

SOCIAL GAMIFICATION WORKS! EMPOWERING STUDENTS IN 21ST-CENTURY HIGHER EDUCATION

bit.ly/GamificationGeCon22



@Large Research
Massivizing Computer Systems

Prof.dr.ir.
Alexandru
IOSUP

Prof.dr.ir Ana Lucia Varbanescu, Jesse
Donkervliet, Tim Hegeman, Otto Visser



Thanks Google Images for visual material, and Jorge Torres Gomez and the GeCon 2022 team for the invitation.

US IN 1 MINUTE



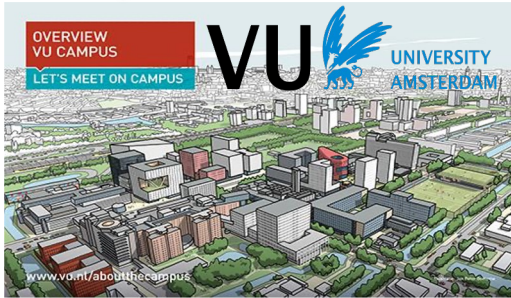
WE'RE

MASSIVIZING

COMPUTER

SYSTEMS!

VU AMSTERDAM + UvA + TU DELFT < THE NETHERLANDS < EUROPE



VU
founded 1880
pop: 23,500
Research
University



UvA
founded 1632
pop: 31,200
Research
University,
NL language



TU Delft
founded 1842
pop: 26,500
Technical
University



http://atlarge.science

CURRENT TEAM

This is us, now.

- Professor
- Assistant Prof.
- Teacher
- Visitor/P.-doc
- Ph.D. student
- Early Scientist

WE ARE HIRING PhDs + A NEW ASST. PROF.!

WE ARE A FRIENDLY, DIVERSE GROUP, OF DIFFERENT RACES AND ETHNICITIES, GENDERS AND SEXUAL PREFERENCES, AND VIEWS OF CULTURE, POLITICS, AND RELIGION. YOU ARE WELCOME TO JOIN!

Alumni

They have completed a long-term project in our team.

Shanny Aneep Team VL-e	Athanasios Antoniou Team AtLarge	Sietsje Au M.Sc. student, TU Delft	Johannes Bertens M.Sc. student, TU Delft	Marcin Biczak Researcher in graph-processing team	Mihai Capota Tech Lead Graphalytics
Bogdan Ghit Ph.D. student, TU Delft	Yong Guo Graph processing	Stijn Heldens Researcher, TU Delft	Alexey Ilyushkin Ph.D. student, TU Delft	Adele Lu Jia Social gaming	Elvan Kula Honors Track
Chris LeMaire Team Graphalytics	Shenjun Ma M.Sc. student, TU	Ahmed Musaafir Researcher, Vrije	Wing Lung Ngai Researcher, Vrije	Leon Overweel Core Team OpenDC	Siqi Shen Massivizing online
Jie Shen Performance modeling	Ruben Verboon Honors Track	Maria Anemona Voinea M.Sc. student, TU Delft	Nozhi Yigitbasi Tech Lead GrenchMark and CMeter	Ernst van der Hoeven M.Sc. student, TU Delft	Jerom van der Sar Team OpenCraft

Research Visitors and Interns

They have completed a short-term stay with our team.

Mugurel Ionut Andreia Research visitor	Matthijs Bijman Core Team OpenDC	Alexandru Costan Research visitor	Kefeng Deng Research visitor	Yunhua Deng Research visitor	Kevin Dethman B.Sc. student, Vrije Universiteit
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ALUMNI

RS

WHO AM I?

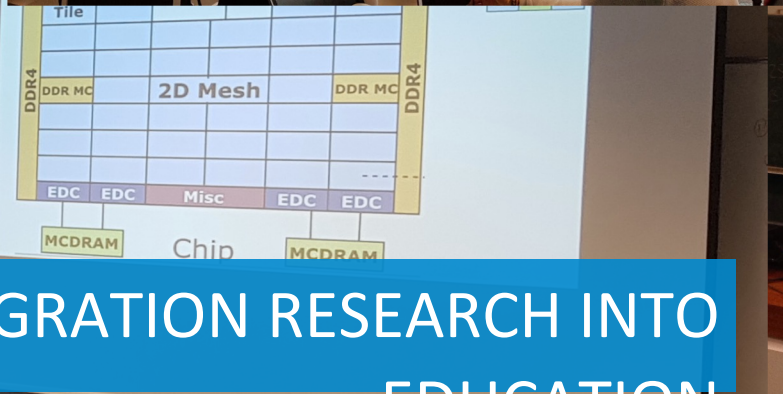
PROF. DR. IR. ALEXANDRU IOSUP

- Education, my courses:
 - > Systems Architecture (BSc)
 - > Distributed Systems, Cloud Computing (MSc)
- Research, 15 years in DistribSys:
 - > Massivizing Computer Systems
- About me:
 - > Worked in 7 countries, NL since 2004
 - > I like to help... I train people in need
 - > VU University Research Chair + Group Chair
 - > NL ICT Researcher of the Year
 - > NL Higher-Education Teacher of the Year
 - > NL Young Royal Academy of Arts & Sciences
 - > Knighted in 2020



Teaching the next generation computer scientists

We teach in bachelor, master, and doctoral programs at VU/TUD in NL, and elsewhere.





A BIG CHALLENGE: MASSIVIZING HIGHER EDUCATION

1

The Challenge: How to **massivize** higher education?

Uniquely European: universal/cheap access to education + students are individuals

MANY CHALLENGES, INCLUDING:

MORE STUDENTS

MORE DIVERSE STUDENTS

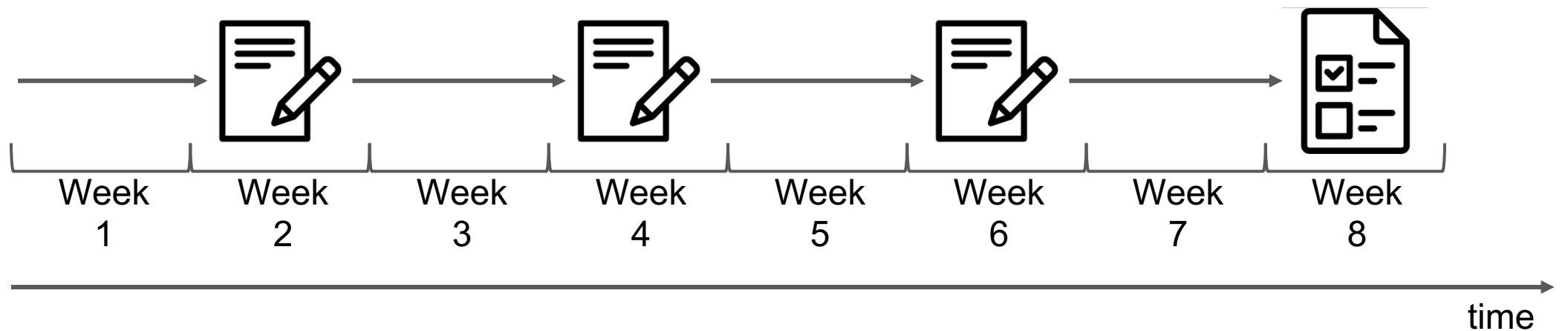
MORE DIVERSE JOBS

CONTENT INCREASINGLY MORE COMPLEX



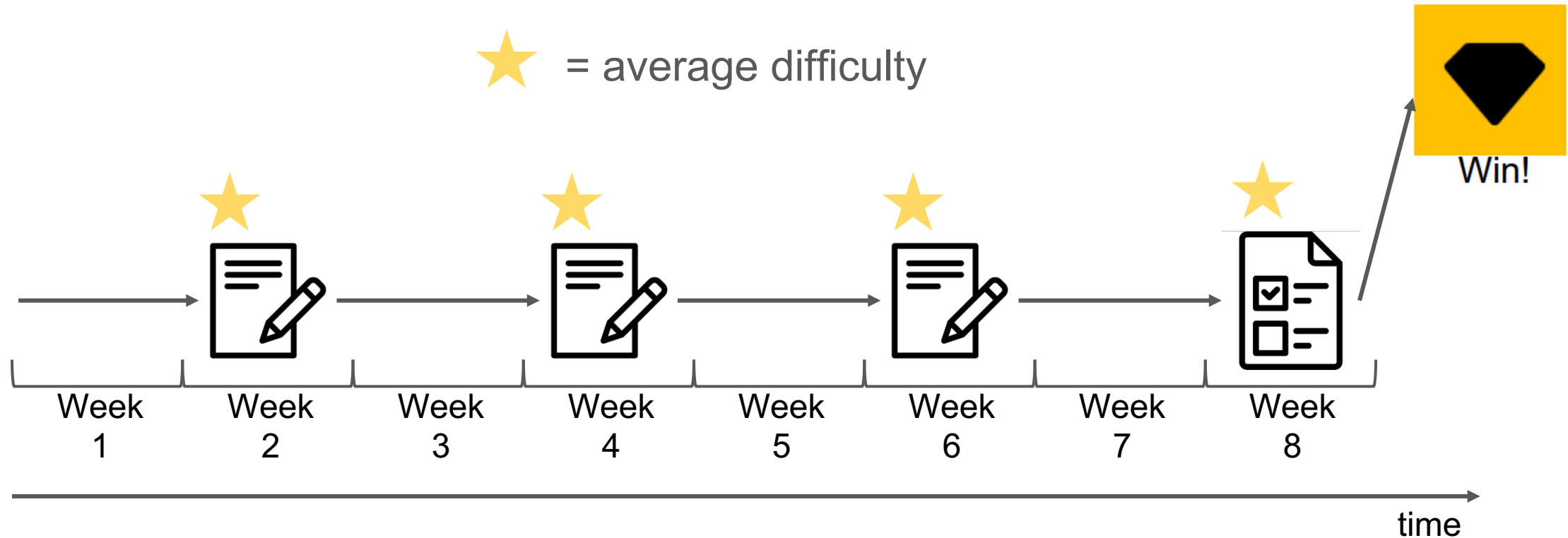
Traditional course design

The path of advancement for a traditional course.



Traditional course design

Assignments and exams calibrated to pass the **average** student



A young man with curly brown hair and a beard is hiking through a forest stream. He is wearing a white t-shirt with red trim, khaki shorts, and orange boots. He has a large blue backpack and is looking down at the water. The background is a lush, sun-dappled forest with green and orange foliage.

Some students want to **explore**, to **create**.

The book cover features a dark background with a complex, abstract pattern of thin, overlapping lines in various colors (blue, green, purple, red) that resemble neural connections or a network. The title and author's name are printed in white.

OUT OF OUR MINDS

LEARNING TO BE CREATIVE

KEN ROBINSON



Some students want to **socialize**.

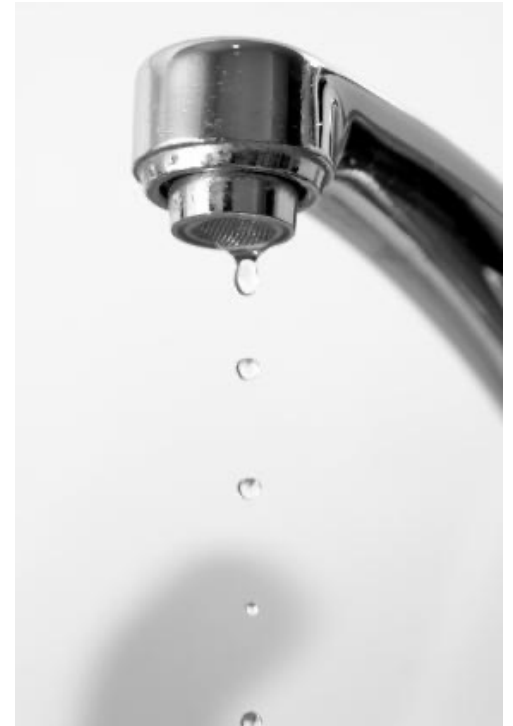


Some students want to **win**.



The “Leaky Faucet”

- Anecdotal example:
Major technical university in the Netherlands*
- “P-in-een” of an important BSc track
- Completion “in time” of the BSc
- (What do students think about it?)



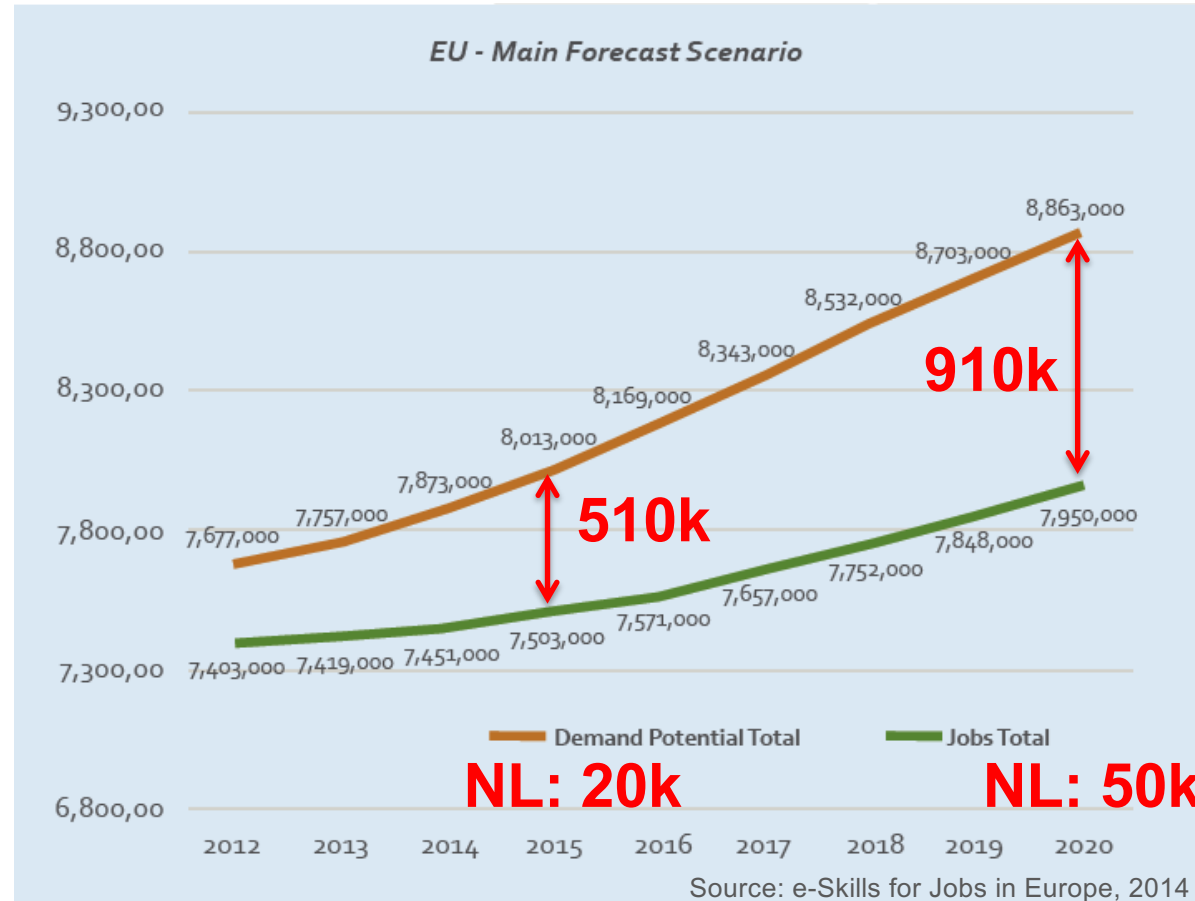
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<50%

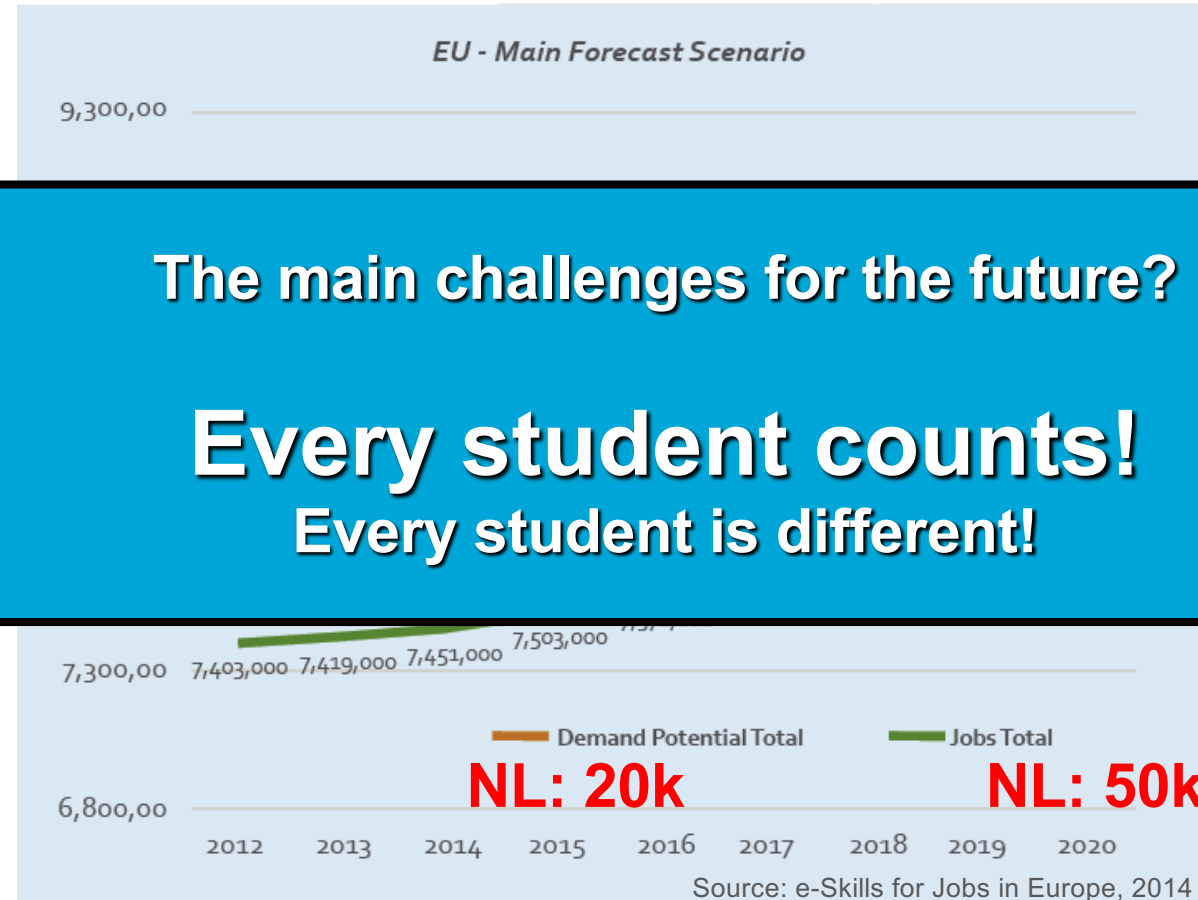
ELSEVIER

* THE-QS world rankings, 2012—2021.

Let's Extrapolate to Europe: The People Gap in ICT



Let's Extrapolate to Europe: The People Gap in ICT



The main challenges for the future?
Every student counts!
Every student is different!





EVERY STUDENT
COUNTS! WHAT
CAN WE DO
ABOUT THIS BIG
CHALLENGE?

2

Intuition social gamification: Advances in gaming, during last 10 years, engage and enthuse **diverse people**

Beyond eyes



Q: What is **gamification**?

A: The use of thinking and techniques designed for gaming in non-gaming settings, e.g., in education.



<http://bit.ly/VUGamification>

Q: What is **social gamification**? How to use?

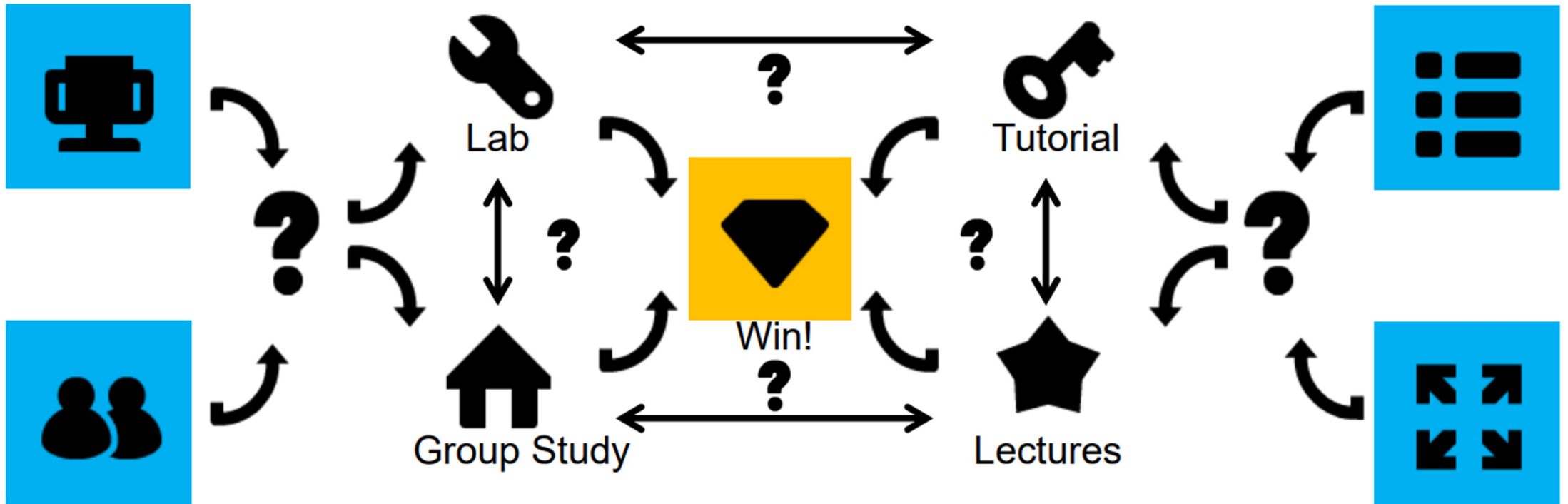
Students choose their path of advancement. Teamwork and classroom engagement. Course dynamics. Feedback.



<http://bit.ly/GamificationTedTalk>

Gamified course design

Creating a course is like creating a complex puzzle!





HOW TO USE SOCIAL GAMIFICATION IN HIGHER EDUCATION?

3

A Framework for Gamification in Higher Education

1. Decide on Learning Objectives and related content
2. Describe the perfect student, design for personas
3. Design the gamified experience*
4. Playtest your design and check for fun!
5. Operate your gamified course



(Assuming you want to gamify a traditional course.)

A Framework for Gamification in Higher Education

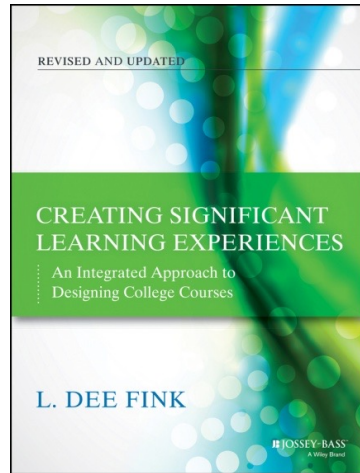
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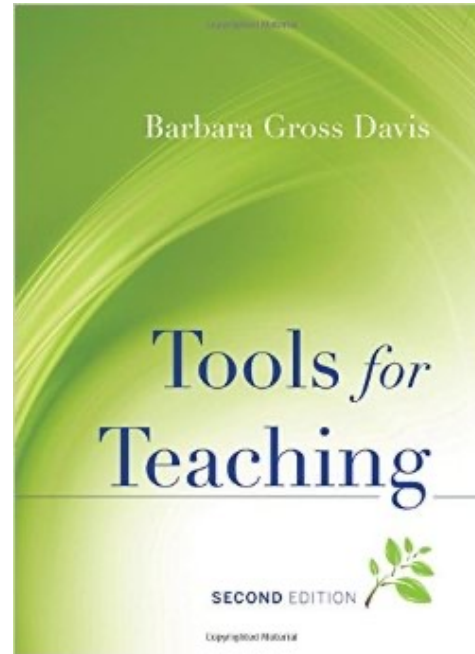
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1. Decide on Learning Objectives and related content.

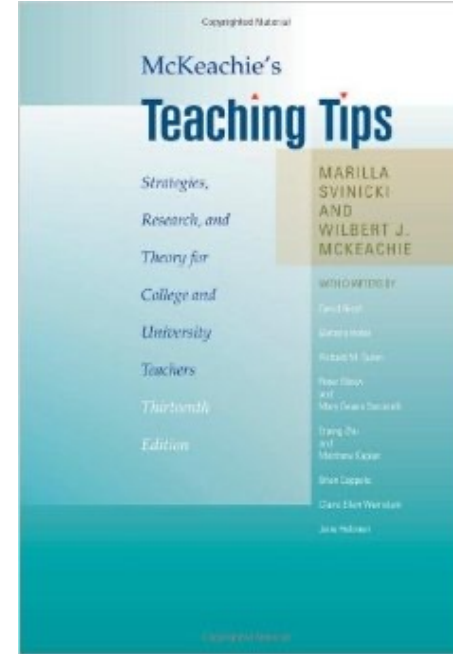
Have You Read These? Or Similar? Or Followed Basic Teaching Qualifications Courses?



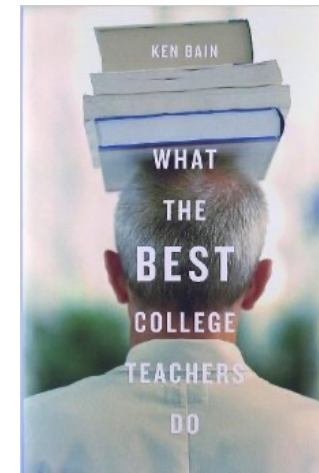
Learning how to learn
Significant learning



Group work
Assessment



Planning, team
Grading



From the
trenches...



“After this session, you will be able to...”

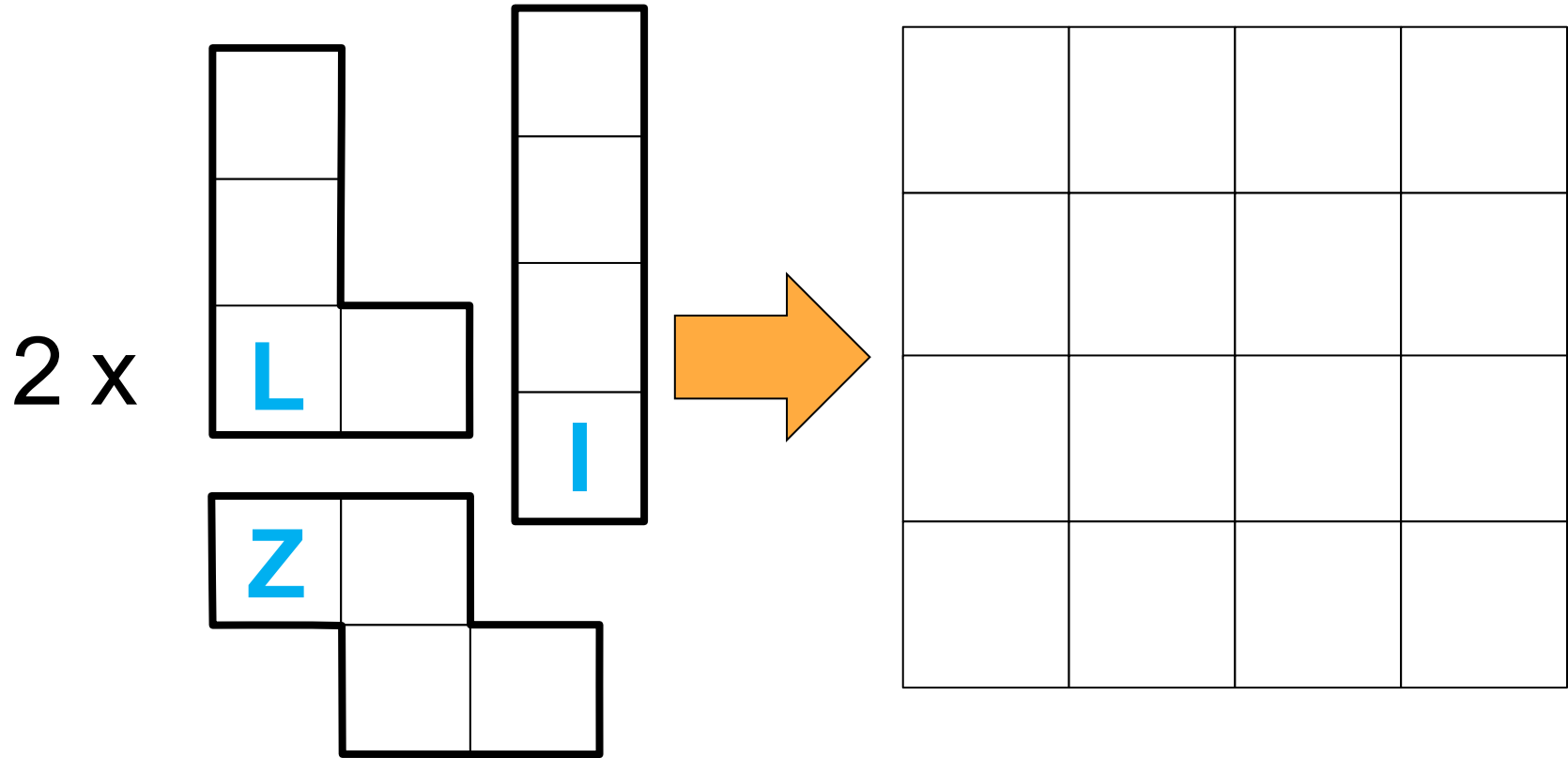


1. Design paths of advancement for different student personas
 2. Identify and explain the mechanics and dynamics that are most likely to motivate your students
 3. Design assessments that are likely to challenge students yet avoid common pitfalls
 4. Understand basic concepts in how to construct, playtest, and operate a gamified course
 5. [Homework] Try out your gamification skills, in short exercises
- OR —
1. You can play games, read email, etc., so choose your own adventure



Content Unlocked!

You can play games, read email, etc., so choose your own adventure



A Framework for Gamification in Higher Education

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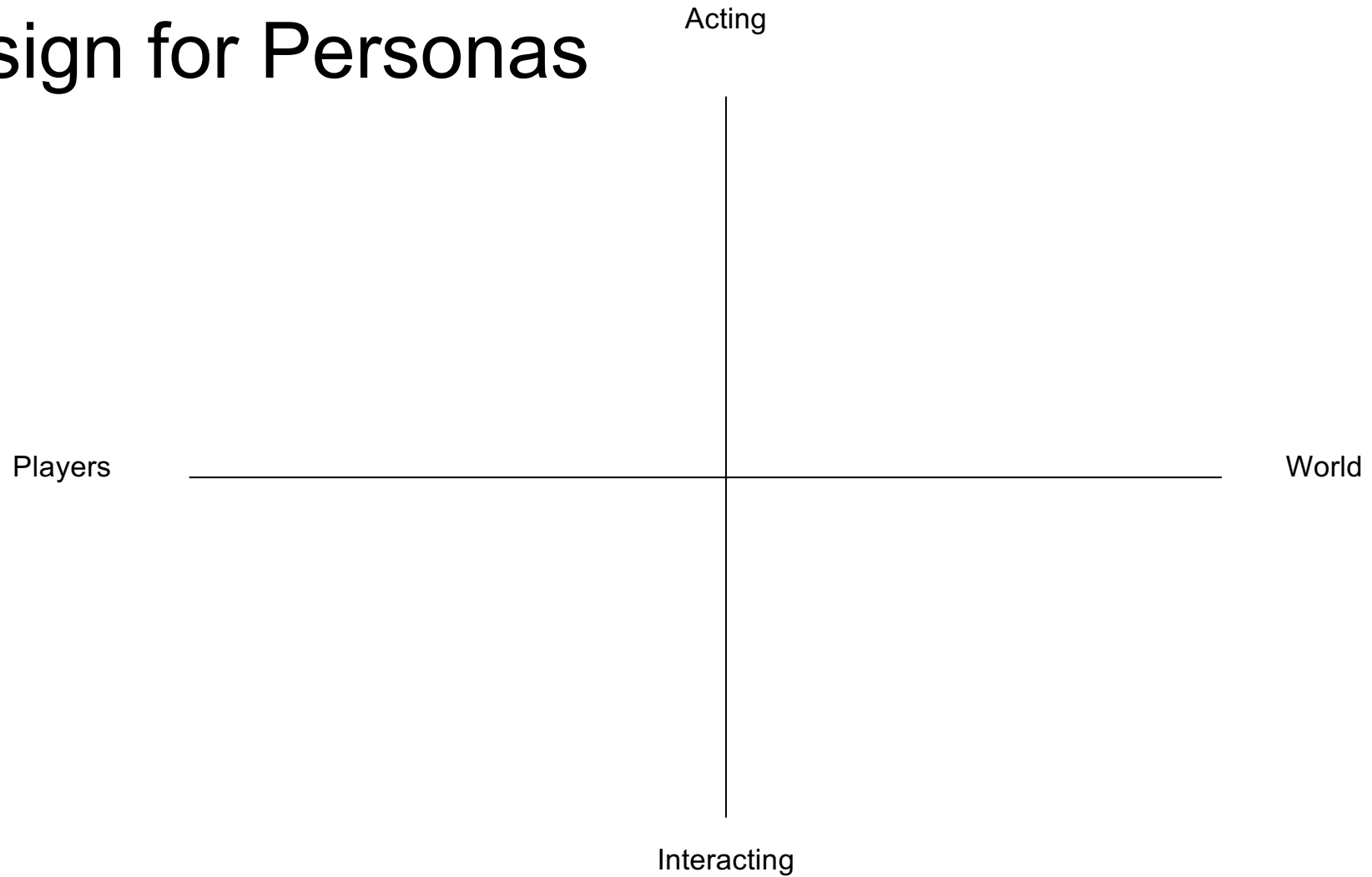
Describe the Perfect Student...

But the perfect student does NOT exist.
(And yet we are all here.)

- Achieves all course objectives
- Explores new directions
- Socializes with students around
- Excels in all tests, early

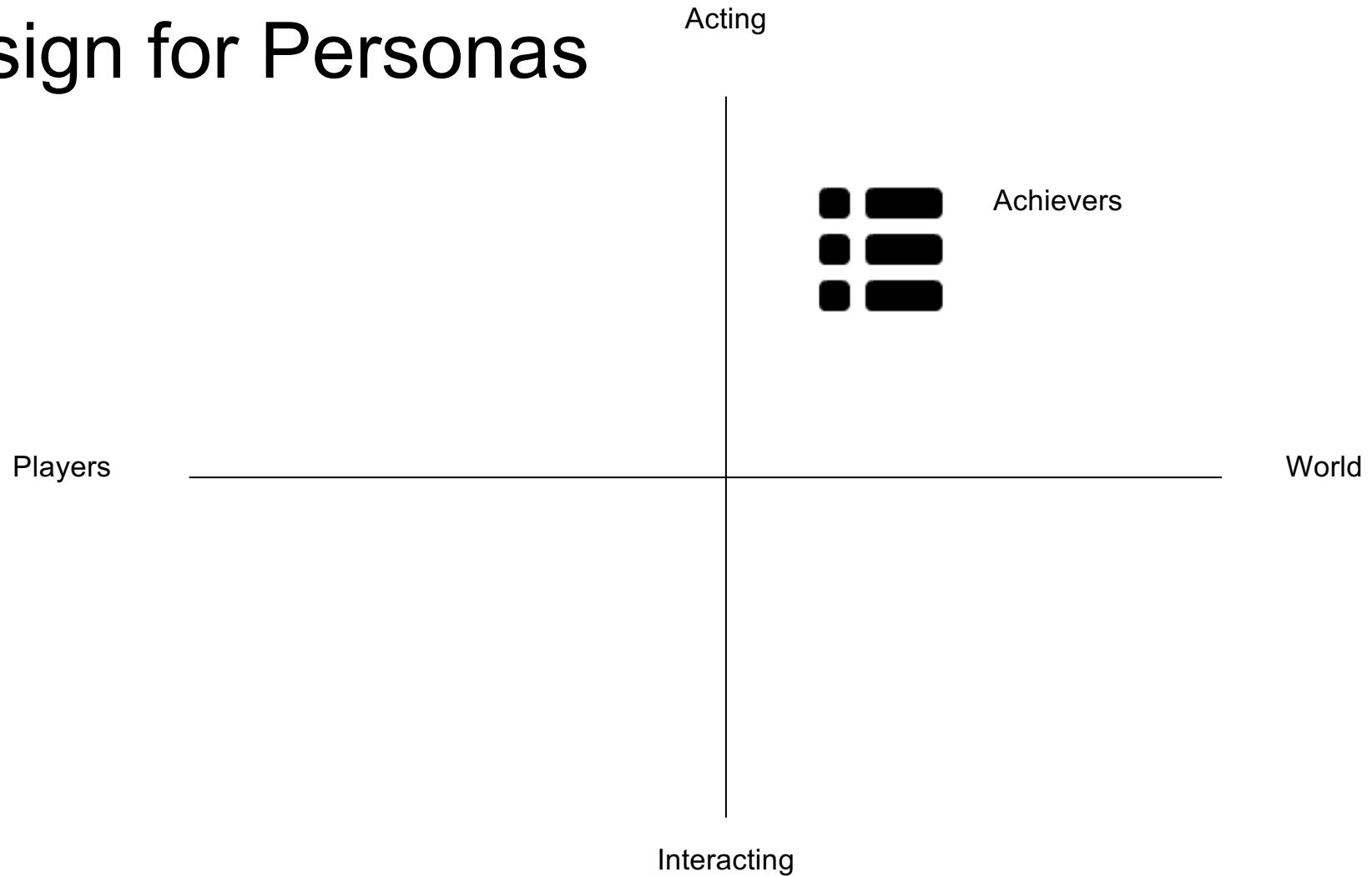


Design for Personas



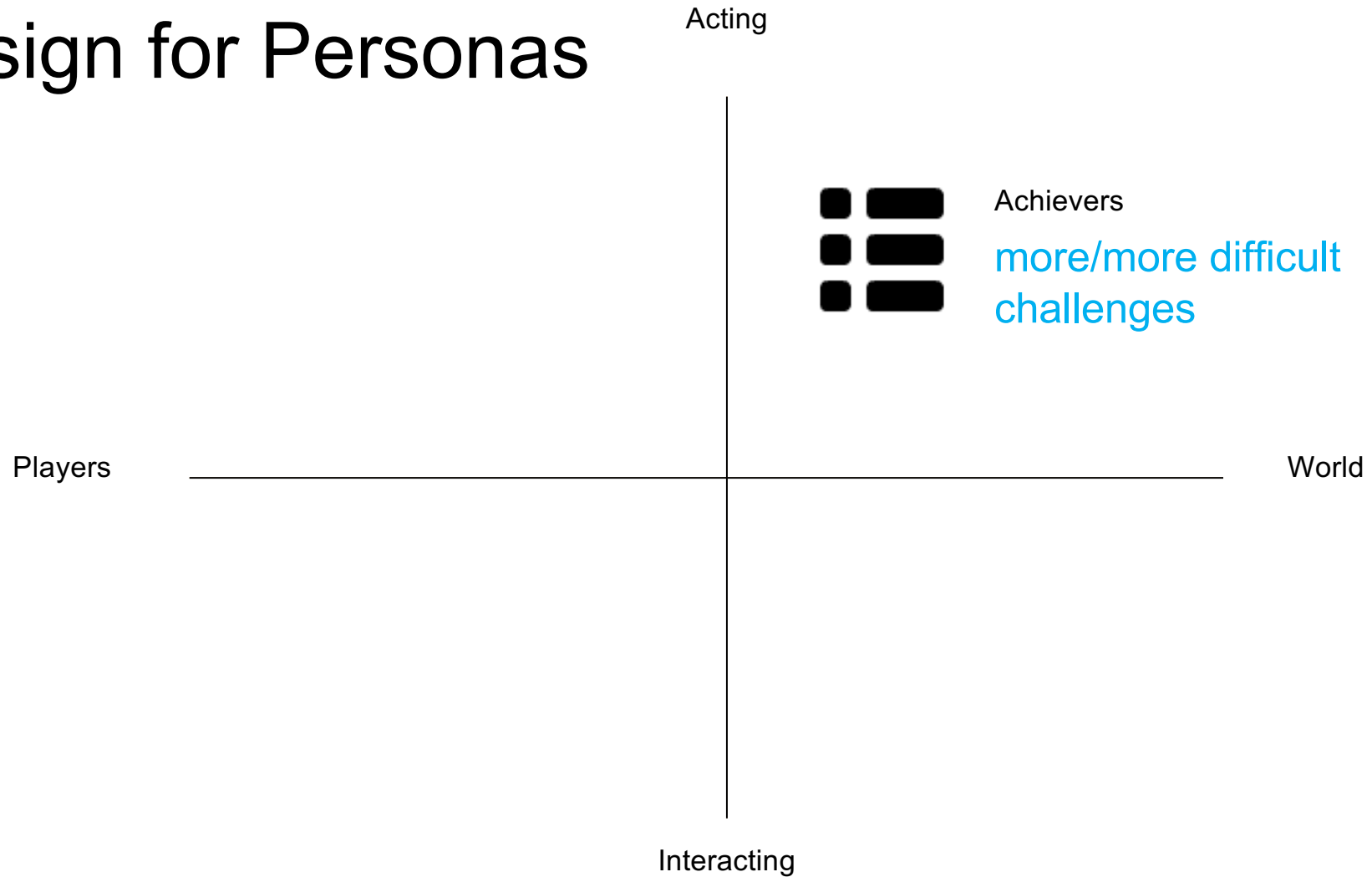
- Richard Bartle's "Players who suit MUDs"

Design for Personas



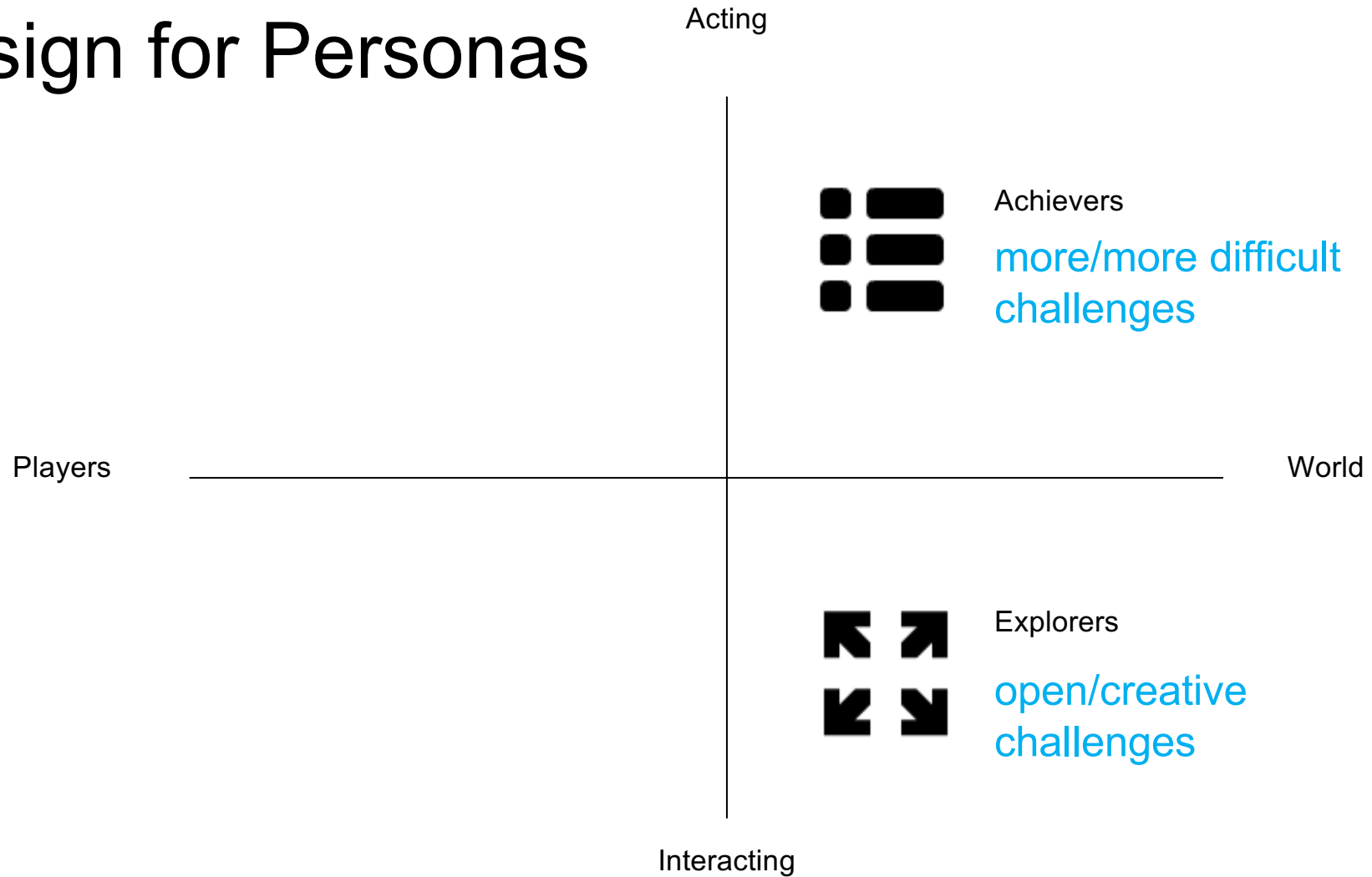
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Design for Personas



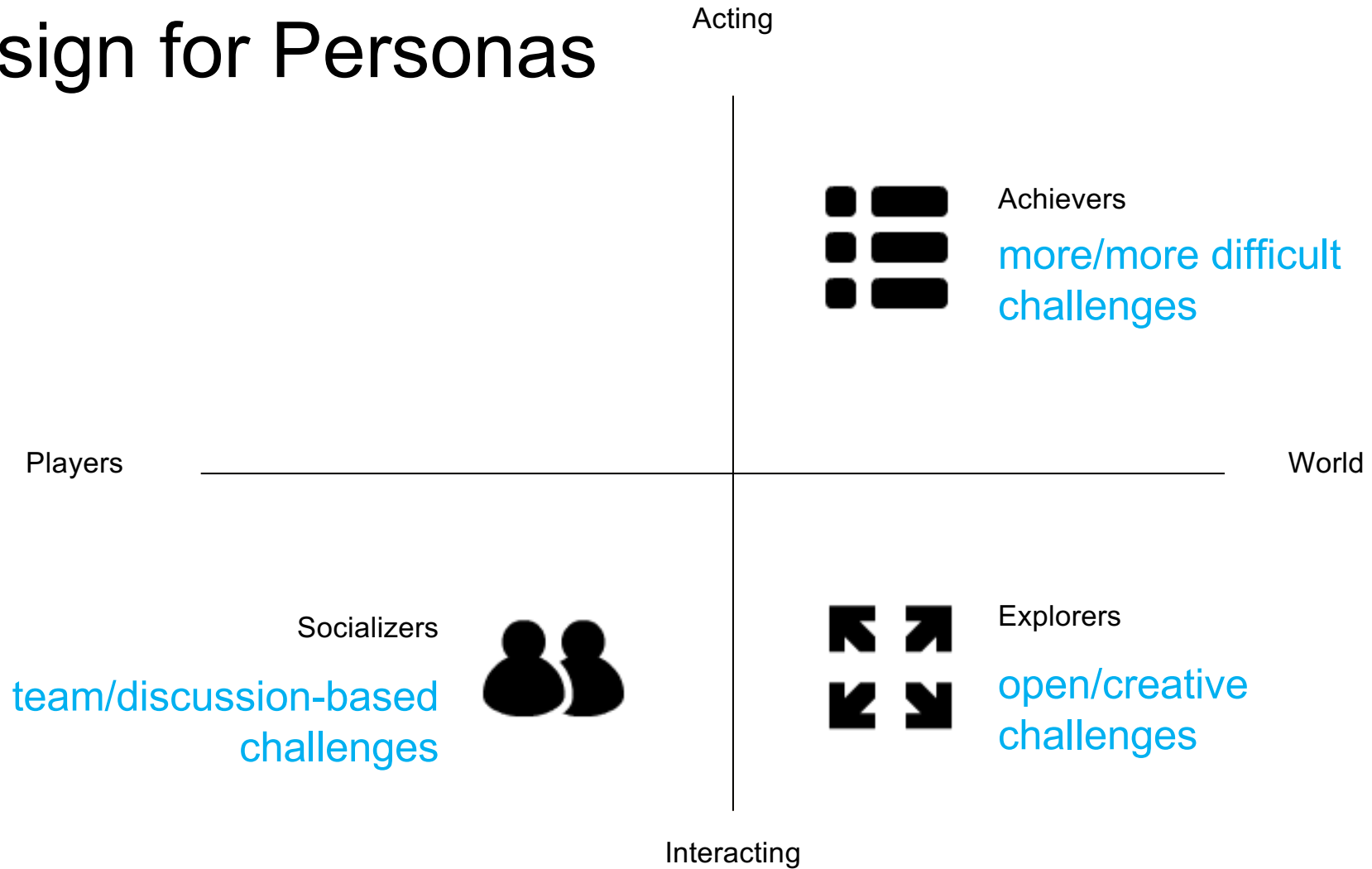
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Design for Personas



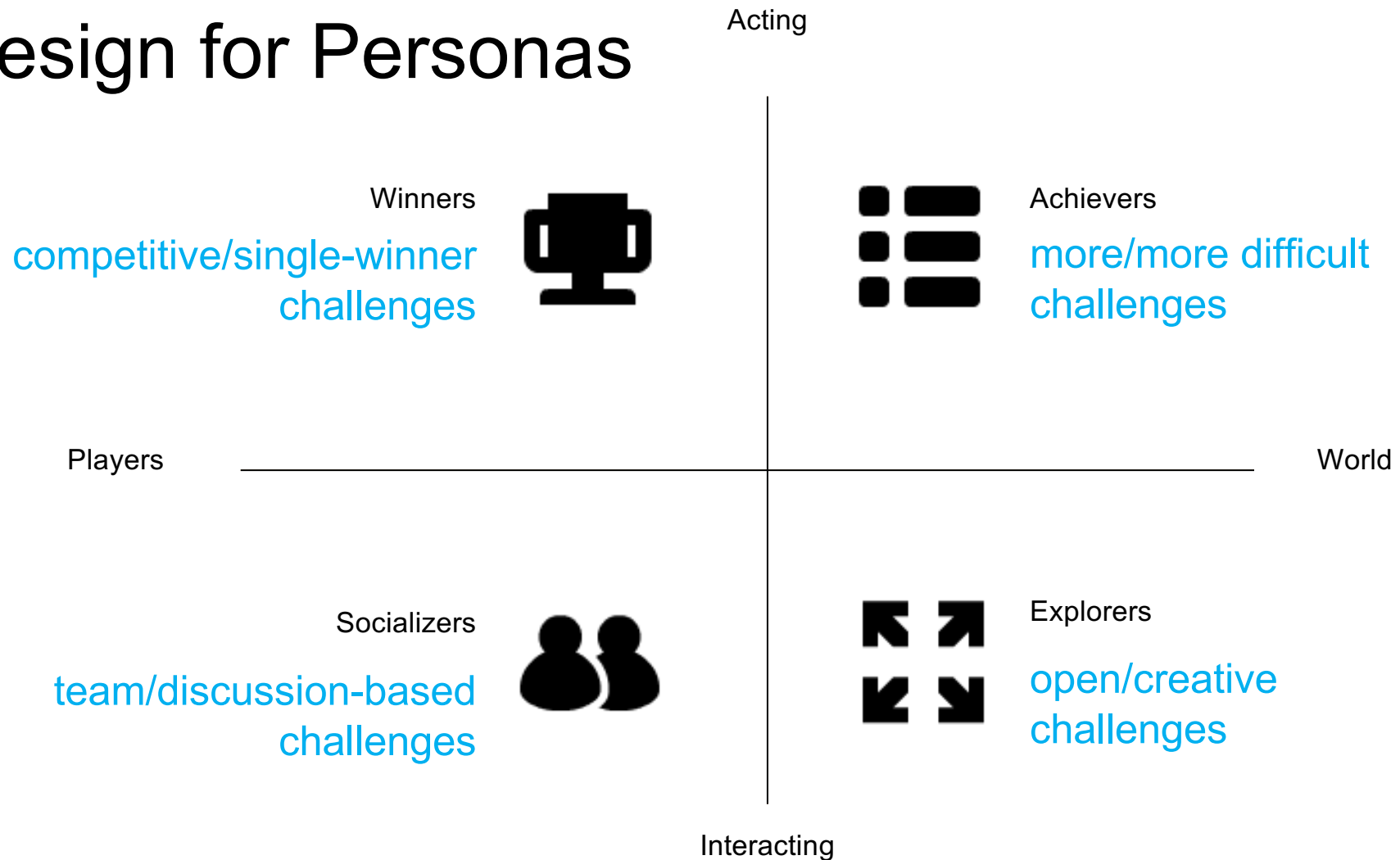
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Design for Personas



- Richard Bartle's "Players who suit MUDs"

Design for Personas



- Richard Bartle's "Players who suit MUDs"

A Framework for Gamification in Higher Education

1. Decide on Learning Objectives and related content
2. Describe the perfect student, design for personas
3. Design the gamified experience.
 - Gamification is not the BLT sandwich of education
 - Focus on the Mechanics-Dynamics-Aesthetics Framework
 - Focus on Mechanics and Dynamics
 - Focus on Assessment
4. Playtest your design and check for fun!
5. Operate your gamified course

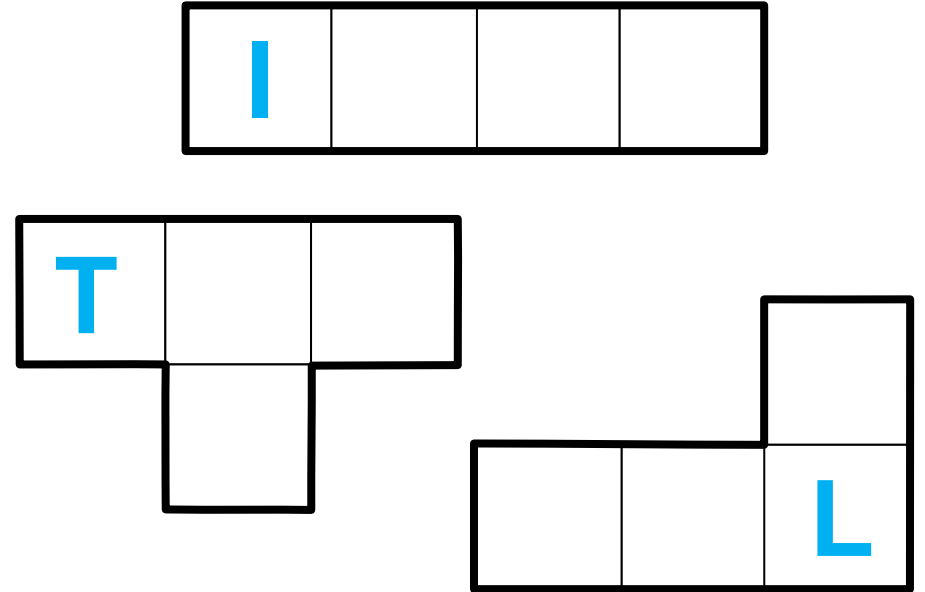
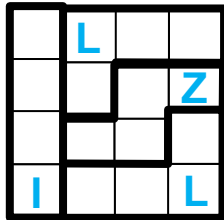
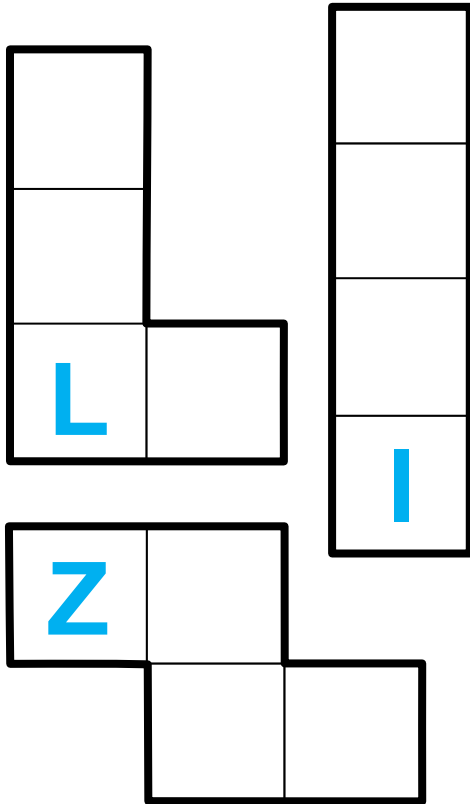




Content Unlocked!

You can play games, read email, etc., so choose your own adventure

2 x



First, Myth-Busting: Gamification Is NOT Only:

Playing a game in the classroom



PBL = The BLT sandwich of gamification =

- Points
- Badges
- Leaderboards



Q: What's in a game?

A: **Over 250,000,000 active players**

Social Gaming =

100,000k+ players who benefit from social engagement



[http://djmag.com/sites/default/files/article/image/DJMagArenaPicsPt4%20\(13%20of%2017\)_0.jpg](http://djmag.com/sites/default/files/article/image/DJMagArenaPicsPt4%20(13%20of%2017)_0.jpg)

1. **Mechanics**

Explore, do, learn, **socialize**, compete
+

2. **Dynamics**

Player progress and interaction, ...
+

3. **Game Content***

puzzles, challenges, extra-projects, culture

* Art class pending.

Gamification Mechanics

- Mechanics = how the system turns inputs into outputs

Mechanics are applied directly, by the system (course staff), without further interaction from students.

- Points
- Badges
- Leaderboards

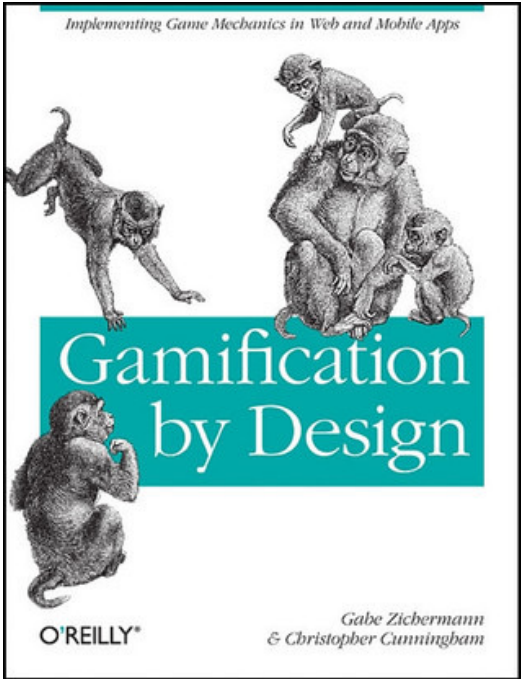
- Game states, s
- Challenges for each player

- Rules, tutorials, guidelines, helpers, checklists
- Feedback
- Unlocked content

- ... so many more

Don't read this slide!

Because there are books about this



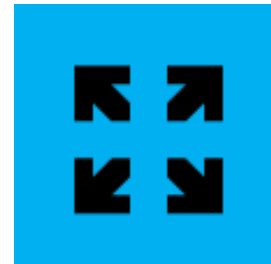
Assessment That Motivates!

10,000 points for a 10


+50 for good activity

+1,000 for most challenging activity

Badges, unlocked content

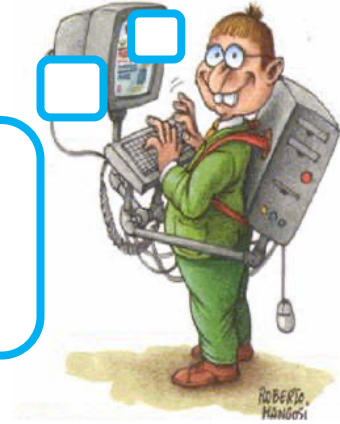


A Diverse Scoring System

1. Course Points	2. Access Tokens	3. Brownie Points
10,000 for straight 10	Start with 1	
+1,000 team self-study		
+1,000 lab bonus #2	Bonus Lab assignments	I will bake brownies for <u>you!</u> (but not force you to eat them)
+500 lab bonus #1	Advanced topics (GPUs, clouds)	
+300 correct exam Q		
+50 activity in Lab/Lecture/Tutorial	Discuss w Lecturer	
	Propose Exam Qs	
NO points for free!	Rec. letter	



(Social) Gamification Dynamics



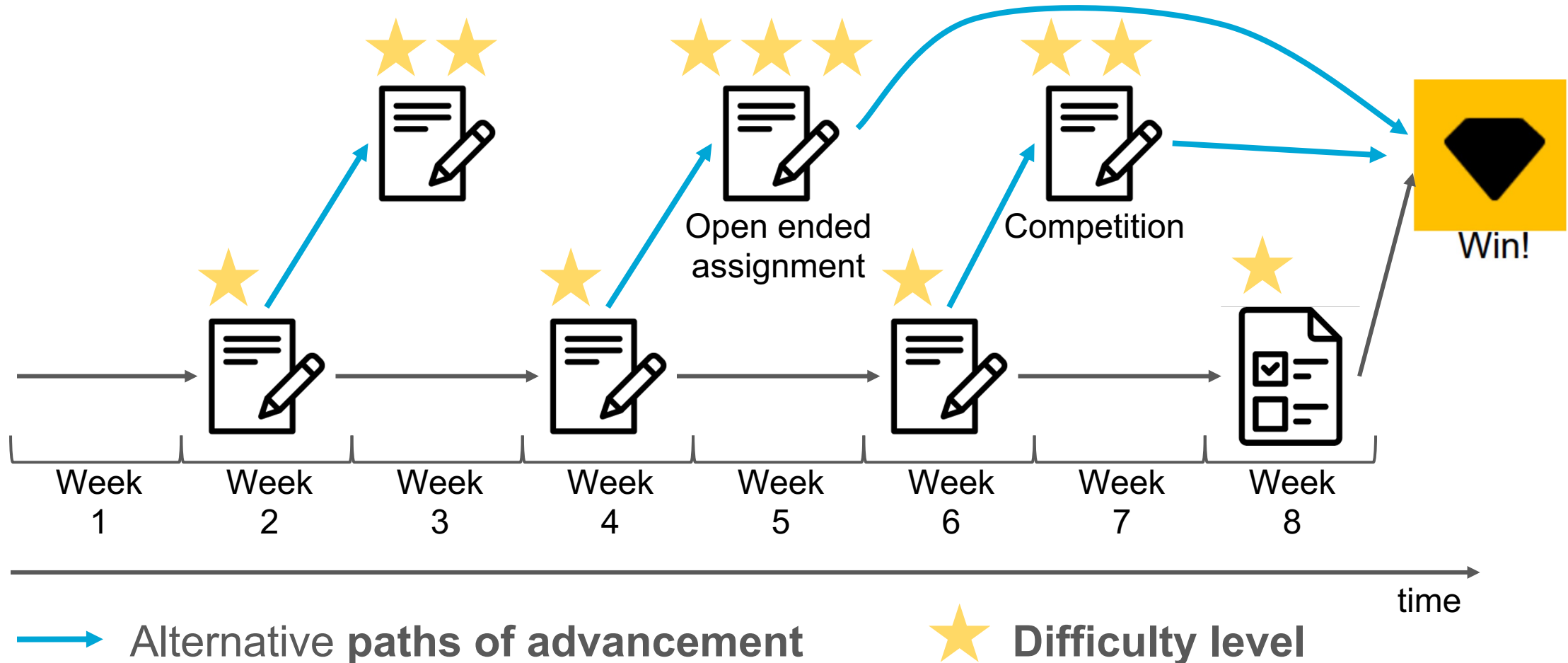
What is my status?
How to get closer to winning?
When can I make a *choice*?

- **Individual dynamics** (so, regardless of what others do)
 - Students can spend their points for some reward
 - Students earn access to more advanced content
- **Group dynamics** (so, regardless of what students outside the group do)
 - Peer-reviews are discussed with the group (mechanic), and result in bonuses/additional discussion (dynamic)
- **Cohort dynamics** (so, all students acting)
 - Top-20% participate in extra lectures
 - Bonus/brownies for best student/group of the day



One technique for **gamified** course design

Multiple paths available for students with different **skill levels** and **interests**.



Gamification Mechanics & Dynamics in Our Courses


- **Too many to list here**

- Scoring system is but one element
- Badges? Only for B.Sc., some “random”
* Manga cum laude

- **Onboarding** (mechanics)

- Entry quiz
- Story every lecture

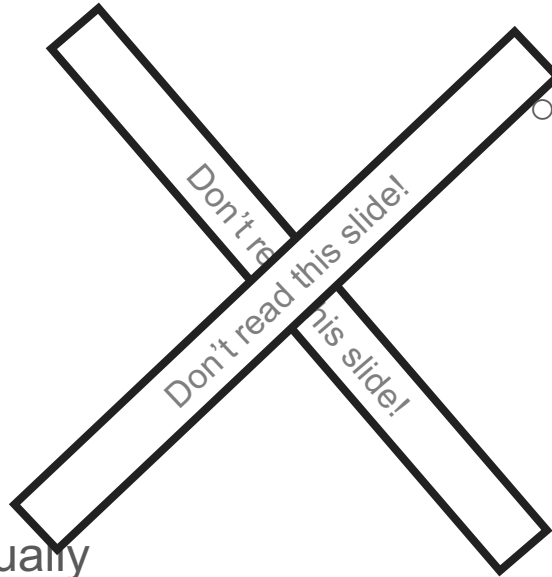
- **Social Learning** (dynamics)

- In-class teams, competing casually
- Self-study as team effort, competing
- Involve Winners and Achievers in class
- In  ve Winners and Explorers in self-study

- **Different player types** →

Different MDA

- Ladders, ranking, end-lecture quiz:
mostly for Winners
- Content unlocking (dynamics):
Mostly for explorers and achievers



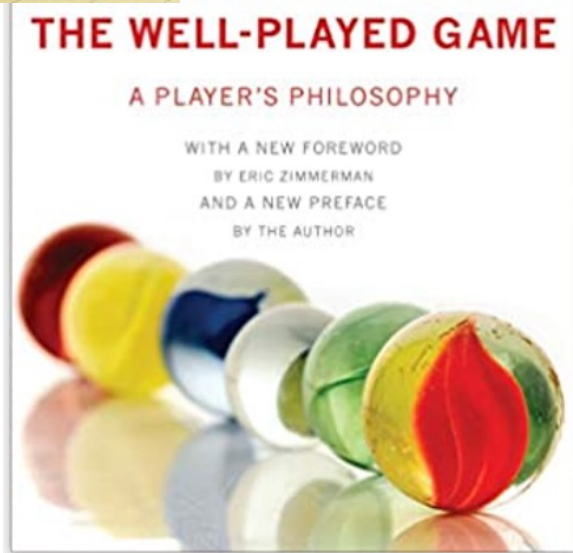
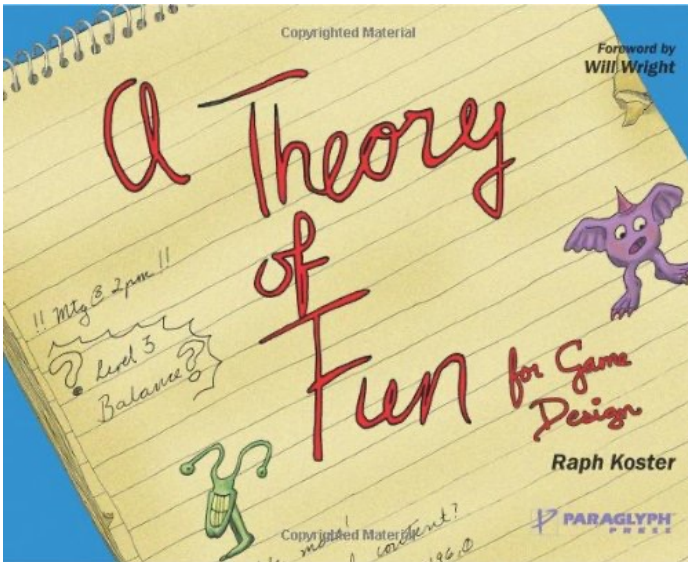
A Framework for Gamification in Higher Education

1. Decide on Learning Objectives and related content
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(Assuming you want to gamify a traditional course.)

Playtest Your Own Course!



1. Fine-tune fun
2. Are you increasing student motivation? Mastery, Access, Autonomy, Higher Goal
3. Are you rewarding the right things the right way? Balance different paths of advancement, focus on positives

Challenging and Diverse Content to Activate Diverse Students

Learning Objectives

BSc-CE (6E) (8h)	MSc-CE (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, Virtualization
Functional Organization	Cloud programming models
Multiprocessing	Case studies
Performance Measurements	Guest lecture
Directions in Computing	

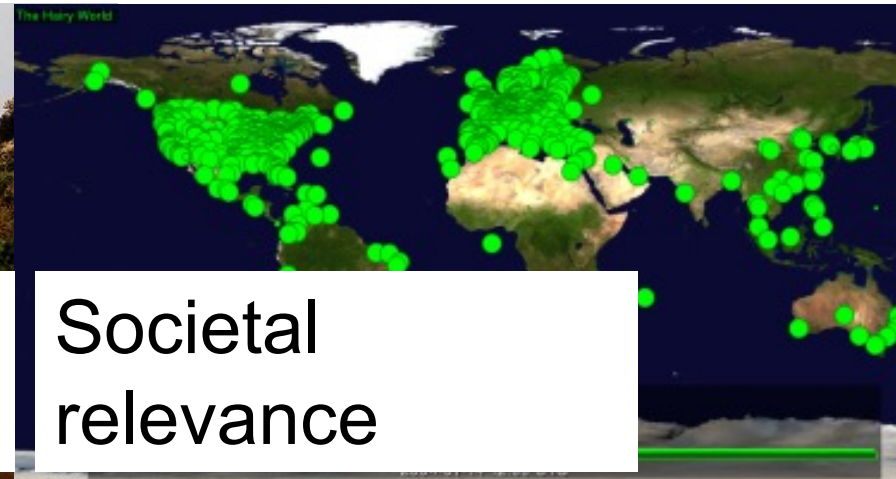
Try something else
Try something else
Try something else



Industry
state-of-the-art



Topics touch
today's research



Societal
relevance



Photos: (left) courtesy Google Inc. (middle) <http://www.flickr.com/photos/dimitrisotiropoulos/4204766418/> (right) personal library of A. Iosup.

Experience Operating Our Courses

Learning graph overview

- Analyze shortcuts
- Make sure students know how to navigate the puzzle

Public overview (student's view)

- Updates often & complete
- Unique view per student

Private overview (your & your team's view)

- Statistics: not only how many and which students are lagging behind?, but also which students are succeeding beyond expectation?





DOES SOCIAL
GAMIFICATION IN
HIGHER WORK IN
HIGHER ED?

4

WHY?

We Used Social Gamification in >20+ Operational Years, 2011–ongoing

- B.Sc. Courses
 - [VU, TUD, and UvA Computer Organization](#) (5+ years each)
- M.Sc. Courses
 - [TUD Cloud Computing](#) (4 years, co-teaching)
 - [VU, TUD Distributed Computing Systems](#) (5+ years each)

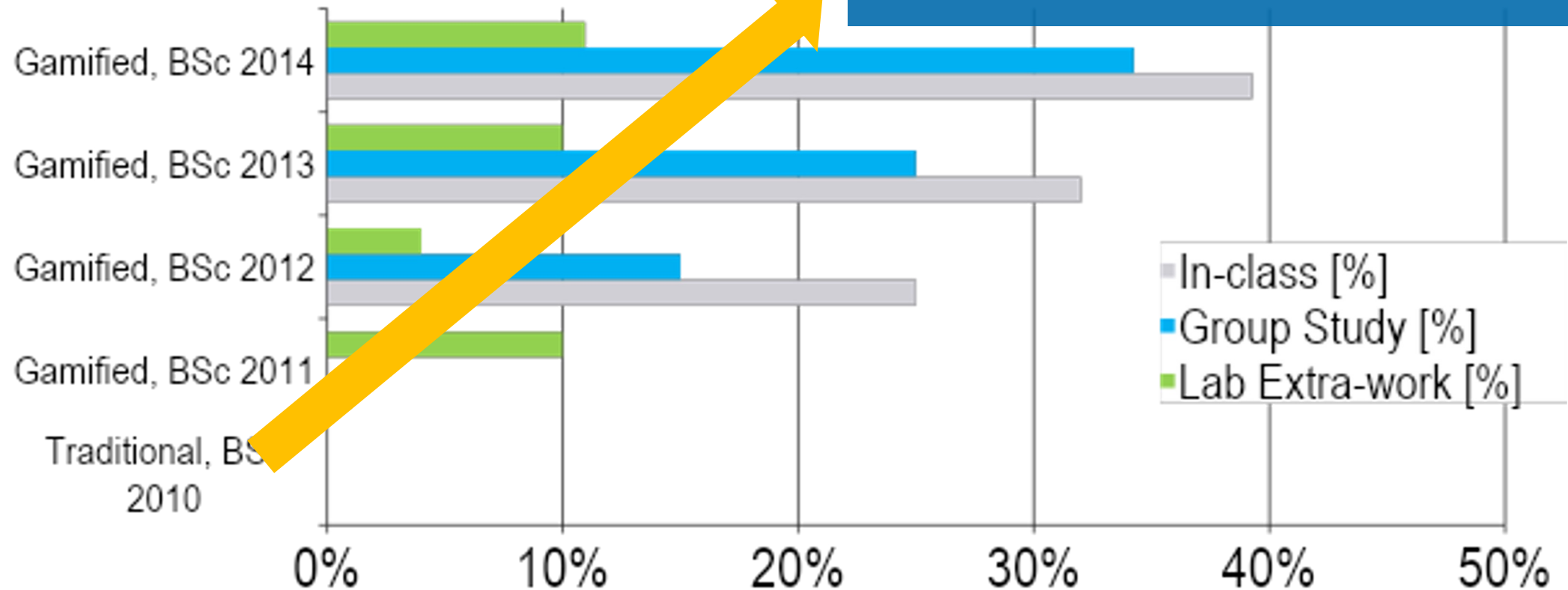
Main lesson: manage course dynamics!



SOCIAL GAMIFICATION CAN LEADS TO GOOD* RESULTS

* [Iosup et al. SIGCSE'14]

RESULTS 2015-2020 FOR UPCOMING ARTICLE



Extra work due to gamification, relative to traditional course [% all students]

SOCIAL GAMIFICATION CAN LEAD TO PERSONAL BENEFITS

“ 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.

”

WARNING: SOCIAL GAMIFICATION ALSO INCURS COSTS!

Gamification takes time and energy

- One week to consider gamification elements +
- One day per lecture for adaptation +
- Continuous adaptation +
- Continuous assessment, e.g., end-lecture quiz +
- Explaining a new system to students +
- The nitty-gritty details

Gamification also takes personal effort

- A new system has to conquer inertia
- A new system has to conquer doubt



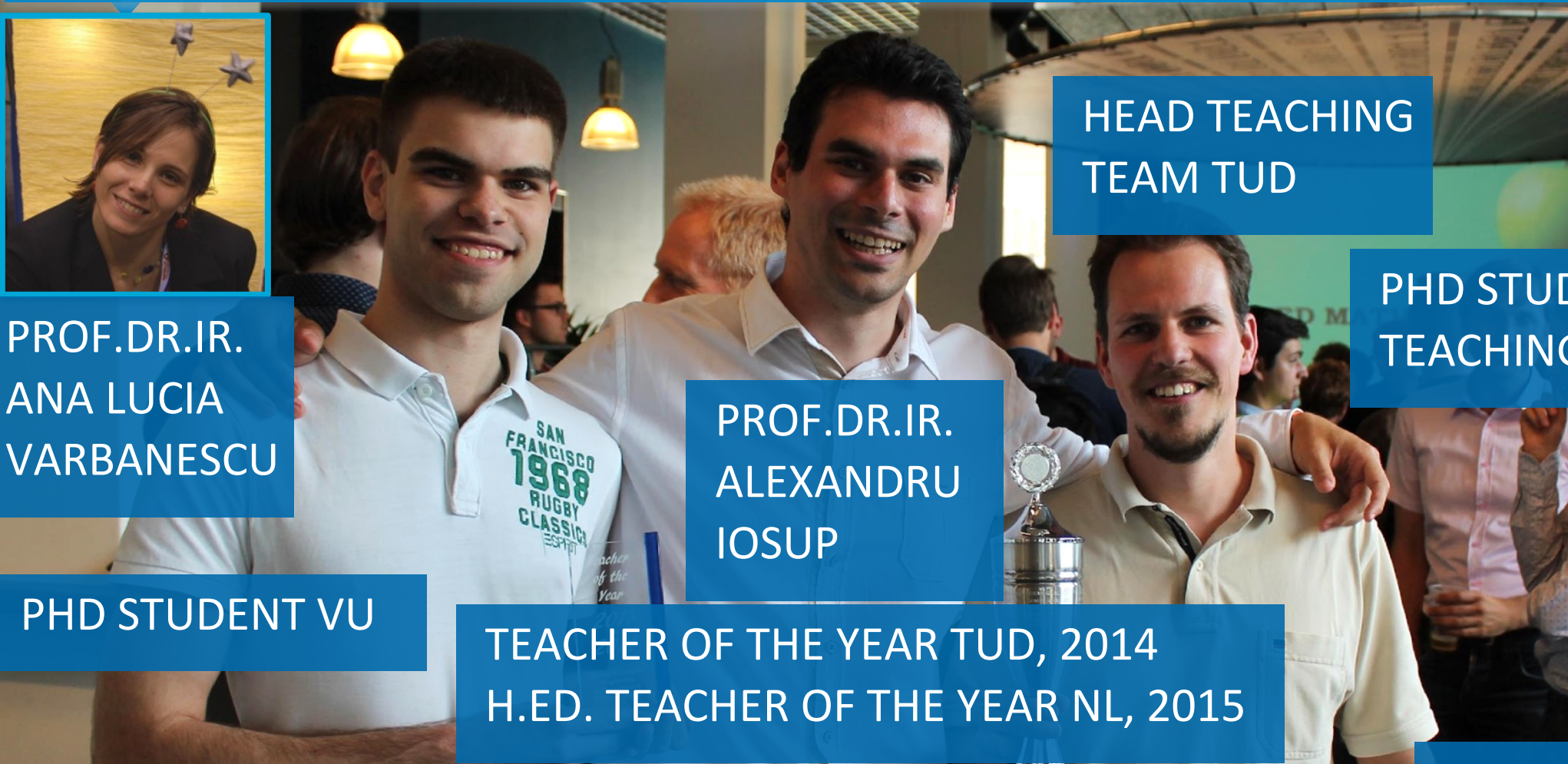
SOCIAL GAMIFICATION WORKS IN HIGHER EDUCATION!



PROF.DR.IR.
ANA LUCIA
VARBANESCU

PHD STUDENT VU

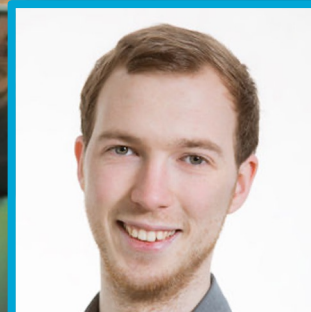
TECHNIQUE MENTIONED IN DUTCH PARLIAMENT



HEAD TEACHING
TEAM TUD

PROF.DR.IR.
ALEXANDRU
IOSUP

TEACHER OF THE YEAR TUD, 2014
H.ED. TEACHER OF THE YEAR NL, 2015



PHD STUDENT +
TEACHING TEAM VU



TEACHER OF THE
YEAR TUD, 2019

WHY DOES SOCIAL GAMIFICATION WORK BETTER THAN TRADITIONAL METHODS?

... GIVES CONTEXT AND MEANING TO DIVERSE **STUDENTS**

... ENABLES GIVING FEEDBACK TO DIVERSE **STUDENTS**

... ENABLES DIVERSE, DEEP **MATERIAL & PATHS**

... ENABLES PRINCIPLED DESIGN FOR COURSE **DYNAMICS**

... ENABLES INCENTIVES FOR **SCALABLE EDUCATION**

... ENABLES FINE-GRAINED **TEACHER** SPECIALIZATION

... GIVES CONTEXT AND MEANING TO **TEACHERS**

IT ATTRACTS
THE NEXT GEN
OF TEACHERS



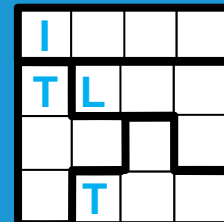
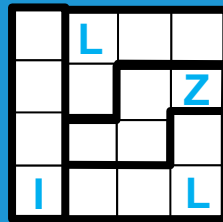
TAKE-HOME MESSAGE: SOCIAL GAMIFICATION CAN HELP WITH MASSIVIZING HIGHER EDUCATION



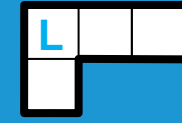
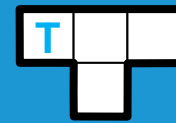
5

ALTERNATIVE
PATH:

Solutions (2x)



Homework
(3x)



x 4

x 4

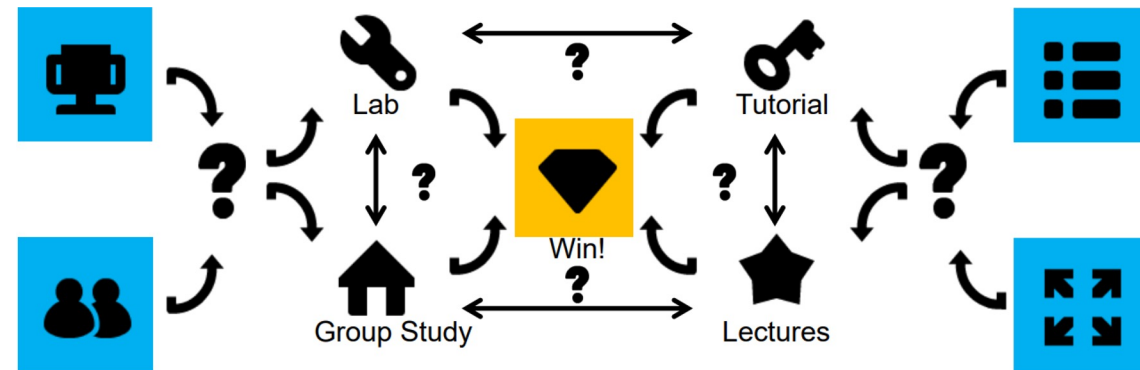
x 2

56

A Framework for Social Gamification in Higher Education that Works!

1. Decide on Learning Objectives and related content
2. Describe the perfect student
3. Design the gamified experience

- Mechanics and dynamics
- Rewarding assessment



4. Playtest your design and check for fun!
5. Operate your gamified course.

READY PLAYER ONE: SOCIAL GAMIFICATION FOR EDUCATION

MASSIVIZING IS
THE CHALLENGE

USE GAME
THINKING &
TECHNIQUES

WORKS FOR
STUDENTS &
TEACHERS

ATTRACTS THE
NEXT GEN OF
TEACHERS

[Iosup and Epema, SIGCSE'14]
200+ citations

Talks + Courses
VU/4TU 2015-2021

Talk Jesse Donkervliet,
VU, June 2018

Keynote Iosup,
NSF/TCPP EduPar'18



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