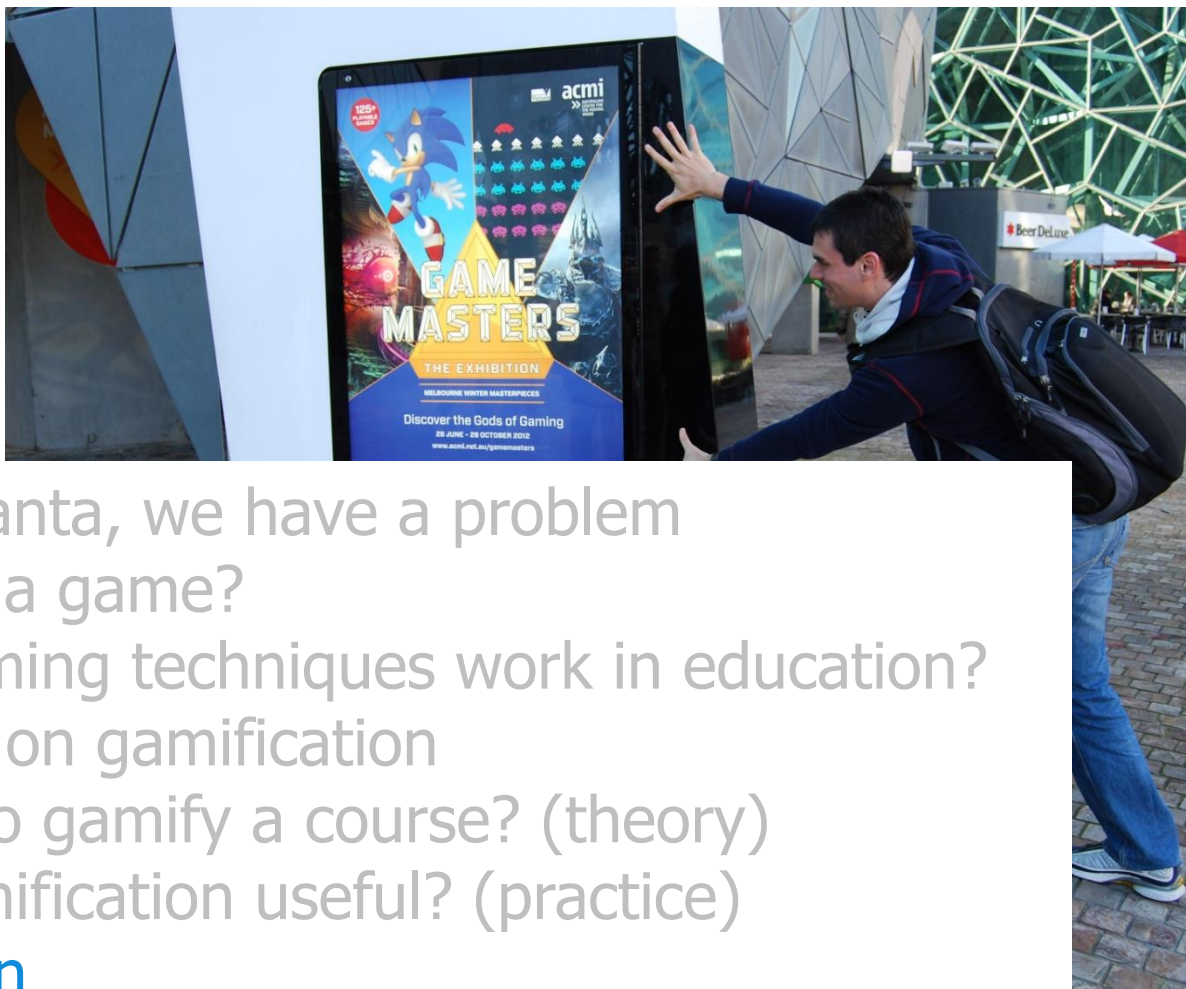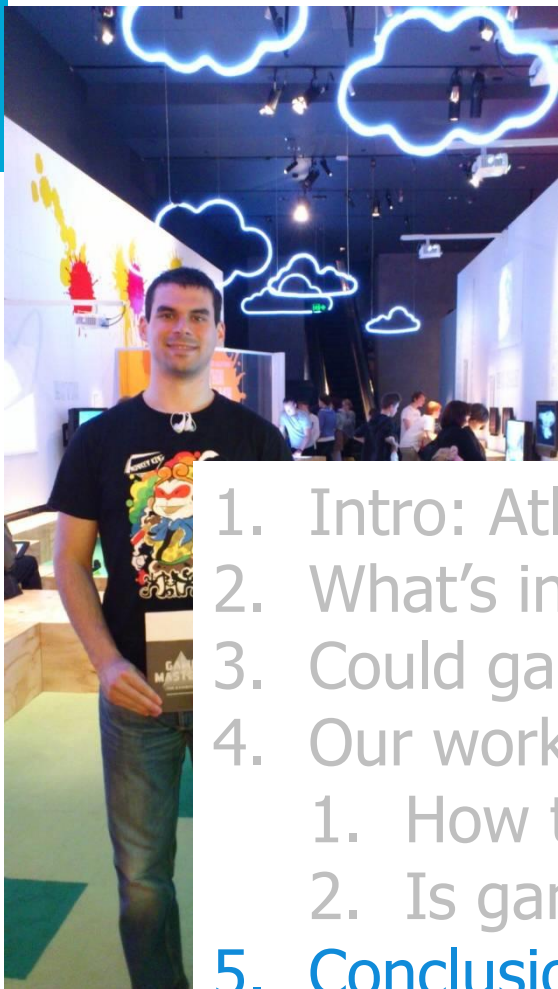
Legend:
- Lab [%]
- Self-study [%]
- In-class [%]

Categories: B'14, B'13, B'12, B'11, B'10*

Axis: 0%, 20%, 40%

What Is This Talk About?

Take-Home Message

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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Take-Home Message

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Tip: Ask other findings?

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.

*TU*Delft

We Also Found That…

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

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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

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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

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The Scoring System for TI1400/TI1405

1. Co... **Ba**... **Points**

10,000 for straight 10 Start with 1

+1,000 **t**...

+1,000

+500

+300 c...

+50...

+25

+500

Q: What is unusual about this scoring system?

Q: Why this complicated system?

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**?

VENI Alexandru Iosup

Grids/Clouds
P2P systems
Big Data
Online gaming

Dick Epema

Grids/Clouds
P2P systems
Video-on-demand
e-Science

VENI Ana Lucia Varbanescu

HPC systems
Multi-cores
Big Data
e-Science

Henk Sips

HPC systems
Multi-cores
P2P systems

VENI Johan Pouwelse

P2P systems
File-sharing
Video-on-demand

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Publications

- see PDS publication database at publications.st.ewi.tudelft.nl

A. Iosup and D. Epema, An Experience Report on Using Gamification in Technical Higher Education, ACM SIGCSE'14. http://goo.gl/v97zSW