Lessons learned on adult student engagement in an online gameful course

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Abstract— **Gamification has captured the interest of both Human-Computer Interaction and Educational Sciences during the last past years. However, most of the available case studies in the literature are not focused in online higher education environments, even less considering the demographics of adult learners. This paper presents the design and development of an online gameful course of Computer Networks formed by two groups with an average age older than the common university students. This approach aims to encourage adult learners to solve non-graded formative activities and to increase their sense of kinship to the group. After one semester, the results revealed a moderate effect on student engagement, but a low enrolment rate. In contrast, a similar previous study revealed promising outcomes. The main goal of this work is to present the obtained results and to analyse the relevant issues in order to understand the source of the engagement differences perceived.**

Keywords— Gamification, engagement, higher education, e-learning, networking, adult learners.

I. INTRODUCTION

Nowadays, instructors face the challenge of motivating their students since they do not often find a motivation in the learning process. Practitioners also face the design of student-centred activities in order to achieve the expected learning outcomes. Student's engagement has been a major concern for the education practitioners at all levels since long. Due to this issue, the importance of student motivation has evolved from a peripheral to a central perspective in psychological and educational research over the years [1].

Accordingly, different studies considering the use of game design strategies reveal that they can increase students' motivation, to engage them on a learning process when used properly. Therefore, gamification, conceived as the use of game design elements in non-game contexts [2], seems to be a promising technique to promote motivation, commitment and certain attitude in people [3]. Therefore, many gamification design frameworks are now available in the literature [4, 5]. Through gamification, students could be motivated to learn in a new way, also enjoying otherwise the traditional processes. Thus, the addition of game elements and mechanics aims to reduce the lack of motivation and boredom in the learning process.

In this way, the potential of gamification techniques is addressed to the achievement of the expected learning results through the motivational principles, being reflected in the amount of available educational experiences found in the literature [6, 7]. However, few of these studies are focused on 100% online environments, and in lesser extend (almost none) on the specific target of adult students. Generally, results and findings from a wide range of studies reveal that learning gamification could be a key to increase student motivation and engagement, although the achievement of that effect is not trivial and a great effort is required in the design process [8]. Moreover, researchers and practitioners have notified a low or "null effect" due to poor (commonly "ad-hoc") designs too, in contrast to their higher expectations. Regarding these concerns, our general interest is to study the motivational effects on adult learners of an online gameful course in higher education and specifically, to know the reasons why the engagement outcomes can be more or less promising depending on the applied design principles.

Therefore, we propose the following research question in the present study: *What design components were relevant to adult student engagement in an online gameful course?* To answer it, this paper is structured as follows: we describe the design proposed in our course in Section II. Next, we present different data collected and the analysis in Section III, while discussion is carried out in Section IV. Finally, we conclude this work providing some insights on present and future work in Section V.

II. DESIGN

The aim of this section is to describe the proposed gameful design within an online course of Computer Network Design (onwards NET). This course was held at Universitat Oberta de Catalunya (UOC) [9], a fully on-line university in Barcelona, Spain. This institution offers graduate and postgraduate programs in Catalan, Spanish and English, currently amounting to about 55.000 students. All courses at UOC are usually divided into separate virtual environments, according to the native language of the students. Thus, the NET course was divided into two different virtual classes: Spanish and Catalan, although the gameful experience is only developed in the English environment.

As a starting point, it should be noted there are two types of activities that a student needs to address in the NET course. On the one hand, activities with the purpose of testing whether the student has acquired the appropriate knowledge and contribute to the final grade. On the other hand, activities that are purely designed for the skills improvement without a real impact on the final grade. Regarding the second one, the course study guide lists a small group of activities that are considered an integral part of the study schedule, such as practical exercises and self-assessment tests.

Therefore, the kind of work proposed in the online gameful course involves refining their skills and the rewards are mostly related to providing additional degrees of flexibility or advantages in carrying out graded activities (see Tables I and II). Thus, the aim is also to somehow compensate the time devoted to the training activities, since they are not graded. Considering these assumptions, we identify the expected behavioural outcomes from the gameful design as follows:

- To motivate online students in solving training activities (not graded)
- To increase the feeling of kinship between e-learners in the same group

Previous to any description of the design guidelines, we highlight that before running any gameful experience (in previous editions), the accomplishment rate of skill-related non-graded activities in both courses was 0%, and the sense of comradeship and communication between students (a common issue in online studies) was low (almost null). The latter was noticed by the lack of interventions (post/replies between instructor-student) in the communication channels.

Consequently, to be able to start the design of the online gameful course, we rely on SPARC, a simple framework that provides a guideline to develop and analyse the design process [10]. Based on these principles, we structure the gameful experience from three points of view: metaphor (which contextualizes the rules in the learning context, giving sense to the whole activity), rules (which describe the basics of the activity), and tool (which is used to implement the rules and the metaphor). Furthermore, during the design process, it must be ensured that five dimensions (one for each letter of SPARC) are present in the proposed experience: Sense, Purpose, Autonomy, Relatedness and Competence (for a designer self-assessment).

A. Metaphor

The main purpose of the metaphor is to directly feed from reality. Therefore, given the NET course topic, the activity is inspired in the expected day-to-day activity for two IT staff teams (support) at a network corporate (here named PIED-PIPER and ENCOM which fits to both groups of the course). To manage the tasks assigned in their daily work shift, an issue tracking management, or "ticketing" system is used. Regularly, project leaders (instructors) generate tickets

containing tasks that needed to be carried out (individually or in group). All tasks associated with a ticket are related to some formative (non-graded) activity. IT staff members (students) assign themselves the available tickets they thought capable of solving (partially or totally). Once accepted, it is the team member's responsibility to bring it to completion, either individually or with the help of other team members, depending on the typology of the associated tasks.

Thus, to incentivize the ticket completion, the company also announces a set of goals (or "milestones"). To reward the effort of the IT staff, the whole team obtains certain bonuses whenever a milestone is achieved. Students can choose to which milestone the accomplished ticket belongs, each milestone requiring N tickets. The essence of this activity is a collective effort within all course students, as a single team: the IT staff. In this sense, the activity encompasses the entire course.

TABLE I. MILESTONES AND BONUSES IN GROUP A: PIED-PIPER

Milestone name	Bonus
0: Set up the lab	It opens the possibility to obtain an official Cisco certificate
A: Bandwidth upgrade	The on-line exams can be retried once
B: Remote work via VPN	A sample from last course will be published
C: Tech Crunch Disrupt setting	Students are granted with an extra week to complete a delivery
D: Cloud setup	Students are granted with an extra week to complete the Practice
E: Dark fibre upgrade	The sum of all exercises sums up to 11
F: Condor Cam network	3 specific questions or exercises will be published

TABLE II. MILESTONES AND BONUSES IN GROUP B: ENCOM

Milestone name	Bonus
0: Upgrade routers to IPV6	It opens the possibility to obtain an official Cisco certificate
A: Gbps Etherchannel backbone	The on-line exams can be retried once
B: Remote work via VPN	Activating the download of additional course materials
C1: Open a new branch in Hong Kong	The exercise 2 has a potential of up to 12 points
C2: Free-space Optical (FSO) laser link from HK branch	Graded exercise 2 actually counts 12 points
D: South Atlantic Express (SAex) link participation	You can redistribute question weighted grades as desired
E: Dark fibre across London	The submission date is moved one week
F: European Data Relay System (EDRS) node deployment	Students will be given the opportunity, once the grades are published, to resubmit it

B. Rules

The proposed rules are very simple, inspired in a reward-based crowd-funding model where several stretch goals related to a project are achieved by raising monetary contributions from a large number of people. In this case, instead of money, completing tickets become company

milestones. These milestones are independent from each other, so there is no linearity or dependency.

When a ticket is completed and assessed successfully is added to the class scoreboard. Each time a milestone is achieved, all students benefit from it, even if they do not directly participate in the activity. The flow is described in Figure 1. Additionally, the difference in the number of students enrolled in each group is taken into consideration to balance the number of tickets and proposed tasks to be solved.
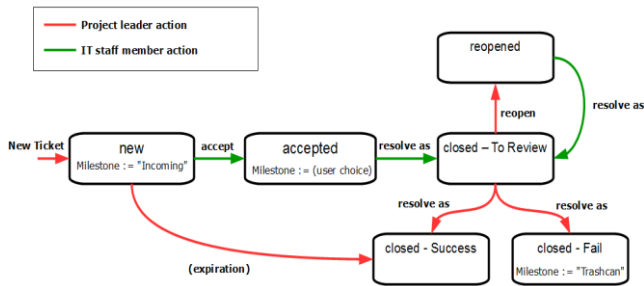

Fig. 1. Activity workflow.

C. Tool

The selected tool is *TracWiki* [11], an open source, Web-based project management and bug tracking system, commonly used in organizations such as ours in the metaphor. It supports ticket description and comments, version control log messages, milestone descriptions, report descriptions, etc.

III. ANALYSIS AND RESULTS

To answer the proposed research question, we run an analysis process and present the results of the online gameful course previously described. The study was conducted from February 2016 to July 2016 in two groups of Computer Networks (NET). They are two optional subjects at the Information Technology itinerary in e-learning mode of Computer Engineering degree.

The main works were conducted by means of the software Minitab[1] (version 17.1.0), a statistics package developed by Minitab Inc. A total of 147 students enrolled in both groups, described as follows: Age range=21-56 years old, mean=36.29, median=37.00, StDev=8.13, as graphically shown in Figure 2. Moreover, the student's sample of this study (by means of the students' age) was normally distributed considering the Anderson-Darling Normality Test with a p-value of 0.09, a test commonly used to determine if the data satisfy the normality distribution.

In addition, the student sample was taken as representative considering the UOC student profile, where 64% of them are

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more than 30 years old, and 27% for the 40+ age bracket, most work full-time and are financially independent (95%), married (73%) or have children (58%) - data taken from an internal study. This is not the common profile of students who commit full-time to university degrees or masters in our country (20-25 years old). Regarding gender, 135 out of 147 (91.84%) were male. Digging into the personal context, data reveals that 25.20% of students have finished previous university studies, 83.00% worked full time and 38.20% had family with children. This is not a common demographic context in higher education in comparison to most of the related studies available in the literature.

Therefore, the objective of the analysis process is to know how engaging the online gameful course to adult learners was. To carry out this process, two different viewpoints have been considered: user interaction (through system logs), and feedback (through the use of questionnaires).
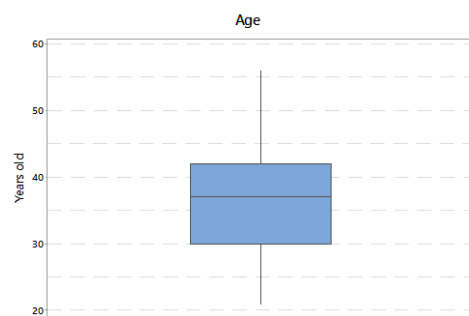

Fig. 2. Student's age boxplot (n=147).

A. Student interaction

At the beginning of the course, students were informed that participation in the online gameful version of the course was totally voluntary (the tool and bases were available). Each student was able to check it and decide to join the activity or not. They were free to choose the "traditional" structure of the course too. Therefore, given the voluntary nature of the experience, the sample of students from both groups was comprised of 31 students out of 147 (21.09% of the total students who enrolled in the Computer Network Design course) with a dropout rate of 0%. That is, none of the students who participated moved to the traditional format when possible.

Thus, students successfully delivered a total 303 tasks, 151 tasks being part of 55/90 tickets successfully resolved by group PIED-PIPER (61.12%) while 152 tasks being part of 60/115 of available tickets successfully resolved (52.17%). In a more detailed analysis, most of the unsolved tasks required to be developed not individually and not all milestones were reached. Thus, group A reached 5 out of 7 milestones: 0, A, B, C, D, and partially F (see description in Table I) as well as group B reached 5 out of 8 milestones: 0, A, B, C1, E (see description in Table II). The students could assign the resolved tickets to the milestone that most interested them.

Moreover, the tickets were enabled progressively as initially planned considering the final amount of participants, regardless the evolution of each group (the tickets were accumulated and did not expire). The solving rate of tickets was regular throughout the course in both groups, as shown Figure 3. However at the beginning of the course the group A was more active while in the last weeks, the performance of group B was a little better. Despite that, dataset shows some imbalance in the ticket development between the participant students being described with a task range=1-70, mean=1.15, median=6.00, and StDev=12.58. This suggests that not all students carried out their contributions to the same extent, although they were equally rewarded.
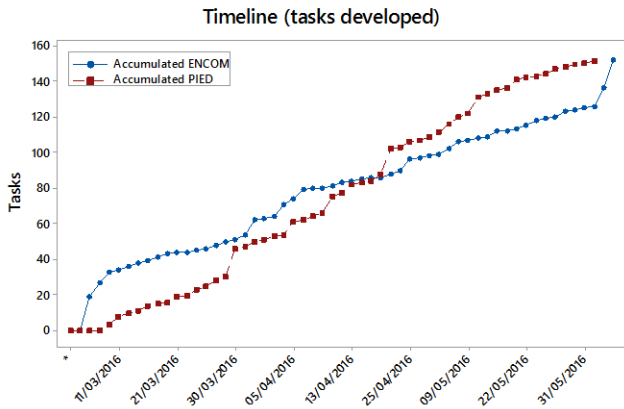
Fig 3. Timeline of successfully tasks developed (aggregate)

Once we have analysed how the students developed their tickets from a quantitative viewpoint, we consider the quality of these submissions. Regarding the flow described in Figure 1, when a ticket is submitted for the assessment, it can be accepted or refused (failed or reopened). Firstly, group PIED-PIPER reached an acceptance rate of 36.18% of deliveries and ENCOM, 39.74%. These rates are low, however, although thinking that they would leave the tickets submission because the first rejections, students completed the vast majority of them in a second instance.

B. Student feedback

The objective of the following analytical process is to know the perception and the most relevant triggers to adult learners. In this section, we summarize the responses collected from an online questionnaire ran at the end of the course. Students were asked to rate some items at a five-level *Likert* scale, from level 1 (very disagree) to level 5 (very agree). As follows, we highlight the most relevant findings due to the limitations of this paper. Firstly, participant students were asked about their overall perception about the online gameful course. Thus, Fig. 4 shows some imbalance in their responses, more than half perceived the proposed design as "agree" or "very agree", more than three quarters did not perceived it as a poor experience.
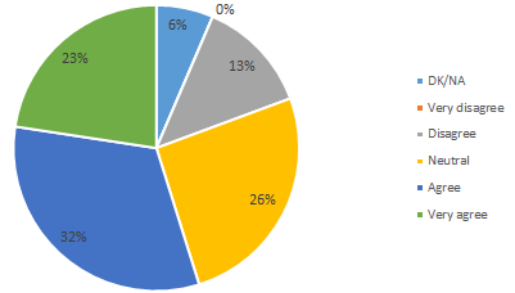
Fig 4. Participant students' perception (n=31)

Additionally, the students were asked about the main motivations in solving non-formative tasks. Results reveal a low motivation due to the social pressure of other members, and slightly better (moderate) regarding the social relationships and group rewards (see Table III). Moreover, they were additionally required to answer concerning the design points of view of cooperation or competition, as the cores that guide the metaphor and rules. 89.80% of them revealed preferences towards the cooperative environments as opposed to the competition between students. The valuation of common benefits, even if they have not participated, was upper to level 3 (neutral) by 80% of them.

TABLE III. MOTIVATION

Item (n=31)	Statistic parameters			
	Range	*M*	*Me*	*StDev*
I developed tickets motivated by group	1.00-5.00	3.34	4.00	1.13
I developed a minimum amount of tickets due to group pressure	1.00-4.00	2.15	2.00	0.86
I was exclusivity motivated by rewards	1.00-5.00	3.32	4.00	1.03

Considering the students enrolled in the course (even if they decide not to participate), it was intended to know how the proposed competences were perceived. Consequently, the evaluations are shown in Table IV. This feedback suggests that students were moderately interested in developing the language competence (shown by the use of English language) and interpersonal (solving group tickets and achieving group milestones). However, the creativity required to solve the proposed tasks was the most highly valued competence.

TABLE IV. COMPETENCES

Item (n=147)	Statistic parameters			
	Range	*M*	*Me*	*StDev*
Creativity	1.00-5.00	4.21	4.00	0.80
Language	1.00-5.00	3.70	4.00	0.83
Interpersonal	1.00-5.00	3.51	3.00	0.88

Moreover, asked about some statements regarding the five dimensions of the SPARC framework (Sense, Purpose, Autonomy, Relatedness and Competency), some interesting insights can be observed, as summarized in Table V. Despite all values presented are above 3 (neutral), only one of them (competence) is above the "agreement" level (4). In the other end, the feeling of autonomy was perceived slightly above neutrality. Sense, Purpose and Relatedness are higher, scoring values slightly below the threshold of "agreement".

TABLE V. DIMENSIONS

Item (n=147)	Statistic parameters			
	Range	*M*	*Me*	*StDev*
Sense	1.00-5.00	3.90	4.00	1.04
Purpose	1.00-5.00	3.89	4.00	0.97
Autonomy	1.00-5.00	3.31	3.00	1.29
Relatedness	1.00-5.00	3.93	4.00	1.08
Competence	1.00-5.00	4.16	4.00	1.03

IV. DISCUSSION

The results revealed an initially unexpected effect on student motivation since a low percentage of them (21.08%) enrolled in the online gameful course. Hence, it seemed the students did not to perceive the proposal as "attractive" and decided to continue in the non-gameful version of the course. By means of the responses' analysis, the most repeated argument was "the lack of time", which made us consider that the proposal was perceived like a greater effort. Although many of the students argued "the lack of time" limitation, this rate was much lower than a similar demographic in previous study [8]. Additionally, it is remarkable that 21.64% of enrolled student admitted that they did not even consider the published bases.

Regarding the expected outcomes, the motivation of participant students in solving training tasks (not graded), was moderate, achieving rates of about the 61.12% and 52.17% of tickets successfully solved in both groups. We are aware the starting point was 0% in non-gameful editions and we have designed a "one-size-fits-all" experience to motivate a section of the students. However, we consider the motivational effect as moderate, slightly lower than our expectations, despite of the 60% of them valued it as positive/very positive, reaching the 80% including the neutral feedback. The second expected outcome, to increase the sense of kinship between e-learners in the same group, was partially achieved too. The participation was higher than the mean number of interventions between student (almost 0%) and most of the non-delivered tickets were requesting group collaboration.

At this point, to answer the research question (*What design components were relevant to adult student engagement in an online gameful course),* we rely too on an analysis conducted in a previous study developed from September 2015 to February 2016 in two groups of the Requirements Engineering

course taught online [8], onwards SOFT. It was an optional subject at the Computer Engineering degree too. Regarding participation, a great difference is perceived between the two gameful courses (63.82% and 26.72% of the total students in the courses SOFT and NET respectively), as well as a total of achievements of 62.00% and 80.00% in two groups in SOFT, in contrast to 61.12% and 52.17% in NET). Therefore, we aim to describe the possible reasons, which would explain their motivations from diverse points of view (despite of most of the design principles applied in both courses are common) as follows:

- Demographic: the attributes of both samples were similar and fit the so-called adult learners. SOFT course presented the following demographic data: age range=22-53 years old, with mean=34.07, median=34 and StDev=6.88, were 91 out of 94 were male. This characteristics (adult learners) did not differ at all from those presented in this case study (see Section V), therefore we cannot consider demographics as relevant variable to explain the perceived differences.

- Course contents: although the course and contents were not the same (they are different subjects), both are presented as optional subjects in the online Computer Engineering degree. These studies stand out by learners that encourage professional skills as proposed in the non-formative tasks. Thus, we do not consider them as relevant as to strongly influence participation and motivation.

- Language: while the course SOFT allowed contents and communications in their native language (Spanish and Catalan), the course NET was limited to the use of English language. This limitation was applied to the whole course design with a clear purpose of improving the linguistic competences since the vast majority of technical documentation is available in this language. However, analysing the feedback from students, we consider that this item could be a relevant issue to explain a lower participation rate in the current online gameful course.

- Rules: the rules proposed in the course NET were slightly more complex than in SOFT. Therefore, it becomes necessary a long onboarding period to involve the students (avoiding a simultaneous introduction). Received feedback leads us to consider that our onboarding process required a longer time to successfully introduce the more complex rules. Similar to the language issue, we consider that the combination of a short onboarding period and complex rules could be perceived as a barrier for the student participation.

- Metaphor: the same metaphor applied in both studies, but adapted to each subject (software or networks environments) as well as rules context, giving sense to

the whole activity. Additionally, it was considered that the principle of *one-for-all & all-for-one* was appropriate to easily understand the proposed cooperative environment. The data taken from the questionnaires seem to corroborate this thought. Therefore, we do not consider these design elements and its minor changes as relevant.

- Tool: the selected tool to support the online gameful design was changed from Trello (in the SOFT course) to *TracWiki* (in the NET course). We suspect that a wiki system was not the most appropriate tool and ended being a relevant barrier for the student enrolment. The need of more intuitive, visual, even allowing a "drag & drop" interaction seems to be relevant. Diverse tools like *Trello* could be the key to make it initially more attractive to participants.

V.   CONCLUSIONS

We have presented the design and analysis of an online gameful course in a Computer Engineering degree with predominance of adult learners in this paper. It relied on the application of game design elements and properties in non-leisure environments as its motivational foundation. To guide the designing process, we laid the SPARC framework towards to motivate online students in solving training (not graded) activities and to increase the sense of kinship between in the same group.

A total of 31 students voluntarily joined the course, being the experience assessed from both quantitative and qualitative standpoints. The proposed objectives of engagement were moderately reached by participants although most of them initially decided not to join. Accordingly, we analysed the possible keys to explain the engagement differences perceived compared to a previous similar experience, considering as relevant the requirement of a non-native language in all communications, an insufficient onboarding period, the complexity of rules and an the use of an inappropriate tool. As further work, we will analyse the effect of personalized gamification to enhance the adult learner engagement in online gameful courses.

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