On the Gamification of a Graduate Course on Cloud Computing

Alexandru Iosup
Parallel and Distributed Systems Group
Delft University of Technology
The Netherlands
A.Iosup@tudelft.nl

Dick Epema
Parallel and Distributed Systems Group
Delft University of Technology
The Netherlands
D.H.J.Epema@tudelft.nl

ABSTRACT

Keeping diverse groups of students motivated and engaged in the curriculum is a major challenge of today's technical universities, especially in Europe. Gamification, defined loosely as the use of social gaming elements to activate students in learning activities, can help with addressing this challenge. This poster introduces gamification as a teaching technique, and discusses its application in the area of distributed HPC education through a graduate course at TU Delft. We discuss the goal and topics of the course; and the gamification mechanics, dynamics, and content-related elements. Over the past two years, we have seen an accumulation of evidence that gamified courses can lead to a high ratio of students who pass after the first attempt, and that gamification can be a promising technique.

1. THE PROMISE OF GAMIFICATION

On the Need for a New Approach in Technical Higher Education: We believe that technical higher education is facing an array of important challenges, especially in Europe. The new generation of students seems to be less motivated to complete a technical education than the previous. The new wave of students may be much more international and multi-cultural than before. There is an ongoing blame-game between educators and students; in particular, most faculty consider their teaching above average[1], and there is a tension between research and teaching as career-developers.

Challenges of systems courses: Among technical courses, computer systems courses pose specific challenges: they require holistic knowledge and mastery of many technical disciplines, and they confer experience through both discussion and practice.

Gamification in a nutshell: We operate within the conceptual gamification framework of Zichermann and Cunningham [4]. For them, as for many traditional theorists of computer games, games contain mechanics, dynamics, and aesthetics. Mechanics—point systems, levels and access, etc.—define how games operate as systems. Dynamics—badges, social engagement loops, unlocking content—guide the way players interact with the system mechanics. Aesthetics refer to the game content and may be more personal to the game designer and less amenable to systematic analysis.

Various types of players: Gaming theory identifies four primary player-motivations defined by Bartle [1]: *Explorers* are players who enjoy understanding the world–the student who is curious. *Achievers* are the ambitious player who wants to complete most of the challenges they encounter. *Socializers* participate in the game mainly because other players, in particular players like them, also do. *Winners* (*Killers* in Bartle's taxonomy) want to complete challenges at the expense of other players, e.g., to be the best.

The promise of gamification: We see gamification as a technique for technical higher education: the course becomes a systematic game with player-students trying to pass the course (win the game) while also having a good and rewarding personal experience. Gamification promises to improve the motivation of the students, to include more types of students in the same classroom (via multiple paths of advancement), and to offer better feedback to both course managers and students (via more and more varied, albeit smaller, assessment points.) This promise has been successfully explored in other settings than ours [2–4].

2. IN4392 CLOUD COMPUTING: A GAMIFIED GRADUATE COURSE IN HPC

IN4392 Cloud Computing is a systems course that focuses on the cloud computing paradigm. Cloud computing has emerged in the past few years as an IT paradigm in which the infrastructure, the platform, and even the software used by IT operations are outsourced services. Departing from the IT services of the past two decades, cloud services can be used flexibly, that is, when and only for how long they are needed, and leased for prices charged in small increments according to the actual usage. The cloud computing model impacts favorably on the operation of small and medium sized enterprises (SMEs), by reducing the initial investment in IT and the maintenance overheads, and by allowing SMEs to focus on developing their core technology and business, rather than becoming expert IT operators. There are currently hundreds of commercial cloud-based service providers, such as Amazon, Microsoft, Google, and SalesForce.

2.1 Course Design

[1]Reported, for example, by (Blackburg and Lawrence, 1995)(Bok, 2006)(Gillespie et al., 2010).

SC13 November 17-22, 2013, Denver, CO, USA

Table 1: Course topics for Cloud Computing.

Overview of cloud computing
Scheduling and Resource Management
Data Centers and Energy Efficiency
Multi-tenancy concepts, incl.virtualization
Cloud programming models
Case studies
Guest lecturer

Table 2: Use of gamification mechanics and dynamics for Cloud Computing.

Point Systems	Course points, access tokens
Levels and access	Access to various elements
Leaderboards	Hall of Fame
Onboarding	Entry quiz, 5% bonus to final grade
Social engagement loops	Teams of 2 for Presentations, Lab
Unlocking content	Unlocking Lab bonus assignments

Course Goals: After completing this course, students should be able to: explain basic concepts, objectives, and functions of cloud computing, implement complex applications using cloud computing, and analyze the current and emerging state-of-the-art in cloud computing.

Course Topics are summarized in Table 1.

Structure of the Course: IN4392 is designed as a 7-week course, and accounts for 5 credits or about 140 hours of work. The course consists of five components: lectures (1 block of 2 hours per week), presentations by students (1 session a week, in weeks 4–6), article reviews by students (about), four small lab exercises (about 5 hours per student), and one large lab exercise (about 50 hours per student).

Assessment and feedback: Every student has to give a 20-minute presentation of one paper from a selected topic matching the course. Students have to write 7 paper reviews, in three stages, to be reviewed by the course managers; students receive detailed feedback after the first review, and grades and remarks after their next (twice per course). The small lab exercises are optional and checked by the TAs. The large lab exercise is completed by the student through a report, a demonstration, and a submission of code. Course managers and TAs read the report for every student, and can ask for clarifications and improvements. The TAs verify the code for each student.

2.2 Gamification

Gamification mechanics and dynamics: (Table 2). We set a points-scale in which 10,000 points are required for a course grade of 10; without bonuses, 2,500 for the presentation, 3,500 for the reviews, and 4,000 for the Lab assignment. Participation without contribution is not rewarded. Various content items and bonuses related to the Lab can be unlocked. The Hall of Fame is periodically updated and allows each student to get progress-feedback. Onboarding offers a small reward to students at the start of the course. Various teams stimulate social engagement loops. We use various social engagement loops, including in-class discussion. We also use peer assessment for the presentation component of the course, after preliminary instruction on evaluation criteria. We collect meaningful information through end-lecture and in-class quizzes.

Support for player types: Our Cloud Computing course uses in-class discussion to explore concepts and to socialize, in-class team-based exercises to stimulate competition, team presentations to encourage achievement, and pair-programming in the laboratory to encourage socialization. The leaders of the Hall of Fame are named at lecture start, which increases their public status and incentivizes them to return to the classroom.

3. EXPERIMENTAL RESULTS

Course results: We consider the 2012-2013 edition of Cloud Computing very successful. Over 30 students passed our course at their first try, yielding a high passing ratio of over 60% of the enrollment and over 85% of the students who actively participated (who have passed the minimal threshold of capitalize on at least 2 of the over 20 scoring opportunities). The best students delivered portfolio-grade reports. Several of our students reported back of having obtained a job in the cloud computing industry. Several others have completed a related M.Sc. thesis.

Student Satisfaction: Student satisfaction was evaluated by a neutral party, as is common for courses at our university. On the positive side, "Student were let very free in how they could fill in the assignment, this way students could really make it their own project." On the negative side, "students put a lot more hours in this as required and could get in problems with other courses." Students have to quantify the number of hours spent on the Lab assignment, so indeed we found the average extra-time to be about 20%.

The impact of gamification: The course managers have experienced an enjoyable classroom. Students were interested in both the content and the structure of the course, and high in-class attendance contributed to many social activities. over 60% of the teams did extra-work to unlock content and achieve bonuses; this explains much of the extra-time our students reported.

4. CONCLUSION AND ONGOING WORK

To address various issues in technical higher education, we have presented in this work a technique for the gamification of a graduate HPC course, on cloud computing. Specifically, we have designed course mechanics, dynamics, and main content, and designed paths of advancement for four major types of students.

Our results with implementing this technique and testing it with over 50 students, suggest that gamification can be successfully employed as a higher-education teaching technique. We have observed a high passing ratio, excellent results for the top students, and general classroom engagement with the course.

5. REFERENCES

[1] R. Bartle. *Designing Virtual Worlds*. New Riders Games, 2003.

[2] R. Brewer, L. Anthony, Q. Brown, G. Irwin, J. Nias, and B. Tate. Using gamification to motivate children to complete empirical studies in lab environments. In *IDC*, pages 388–391, 2013.

[3] Z. Fitz-Walter, D. Tjondronegoro, and P. Wyeth. Orientation passport: using gamification to engage university students. In *OZCHI*, pages 122–125, 2011.

[4] G. Zichermann and C. Cunningham. *Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps*. O'Reilly Media, 2011.