Teaching Computer Skills while Engaging Students: A Gamified Approach to Word Processing

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***Abstract*—Learning computer skills while attending classes at the School of Humanities of the University of Padua can be little engaging. Low interest on the subject is paired by low resources by the School. Yet, effective computer skills are increasingly important in a society were everyone knows how to use a smartphone but might get lost while using a complex software. In this paper we address the problem of motivating students to acquire computer skills in word processing by organizing a series of activities based on a gamification approach. A suite of automatic tools give the students control of their learning progressions, provide immediate feedback to their activities, and engage them by modulating the difficulty of the proposed steps. Initial results with a group of History undergraduate students are presented, together with a proposal for a novel approach that is under test.**

***Index Terms*—Gamification, student engagement, computer skills**

I. Introduction

The ability to effectively work with a text processor is of fundamental relevance for students of faculties in the humanities. The difficulties of structuring reports and the final thesis, already discussed in detail by Umberto Eco [2], are often increased by the difficulties in mastering the required computer tools for an effective formatting with a word processor. The causes can be due to a variety of factors. First of all, an increased computer illiteracy, that is a limited capability of critically analyzing and understanding the potentials of Information and Communication Technologies (ICT) as tools for work, free time and socialization [10]. Notwithstanding the preconception that younger generations are innately able to interact with computer systems – being constantly surrounded by smartphones, tablets and any kind of digital device – computer illiteracy is an issue also for the so-called digital natives [3].

Computer literacy can thus be confused with the skills of interacting with digital devices, which do not include the real comprehension of the underlying processes by which these devices are operating. A lack of deep understanding of the functioning of computer tools and programs is reflected by the reduced autonomy that can be observed in students that face practical issues, for instance while formatting a text with a word processor. By correcting the draft versions of master thesis, we continuously observe that common activities – such as creating an index, linking cross-references but even using a predefined style – are considered way too difficult by our students, who prefer to perform automatic tasks manually. It seems that the cognitive load of learning how to effectively use these common tools is perceived higher than the effort (and the boredom) of performing a repetitive task. A partial reason for this is the huge amount of uncontrolled information that is present on the Web, that makes it difficult to find a correct solution among the thousands of courses, *how-tos*, blogs and forums. Hence, it is of paramount importance to promote an informed use of ICT, based on a critical evaluation of what is available on the Web.

We believe that, in order to promote effectively computer literacy, teachers should take into account a famous quote from *Mary Poppins* (Stevenson, 1964): In every job that must be done, there is an element of fun. You find the fun and – snap – the job's a game! Yet, maybe because computers are mainly used for games, enjoyment is usually not considered during the development of courses on the usage of computer themselves. Fun is considered a fundamental component of free time, but not a component of *serious* activities. Yet, recent studies showed quite the opposite: the application of game design element in non-game context can improve both the students performances and the effectiveness of the activity [5], [7].

Our work starts from the gamification techniques described in [1], which proved to be particularly useful in a context similar to ours. Another relevant study, which focuses on students at the university level, is described in [9]. The present approach stems from our experience in gamification, that we exploited in different tasks such as text classification [8] and the development of a social network [6]. Our goal is to integrate these experiences in a gamified system for teaching the advanced use of computer software, in particular word processors for a cohort of students in humanities.

II. Motivation

Since year 2001, the Italian Government modified the organization of all undergraduate courses introducing the obligation of at least 3 ECTS credits in *computer skills*. ECTS stands for European Credit Transfer and Accumulation System, which is a standard for comparing the study attainment and performance of students of higher education across the European Union. It is important to note that, since 2006,

courses assigning 3 ECTS do not have a numerical grade, but are just *pass/not-pass*.

After a number of years of experimentation with lectures and laboratories, in year 2009 the School of Humanities of the University of Padua, introduced a standardized test for most of its undergraduate courses, namely: History, Philosophy, Foreign Languages, Archaeology, Literature, Arts Music and Drama. The test, called *TAI* (Test di Abilità Informatica – Test on Computer Skills) is based on four modules of the European Driving Licence: ITC fundamentals, word-processors, spreadsheets, and using the Internet. This choice is partially motivated by the significant costs of organizing computer laboratories for more than one thousands students each year, and by the reduced amount of personnel available for taking care of computer skills. Basically, a single professor on computer science had to deal with all the students, making impractical the organization of taught classes. Yet, the main motivation is that most professors of the School of Humanities believe that young generations are already enough knowledgeable on the subject to pass the TAI almost without additional preparation.

TAI exams are carried out using a software application called *Minimark*, which is a light and open-source version of the commercial software *Question Mark*. Minimark allows the teacher: (i) to generate automatically the tests, starting from a pool of about 500 questions; (ii) to assign them to select groups of students who has to provide the answers at the presence of the teacher; (iii) to compute the grades. Students are encouraged to undertake a number of applied activities suggested on the course web-pages in order to prepare for the test, but since there is no reward for undertaking these activities (apart from an improved preparation) almost all the students go directly for the test without even trying the applied activities.

TAI structure slightly changed through the years to adapt to students feedback. The number of questions, the material available for the students during the tests, the way scores are computed have varied, following a general trend of progressive simplification, which was not paired by a progressive improvement of the results. The actual version is based on 16 multiple-choice questions (each with a single valid answer), four questions for each of the four ECDL modules, that had to be filled in 16 minutes. All questions have the same scores: one point for a correct answer, zero points for a wrong answer and 0.2 when the answer is left blank.

Up to now, 58 TAI sessions have been organized, with a grand total of 11,169 assigned tests. Results are very unsatisfactory, because on overage only 69.5% of the students pass the test. This low performance is even more serious if we consider that, according to the idea that computer skills are usually necessary in front of a computer connected to the Internet, in the actual version of the TAI students are allowed to use a word processor or a spreadsheet to verify the correctness of their answer and even to navigate on the Web. It is interesting to note that results do not vary with time, even if – as previously mentioned – the test has been progressively simplified. It seems that students adapt their preparation quite fast to the perceived difficulty of the exam.

This behavior can be better understood analysing the frequency histograms of the numerical results obtained by all the assigned tests, normalized on a scale from 0 to 10 where sufficiency is 6. Since, as already stated, the final grade is in the form pass/not pass students are not stimulated to study in detail because there is no difference in grade between a *sufficient* and an *optimal* preparation. The curve (shown in Figure 1) resembling a Gaussian distribution centered slightly above 6, might suggest that students tune the amount of study to obtain the maximum results with minimum effort, and that the final votes are just the effect of errors in students self-assessment of their preparation.

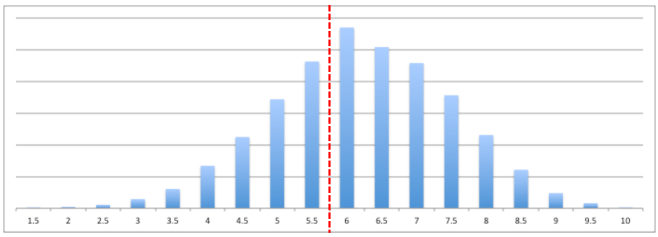

Fig. 1. Frequency histograms of the average results at the test on computer skills based on multiple-choice questions.

Another unsatisfactory result is that, on average, 30.1% of the enrolled students does not show up at the tests (with a considerable annoyance at the organizational level when 300−600 have to be organized in turns to enter in a laboratory with only 44 computers). Such a high rate of careless students cannot be explained by simple indifference towards the subject. It is likely that the lack of a relationship with a teacher, who is met for the first time only the day of the exam, reduces student engagement.

In conclusion, this model shows a number of drawbacks that need to be overcome. In the next section we show how gamification techniques can be applied to improve students engagement and their success rate maintaining the requirements of the actual TAI, that is without organizing taught classes.

III. Gamification Concepts

There is a number of gamification concepts [4] that are relevant for our aims of introducing game mechanics and dynamics in the development of computer skills.

The most interesting concept regards *player control*, which is the recognition by participants that they are in control of their progression from the initial low competence to the final proficiency. Students should be able to choose when to perform a learning activity and when to progress to a more complex one. Thus activities should be ordered in an increasing level of difficulty, balancing the progression between boredom – the activity is too easy for the student – and anxiety – the student perceives that he/she will never be able to complete it. It is likely that the correct fulfillment of an activity is the main motivation to start the subsequent one. This is in contrast with the usual approach for university courses, where is the teacher who chooses the pace of the activities.

Another important concept in game design is called *pathways to mastery* (shown in Figure 2), which is usually subdivided in three phases. In the first phase, called *onboarding*,

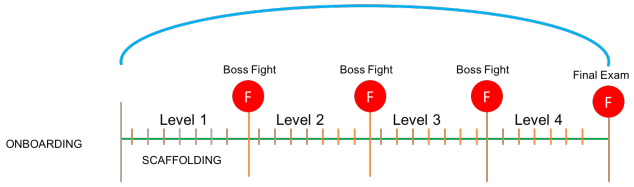

Fig. 2. A depiction of the pathways to mastery.

the participant enters the game in a fast and captivating way. In our case this can be achieved through a first interaction were the requirements are simply to understand the interaction rules and trying to perform an activity that is so simple that is basically impossible to fail. It might be useful to introduce also some elements of fun, for instance providing some witty trivia about computers. In the second phase, called *scaffolding*, the player is trained through a series of simple steps, in order to avoid frustration and to gradually accustom to the effort needed to proceed in the activities. To this end, the first activities are considered particularly easy. For instance, in our case of computer skills: saving a file, introducing some numbers in a spreadsheet or applying bold formatting to a text in a word processor. In the third phase, called *mastery*, the player has the complete availability of the competences gained during the pathways, knows how to perform all the activities, and acquires the correct attitude towards the subject. It can be considered as a rite of passage into maturity, after the necessary steps of initiation and training. In our case, this passage can be symbolized by the final exam, which attests the obtained computer skills with 3 ECTS.

An additional concept relevant to our approach, as stated in [11], is that a gamified system turns over the way participants are evaluated. On the one hand, in a classic evaluation system, students start with a maximum grade and, based on the number of errors in their assignments, gradually decrease it. On the other hand, in a game environment, players start from an initial value of zero and gradually increase their results by accumulating points. This is made possible because players are allowed to repeat a level – or an activity, in our case – as long as they are happy with their results or until they fulfill the requirements. With the first approach, students are likely to be demotivated after the first errors, while with the second approach the main risk is that players do not fall in the *flow channel*, that is the area between boredom and anxiety, and thus either are not engaged or eventually give up.

The possibility to repeat activities almost indefinitely, specially in our case where limited human resources are available, the development of automatic tools to asses the correctness of a given activity. These tools are also suitable for another gamification concept: *immediate feedback*. Knowing almost in real time whether an activity is successful or not may improve engagement.

IV. Gamified Test on Computer Skills

In the first semester of the academic year 2016/17, we introduced a gamified version of the TAI (from now on Gamified TAI or GTAI), which builds on the gamification ideas described in Section III. First of all, GTAI is based on a series of applied activities that focus on the advanced use of a word processor. According to the idea of pathways to mastery, activities start from simple text formatting, to page numbering, to the insertion of multimedia elements.

Students are required to complete the activities, starting from a flat document, using the word processor *Writer* of the open-source suite LibreOffice. The choice of not using the more popular MsOffice depends on three factors. First, students should not be obliged to buy proprietary software (or to change operating system in case they use Linux) in order to take university exams. Second, the format by which Writer saves documents (Open Document Format) is very well documented and, of course, open. Third, if we develop an open-source culture we contribute to save licence money for public bodies and private companies. It is important to note that Microsoft developed a gamified tool for MsWord, called *Ribbon Hero*. Our approach is different because we do not assume that students use the same computer program – in fact, they can use any suite, LibreOffice or OpenOffice, for any operating system and device – and gamification is applied to the results of formatting rather than to the process of formatting.

GTAI is based on two complementary elements: (i) an e-learning platform based on Moodle; (ii) a suite of programs that automatically corrects the activities and deal with the automatic interaction with the students. Both elements include gamification concepts.

As regards the e-learning platform, it includes:

- A *news channel* through which the teacher updates the students regarding all the organizational aspects of GTAI.
- A *table of activities* that describes in detail the activities to be completed, including their due-date; this part is manually updated weekly when a new set of activities is made available.
- A *forum* where all students can interact, pose questions, add comments regarding all the activities.
- A *FAQ* that summarizes all the main threads of the forum.
- A *private messages* area, that helps students with particular issues.

As regard the automatic evaluation of activities, it is organized as follows:

1) Each Monday, a new set of seven activities is made available for correction. Activities are grouped according to their scope, from text formatting, to paragraph and page formatting, page numbering and so on.
2) Students are required to download a flat document, whose content is relevant to the scope of the activity, carry out the required formatting and send the file as an attachment to a given email address. They could carry out the activities at any time using any device (their own or the ones made available by the School of Humanities).
3) An automatic tool, written in Java, replies to the students, to give immediate feedback about how the mail has been processed. In order to add a minimal part of fun, each reply contains a *computer tidbit* on computer science facts and history.

4) A software suite, written in Java as well, analyzes the files sent by the students, checks whether the activities have been carried out correctly, and creates a graphical leaderboard that students can check.
5) Students check the leaderboard, compare their results with the other ones, and are free to retry the activity as many time as they want, until the results are satisfactory. Usually each set of activity is open for corrections for about two weeks.

The above procedure was iterated for six weeks, for a total of 42 single activities. Each set of activities was slightly more difficult than the previous one. The students who finished all the activities had to take a final exam to obtain the 3 ECTS, equivalent to the plain TAI. The final exam consisted in carrying out, in presence of the teacher, a subset of the GTAI activities: basically students were asked to format a document according to a set of guidelines.

A total of 77 undergraduate students in History participated to GTAI, but we have to suspend the activities of 18 students, because they cheated sending files formatted by someone else (a special software module checked for possible copies). Apart from this quite large amount of deceivers, almost one over four, the results of the remaining 59 students are encouraging. All the activities were correctly carried out by 44 students (75%), while among the remaining 15 students, 5 completed almost all the activities, 2 dropped half way during GTAI, and the remaining 8 dropped after the first set of activities. More importantly, 100% of the students that completed the activities passed the final exam.

The average time required to carry out an activity is shown in Figure 3, from which it can be seen that even if the activities were increasingly more complex – e.g. activity *a2* consisted in applying bold formatting to a word in the text while activity *e4* consisted in numbering all the pages but the first one – this was compensated by an increase of students skills.

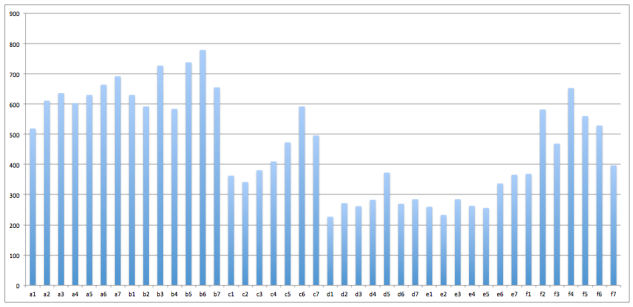

Fig. 3. Average time required to carry out an activity: activities with the same letter belong to the same group (a: characters; b: paragraphs; c: lists; d: pages; e: headers/footnotes; f: multimedia elements.

Moreover, in order to investigate how students perceived GTAI, we distributed a questionnaire where students were asked to assess their judgment using a 5-points Likert scale, from "total disagreemet" to "total agreement". As regards the effort required to carry out the activities, more than 80% of the participants agreed (among these 53% totally agreed) that "the effort was in line with the number of ECTS" (average score $4.3/5$) and that "the time granted was sufficient to finish the activities" (average score $4.3/5$). Although activities were not perceived as particularly easy, because 54% of the participants agreed (and only 7% totally agreed) that "activities were simple" (average score $3.5/5$), students acknowledged that the increase in difficulty was compensated by the increased experience, because 83% of the participants agreed (27% totally agreed) that "difficulty had a balanced increase" (average score $4.1/5$). As a general remark, 77% of the participants agreed (33% totally agreed) that "the participation to GTAI was a positive experience" (average score $4.0/5$). The questionnaire aimed also at evaluating the pure gamification elements. Appreciation was lower than the general appreciation for GTAI. The computer tidbits received an average score of $3.9/5$, the forum $4.1/5$, and the leaderboard $3.6/5$.

V. Future Improvements

The results of the first experiments was the starting point for an additional step towards a gamified test on computer skills. At the time of writing, we enrolled 105 undergraduate students in Language, Literature and Cultural Communication, who will participate to a two-month gamified experience in April and May 2017.

The goals of this new versions are the following:

- Reinforce *player control*: students ask individually for a new activity choosing their personal pace in progressing, or even to redo an activity already successfully carried out in the past.
- Improve the *pathways to mastery*: activities are reordered based on their actual difficulty, for instance considering that some formatting at the text level can be more complex than some other at the paragraph or page level.
- Introduce a notion of *narrative*: the effects of the different actions on a sample thesis or CV will be shown to the students, showing how the document improves step after step.
- Avoid a general *leaderboard*: it is well-known that leaderboards may demotivate participants and in our case the leaderboard received the lowest level of appreciation.
- Discourage *cheating*: each student receives a different plain text, which is checked against the original when the file is sent back after the activity has been carried out.

To this end, we modified the software suite in order to allow students to ask for a new activity at any moment by sending an email to an automatic address. After checking a new mail from a student, a software tool based on a generative grammar creates a flat text, in *ODT* format, which is sent back to the student. The body of the email describes the required formatting activity that has to be carried out on the file. The activity can be the next one in the *progression loop* or an old activity, already done by the student. The choice between a new and an old activity depends on the student pace, with the idea that carrying our too many new activities in a row does not help in memorizing the procedures while a certain degree of repetition may be helpful. After carrying out the activities the students sends the file back to the system, which corrects it and sends back a report. In case the student carried out

successfully an old activity he/she is rewarded with a badge, that can be used to receive suggestions in future activities. The main elements of the procedure are shown in Figure 4.

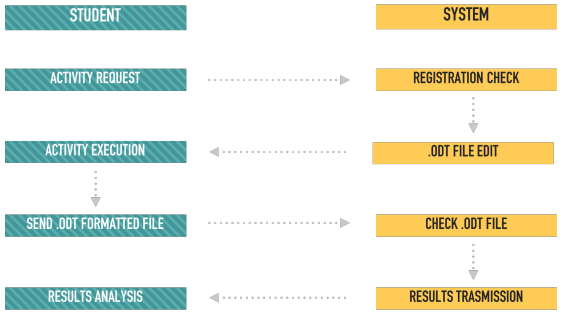

Fig. 4. Flowchart representing the main interaction steps in the novel gamified version or the test on computer skills.

As described in Section IV, one of the problems is that almost $1/4$ of the students cheated by sharing activity files (basically $1/8$ of the students give their files to another $1/8$, but we consider cheaters both givers and receivers). We do not believe that Italian students are natural deceivers at exams, because this high percentage can be due to the fact that students did not perceive the presence of a person behind the automatic tools. Yet, this is a problem that has to be faced. We believe that sending (and checking) different files for each student and for each activity can reduce the problem of sharing files. Moreover, allowing a maximum number of activities each day – for example, one new activity each 12 hours – can reduce the problem of students asking friends to perform the activity at their place. Yet, we cannot run the risk that a gamified experience is associated with deception. To this end we will maintain a final exam also for this new GTAI, as the final step towards *mastery*.

VI. Conclusions

In this paper we present a gamified approach to improve students engagement in developing computer skills. The project started after years of standard evaluation of computer skills, based on a questionnaire to verify computer skills. An analysis of the results of 11169 single grades showed that students at the School of Humanities of the University of Padua were not motivated to aim at a preparation higher than sufficiency.

The core idea of the proposed approach is that students should be motivated to carry out simple editing activities, which are the basis for effectively formatting their final thesis, using some concepts from gamification. This can be achieved by the aid of a software suite that allows the student to control their progress towards mastery, provides an immediate feedback for each activity and permits students to perform each activity as many time as they want or they need, until they master it.

Initial results are encouraging, although a number of issues emerged. This has been the basis for a novel experimentation, which is currently under test, to promote even more students engagement.

References

[1] G. Barata, S. Gama, J. Jorge, and D. Gonçalves, "Improving participation and learning with gamification," in *Proceedings of the First International Conference on Gameful Design, Research, and Applications*, ser. Gamification '13. New York, NY, USA: ACM, 2013, pp. 10–17. [Online]. Available: http://doi.acm.org/10.1145/2583008.2583010

[2] U. Eco, *Come si fa una tesi di laurea: le materie umanistiche*, ser. Grandi tascabili Bompiani. Bompiani, 2001. [Online]. Available: https://books.google.it/books?id=Api6HqazubEC

[3] J. Fraillon, J. Ainley, W. Schulz, and T. Friedman, *Preparing for Life in a Digital Age*. Springer International Publishing, 2014.

[4] K. Huotari and J. Hamari, "Defining gamification: A service marketing perspective," in *Proceeding of the 16th International Academic MindTrek Conference*, ser. MindTrek '12. New York, NY, USA: ACM, 2012, pp. 17–22. [Online]. Available: http://doi.acm.org/10.1145/2393132.2393137

[5] M. Liu, J. Rosenblum, L. Horton, and J. Kang, "Designing science learning with game-based approaches," *Computers in the Schools*, no. 1-2, pp. 84–102, 2014.

[6] A. Micheletti, "Motivating and involving users through gamification: A proposal," in *Digital Libraries and Multimedia Arcives. Proceedings of the Italian Research Conference on Digital Libraries*, 2016, pp. 18–28.

[7] J. Moreno, "Digital competition game to improve programming skills," *Educational Technology & Society*, no. 3, pp. 288–297, 2012.

[8] G. M. D. Nunzio, M. Maistro, and D. Zilio, "Gamification for machine learning: The classification game," in *Proceedings of the Third International Workshop on Gamification for Information Retrieval co-located with 39th International ACM SIGIR Conference on Research and Development in Information Retrieval (SIGIR 2016), Pisa, Italy, July 21, 2016.*, 2016, pp. 45–52. [Online]. Available: http://ceur-ws.org/Vol-1642/paper7.pdf

[9] S. O'Donovan, J. Gain, and P. Marais, "A case study in the gamification of a university-level games development course," in *Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference*, ser. SAICSIT '13. New York, NY, USA: ACM, 2013, pp. 242–251. [Online]. Available: http://doi.acm.org/10.1145/2513456.2513469

[10] E. Parliament, "Recommendation 2006/962/ec of the european parliament and of the council of 18 december 2006 on key competences for lifelong learning," European Parliament, Tech. Rep. [Online]. Available: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32006H0962

[11] L. Sheldon, *The Multiplayer Classroom: Designing Coursework as a Game*, ser. Game Development. Course Technology, 2012. [Online]. Available: https://books.google.it/books?id=qgO-bwAACAAJ