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On the effectiveness of game-like and social approaches in learning: Comparing educational gaming, gamification & social networking

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ABSTRACT

Game-like approaches are becoming increasingly popular in education, with educational games and gamification drawing increasing levels of attention. While games specifically designed for educational purposes have been used for decades, gamification is particularly new and contrasting evidence was presented about its effectiveness. The potential of social networks has also been harnessed by educators and institutions either using popular social networking sites or specific educational instances. This paper studies how well-established approaches (educational game and social networking) compare with more novel ones (gamification and social gamification) in terms of learning performance in an undergraduate course. Four experimental conditions were compared in an experiment (N = 379). Results suggest that all experimental conditions significantly impact on learning performance, but social gamification returned better results in terms of immediacy and for all types of assessments.

1. Introduction

A game is a system that presents a set of meaningful motivating challenges to the player. Game designers can carefully align game mechanics and dynamics with a compelling narrative and a feedback system to create a sense of seamless progression that captures player's attention and can keep her deeply immersed in the experience. Furthermore, game communities provide a venue where players can communicate, share and build knowledge around the game. According to several scholars (Gee, 2007; Squire, 2011) good videogames and their emergent cultures provide problem-solving spaces where learning occurs, because challenge and learning are at the heart of motivation and entertainment.

The potential of videogames as educational tools has created a growing interest and expectations in the gameful world drawing the attention of educators and institutions that want to harness the potential of videogames to create more engaging and meaningful learning experiences that facilitate long-term learning. Such interest has been realized in different directions. On one side of the spectrum, educational games are complete systems designed with the purpose of training their players. Serious game mechanics assist in the translation of learning goals and practices into the mechanical element of gameplay mapping design patterns and pedagogical practices (Arnab et al., 2015; Lim et al., 2014). On the other side, gamification takes

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game elements and uses them in non-game contexts to motivate action (Deterding, Dixon, Khaled, & Nacke, 2011; Werbach & Hunter, 2012). One of the contexts in which gamification has drawn more attention is education (Kapp, 2012), to the point of turning gamification into a buzzword situated at the peak of inflated expectations of the hype cycle in 2013.[1] Early research on the area outlined design and architectural models to incorporate game-like approaches in educational settings (Haksu & Young Yim, 2012; Raymer, 2011; Simões, Redondo, & Vilas, 2013). First experimental studies reported mostly positive outcomes in terms of learning and other educational outcomes (Bellotti et al., 2013; Denny, 2013; Fitz-Walter, Tjondronegoro, & Wyeth, 2012; Li, Grossman, & Fitzmaurice, 2012; Santos et al., 2013; Sheldon, 2012), but also pointed to some preliminary contradictions like the questionable quality of students' feedback (Halan, Rossen, Cendan, & Lok, 2010) or the convenience of certain game elements to convey different kinds of learning (Domínguez et al., 2013). However, recent studies questioning the lack of empirical evidence as well as the effectiveness of educational games and gamification in learning and instruction as well as in broader contexts (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Dicheva, Dichev, Agre, & Angelova, 2015; Hanus & Fox, 2015; Mekler, Brühlmann, Opwis, & Tuch, 2013), suggest that we are now on our way down "trough of disillusionment" of the hype cycle.[2]

Social networks and social media are pervasive today. They offer almost unlimited possibilities for online sharing and collaboration. User interactions are also stored and can be effectively used and mined to crowdsource contents and contributions, offering endless opportunities for personalization. Such possibilities have also drawn the attention of the education and research communities. There is an important and also growing body of literature about the uses and effects of different social media in education. Popular social networks expedite student–student and student–teacher interaction, communication and collaboration improving student's attitude (Despotovic-Zrakic, Labus, & Milic, 2011). Educational networking impacts on students' motivation, retention, engagement, satisfaction, individual creativity and personal interaction, increasing the efficiency of communication and facilitating differing viewpoints (Brady, Holcomb, & Smith, 2010). The individual position that each student has on the network is also important, influencing social learning (Paredes & Chung, 2012), learning performance (Cho, Gay, Davidson, & Ingraffea, 2007) and even creativity (Gaggioli, Mazzoni, Milani, & Riva, 2015). Still, critical accounts question the claims about the purposeful integration of social media as an educational tool because most empirical evidence about the utility and effectiveness of social media is based on self-reported data and content analysis (Tess, 2013).

Social gamification aims to bring together gamification and social networking to combine the potential of both approaches to create compelling socially-driven user experiences. From an educational perspective, it can harness the motivational aspects of gamification to stimulate participation and engagement with learning contents and with other participants. Social networks facilitate communication, explicit social ties and highlight relevant content elements for participants. Their potential can also be harnessed to cooperate and create meaningful conversations in learning interactions. The combination of both can create a kind of multiplication effect in which gamification can be used to promote social desirable learning behaviors, and actions in the social network can be used to design gamification props that produce motivational boosts in educational settings. To our best knowledge, the only study that deals with social gamification in education is Simoes et al. (Simões et al., 2013) which presents a framework for integrating and evaluating gamified elements in primary education. The potential benefits of integration of both approaches have therefore only been cursorily studied.

Beyond the hype, critical voices call for serious empirical account of the motivational and learning potential of educational games (Connolly et al., 2012), gamification (Dicheva et al., 2015) and social networking (Tess, 2013). Within this context, this paper aims to study and compare the educational effectiveness (in terms of learning performance) of four instruments: educational games, gamification, social networking and social gamification. Educational games can harness many of the affordances of games to facilitate meaningful learning experiences. Gamification can be used to foster competition between participants. Social networking promotes collaboration by providing tools for communication, sharing knowledge and by opening spaces for contribution. As gamification and social networking can only be appealing for certain types of learners, we think that the combination of both can successfully address the motivational needs of a wider audience of learners. Educational games have been employed in a wide variety of contexts ranging from commercial off-the-shelf games that can be used in the classroom to games specifically designed to meet learning goals. In terms of educational games, this study focuses on the first type as specific games are difficult to find for each specific educational settings while off-the-shelf and sometimes free games are already available. Although this also requires time to search and assess their suitability for particular learning situations. Education is the area where gamification has been more extensively reported in research (Hamari, Koivisto, & Sarsa, 2014). Therefore there is a wide spectrum of approaches, ranging from game-inspired instructional design that aims to foster engagement and achievement (Fabricatore & López, 2014), to reward-based strategies that focus on extrinsic motivation promoting competition (Domínguez et al., 2013). Our focus is on reward-based gamification as it is more common and easier to implement (Werbach & Hunter, 2012) although we are also aware that extrinsic rewards can ultimately undermine motivation. The uses and results of educational social networking are widely reported also, ranging from models of training and performance that integrate social media as a central part of learning experience (Paredes & Chung, 2012), to a supportive role of social networking in the wider context of the learning experience (de-Jorge-Moreno, 2012). Our focus in this case is driven by the communicative and cooperative affordances that social networks offer and by their capability to highlight relevant contributions and key participants. This also contrasts with our approach to gamification and offers, in our

[1] Gartner's 2013 Hype Cycle for Emerging Technologies: http://www.gartner.com/newsroom/id/2575515.
[2] Gartner's 2014 Hype Cycle for Emerging Technologies: http://www.gartner.com/newsroom/id/2819918.

opinion, a better ground for comparative analysis. Our approach to social gamification will focus on the potential to combine competition and cooperation around learning materials and learning activities to take advantage of external motivators engaging students in social discussion and resulting in better learning outcomes.

In a recent taxonomy, Deterding (Deterding, 2014) suggests that different rhetorics to the gameful world reveal diverse theoretical approaches. Following this we argue that a rhetoric of systems may account for the educational value of games as self-contained learning systems. Meaning and learning are created by interacting with rules' systems through and around games, constructing understanding and skill when engaging with the virtual world through experience. Educational games try to harness such potentialities by creating compelling games that have an educational background resulting in positive outcomes in terms of learning performance. A rhetoric of feedback motivates a model of gamification that perfectly aligns quantified atomic activities and rewarding schemes within pre-specified paths of action in the system. Player-defined attributes like levels and skills are explicit, transparent and reliable indicators of skills and status. Game elements and transparent sets of rules can be implemented in educational systems that explicit learning goals and motivate action towards that objectives resulting in quantifiable impacts on learning performance. And finally, a rhetoric of status addresses for the individual need of social presence and recognition of social networks. Social status is a basic human need. Social networks are public environments that provide means for getting and publicizing status, fitness and trust. Designers can then harness participants' natural drives for status to motivate them to pursue system's goals. In educational terms, needs for status, participation and social recognition can similarly be addressed and aligned with learning objectives impacting in learning outcomes. We argue that different approaches and rethorics can appeal to different learners impacting in learning when gameful and social instruments are used in educational settings. So, in this paper a controlled experiment is designed and performed in the same educational setting to get comparative results of the learning performance of different instruments that represent each approach. Different approaches that are to some extent overlapping but still offering comparable results with a careful design of the educational setting. The educational game focuses on narrative and a storyline that also offers room for exploration. Gamification focuses primarily on competition. Social networking promotes cooperation. And social gamification combines gamification and social networking to compare them with previous approaches. The rest of the paper is organized as follows, Section 2 presents and justifies the experimental design in terms of the objectives, instruments and method. Section 3 presents results. Section 4 discusses findings. And Section 5 presents conclusions outlining future research opportunities.

2. Experimental design

Under the premise that educational games, gamification, social networking and social gamification of learning have the potential to impact on learning, this section presents the research objectives, instruments and methodology to conduct a comparative analysis in one educational setting in order to appraise and compare the learning performance that each instrument delivers.

2.1. Research questions

This experiment sets out to address the following research questions:

RQ1: Do experimental conditions (educational game, gamification, social networking and social gamification) impact on learning performance?

RQ2: Is there any difference in terms of learning performance between experimental conditions?

RQ3: Does the kind of evaluation item influence results on learning performance for the different experimental conditions?

Previous studies and literature appraisals suggest that educational games (Connolly et al., 2012), gamification (Hamari et al., 2014) and social networking (Tess, 2013) impact on learning as well as other behavioral and affective outcomes, but also point to the lack of empirical evidence to support several claims. Furthermore, as there are no comparative studies on the same educational setting and social gamification has been only cursorily studied, we suggest that the first and second research questions can provide additional empirical insights about the effects of different approaches on learning. Contradicting evidence recently presented (Hanus & Fox, 2015) questions the effectiveness of gamification and raises issues about the superficial learning that shallow gamification approaches may promote. Nevertheless, the nature of the evaluation items is not considered in such appraisals. We conjecture that different experimental conditions may suit better with different evaluation items such as tests, short questions, essays, practical assignment or oral examinations. So the third research question addresses to what extent the type of evaluation may account for any influence in terms of measured learning performance in the different experimental conditions. This study compares two kinds of evaluation items: assignments that primarily assess practical skills and examinations that are designed to assess conceptual knowledge.

2.2. Setting

The experimental course was a 10-week undergraduate blended-learning course called ‘Qualification for ICT Users’ for first-year students. The course was designed to introduce basic computing concepts and provide a working knowledge and skills about standard office applications including word processing, spreadsheets, presentations and databases, which are the

Table 1
Summary of instruments synthetizing the main features of the different means and targeted benefits.

Instrument	Features	Approach & targeted benefits
Educational game	Challenges, levels, points, narrative	Not aligned with learning objectives Independent work & exploration of students
Gamification plugin	Trophies, badges, challenges, leaderboard	Competition-driven Motivate participation through comparison with peers
Social networking website	Blogging, questions & answers, liking, friends, built-in twitter, dashboard	Cooperation and communication among participants. Boost participation, collaborative work & community building Promote student-driven discussion
Social gamification website	Blogging, questions & answers, liking, friends, built-in twitter, dashboard, challenges, points, achievements, virtual currency, shop, external rewarding, personalization (status/visibility), peer review	Competition and cooperation Boost participation, collaborative work & community building Motivate participation through comparison with peers Social interaction affords additional means to motivate participation and engagement Addressing needs of different students (player types) and widen participation

learning modules of the course. Syllabus was based on the ECDL/ICDL certification which is becoming an international de facto standard for digital skills.[3] Students had one lecture every two weeks and they must work independently the rest of the time to achieve the learning goals. Supporting learning materials, including videos, and communication tools were available in the learning management platform.

The course had five evaluation items: four practical assignments and one final examination. Students submitted an assignment at the end of each learning module as follows: word processing in week 3, spreadsheets in week 5, presentations in week 7 and data bases in week 9. On week 10 students answered a final examination which was a comprehensive test of all the course contents and modules. Practical assignments required that students completed a set of tasks with a given computer application producing a set of artifacts that were submitted for evaluation. Therefore assignments were designed to assess practical skills. The final examination was designed to assess conceptual knowledge. Assignments and final examination were the two different kinds of evaluation items considered in this study. Students were invited to practice with several activities that in the end helped them to master and hone the skills required to complete each assignment. Students had to use the different options and abstract constructs of the different applications to build complete versions of working artifacts. In the word processing assignment, they were required to produce a professional document. In the spreadsheets assignment, students were required to deliver a spreadsheet that combined data integrated from different sources, functions and graphical elements. As for the learning module on presentations, students were required to create a professional visually appealing presentation that combined text, multimedia elements, and visual effects. In the assignment on databases, students had to present a database with the appropriate structure of tables and relations, and supporting elements like queries, forms and reports. The final examination was a written test of all learning contents and modules that combined multiple choice, fill-in-the-blank and short answer questions. The final examination had 15 questions and students had to complete it in 1 h. Given the nature of this kind of evaluation item, it was designed to assess conceptual knowledge. Students were asked about the meaning and practical application of different concepts and abstract constructs that were used in applications or that were relevant to understand the underlying mechanisms of working artifacts, like “What is a range? Where is it useful? And how is it used?”, or “What are the different types of relations that are possible in databases? How are they implemented? Provide an example of each type”.

2.3. Instruments

In order to compare the effects of educational games, gamification, social networking and social gamification on learning performance four instruments were used. Instruments were chosen based on their capabilities to address students' needs for fun, competition and cooperation. The different instruments offered different features that may eventually impact on learning performance. A summary is presented in Table 1. We chose an educational game that could be readily integrated into the learning experience. It was related to the learning contents but lacking a clear alignment with learning objectives. We aimed to explore the learning potential of educational games with which students can work and explore independently. All other instruments were aligned with the learning objectives and used to support learning activities. The gamification plugin was developed to explore and compare the effects of competition-driven gamification. The social network aimed at exploring and

[3] European/International Computer Driving License – ECDL/ICDL (www.ecdl.com).

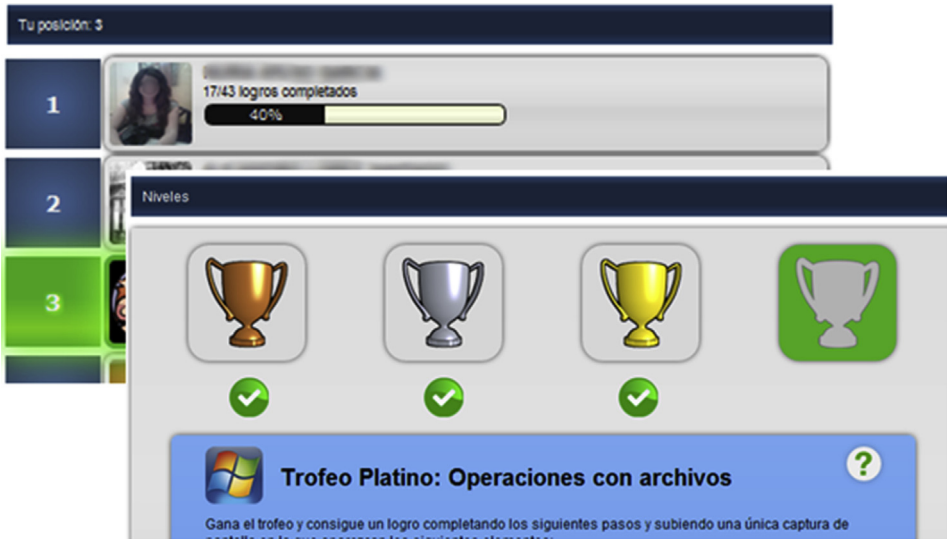

Fig. 1. Gamification plugin. Leaderboard and challenges.

comparing the impact of cooperation in learning performance. Finally, the social gamification instrument was chosen to bring the potential advantages of competition and cooperation together.

The first instrument was the Ribbonhero[4] educational game. Ribbonhero is an educational game sponsored by Microsoft specifically designed to train skills of the Microsoft Office software suite. In the game, players embody a virtual character called Clippy and are asked to help him overcome different challenges that require players to master skills and learn how to use different options of word processing, spreadsheets and presentation applications. Challenges are arranged in six different levels of increasing difficulty. Each challenge opens the corresponding application and asks players to complete a specific task. Examples of tasks are: use text effects in word processing, use chart types & chart styles in a spreadsheet, or use built-in themes in a presentation. Players get points for attempting and completing challenges. The amount of points depends on how well they perform. For instance, hints are offered on demand, but in order to get the maximum possible amount of points, players must not use hints and they have to find their own way to complete the task. Players have different challenges in each level and they can choose which ones they prefer to complete to get enough points to get to the next level. Ribbonhero uses the following game elements: narrative, challenges, levels and points. Ribbonhero is integrated with Microsoft Office applications using an overly layer that also grants small amounts of points to players just for using the applications in their daily activities (e.g. 'italics +2 points'). It features the Microsoft Office applications for word processing, spreadsheets and presentations. The learning module on databases was therefore not supported by Ribbonhero, but this provided an interesting ground to analyze the effects of lack of support after continued work with one of the experimental groups. If the educational game acts as a facilitator of knowledge and skills, we could examine to what extend knowledge transfer ceases when the instrument is no longer present. All other instruments facilitated knowledge transfer for all learning modules.

The second instrument was a gamification plugin integrated in the institutional learning management system (Fig. 1). Learning activities were aligned with learning objectives and presented as challenges. Challenges were carefully divided in tasks that provided short-term goals and students were awarded trophies upon completion of each task. Lecturers had to review students' submissions. A set of badges was also designed to motivate participation by completing sets of challenges (e.g. 'Word expert') or participating and collaborating with other students (e.g. 'Rookie' for enrolling). Finally, a leaderboard was implemented using the number of trophies and badges to rank students. This instrument was designed mostly to foster competition between students with the aim of motivating participation. For each game element (challenge or badge) students could see how many students had completed it and so compare their performance with their peers.

The third instrument was a social networking platform (Fig. 2). The Elgg[5] social networking engine was used as the basis to provide a venue where students can interact and have conversation around learning materials. The platform included basic functionalities to create blogs, ask and answer questions, link videos, and post files and other resources. But the critical elements to harness social interactions were liking and friendship. Students could comment and like on any content thus focusing on their own interests, but also providing important aggregate information that was then used to highlight hot topics and relevant entries on the platform. A friendship functionality similar to Facebook's allowed students to connect with peers with common interests and interact within their own community. A built-in twitter-like system was also included to boost

[4] Ribbonhero 2: http://www.ribbonhero.com/.
[5] Elgg Open Source Social Networking Engine: https://elgg.org/.

Fig. 2. Social networking website.

communication and participation. Students used it mostly as a channel for free expression to share their thoughts and concerns. Finally, a dashboard provided updated information about recent relevant actions in the platform. Lecturers acted as community managers presenting the topics and guiding discussion. Initial contents for each topic were developed including videos describing the most important concepts and skills, activities and supporting materials. At the end of each learning module additional videos were uploaded providing step-by-step solutions to the activities. Students worked collaboratively on the activities and posted their comments, solutions and additional resources. There were no reviews from lecturers in the social networking platform because it was designed as a space for collaboration.

The fourth and final instrument was a gamified social platform (Fig. 3) that combined the potential benefits of gamification and social networking using social interaction to offer additional rewards that motivate participation and engagement with

Fig. 3. Social gamification website: Gamification tools (left), dashboard (top-right) & leaderboard (bottom-right).

course materials and peers. The Elgg social networking engine provided the backbone offering support for the gamification layer that was developed over it. Social features and tools were the same used in the previous instrument. Learning activities were presented as challenges that students could complete and submit. All activities were peer reviewed based on a rubric. Points were awarded for submitting, reviewing and getting positive reviews on their own submissions. Peer review generates valid and reliable rating scores providing also an important room for reflection (Lu & Law, 2012; Xiao & Lucking, 2008) and significantly reduces the burden of lecturers that only had to intervene in case of dispute. A set of achievements was carefully designed to harness the potential of social actions providing additional points to students that participated significantly in the social network (e.g. 'Witty' for getting 15 or more likes on a post, or 'Ancient wisdom' for answering 3 or more questions). Activities and achievements provided points that were used to rank students on a learderboard. Points were also a virtual currency that students could use in a virtual shop to buy several items like an additional 5% on their final mark (external rewarding) or personalization features for their avatars and text messages that provided visibility and status in the platform.

Our design of the social gamification platform was based on previous research on learning styles in game contexts (Heeter, Lee, Medler, & Magerko, 2011) that suggests that different students are driven by different interests. We mostly draw on the literature on player types, and especially on Bartle's classical taxonomy of players (Bartle, 1996; Heeter, Magerko, Medler, & Fitzgerald, 2009; Stewart, 2011), to try to accommodate different necessities around meaningful interactions and conversations with peers and course materials. Activities, points, badges and external rewards were included to accommodate students that may be looking to achieve as much as they can and to optimize their performance ('achievers' in Bartle's terms). The leaderboard was included to accommodate competition. Bartle defines 'killers' as those players interested in 'acting on other players' and in competing with them. Socializers are a type of players driven by their interest to cooperate, communicate and share. Social features, social achievements and personalization features were included to address their necessities so that they could have meaningful interactions and impact on the system and on their peers. Finally, explorers are willing to probe and scan (but not necessarily to complete) all courses of action and having a wide variety of possibilities is important for them. A set of achievements was specially designed for them, providing a limited amount of points for having many small interactions with the system but also hoping that ultimately they would find the way to participate regularly. Our underlying aim for using Bartle's taxonomy was simple: although specific games usually target to specific player types or at least prioritize the feedback for them, in education we usually have a wide variety of students with different learning styles that are representative of all player types. Addressing the needs of as much types as possible could possibly widen the participation resulting in better outcomes in educational terms. Bartle's taxonomy and its variations have already been used by gamification practitioners to design and test gamified systems.

Finally we want to point to the possible overlapping that exists between the different instruments. We think that there is no overlapping between the Ribbonhero educational game and other instruments. Although the game offers a gamification module for Microsoft Office applications, we checked that the amount of points that can be obtained are really marginal having no influence on the progression in the game story. In our opinion it is present mostly as a reminder that the game exist providing a link between office tools and the game software. The gamification plugin was specifically designed to promote competition while the social network was designed to address cooperation. No or minimal overlapping exists in terms of the instruments. The social gamification instrument was designed specifically to combine the social and gamified instruments so there is an obvious overlapping but the aim is to determine if a combined approach yields observable differences in terms of learning performance.

2.4. Technical implementation

The Ribbonhero educational game is offered as free software by Microsoft. Students just had to download and install it. The gamification tool was implemented as a plugin that was deployed on the Blackboard 9 learning management system. Blackboard provides an API (Application Interface) that enables developers to extend its functionalities. The gamification plugin used this API and was programmed using the JSP (Java Server Pages) web technology. A persistent storage external service was used to store plugin's data and students' submissions. The social networking site and the social gamification networking site used the Elgg open source social networking engine. Elgg is free to download and use. It is licensed under GNU General Public License. Elgg runs on a Linux, Apache, MySQL, PHP web server. Since it also has many utilities and already existing plugins, the technical implementation of the social networking instrument just required to install Elgg in a web server and to configure the necessary utilities, plugins and widgets to support designed functionalities. Elgg's basic infrastructure was also used as the backbone for the social gamification platform. In this case, a gamification plugin was developed and deployed on the social networking engine. Elgg is easy to modify and extend providing extensive documentation for developers. The plugin was developed using the same technologies that the Elgg platform uses. It was programmed in PHP and MySQL was the database.

2.5. Participants

A group of 379 first-year undergraduate students participated in the study (212 women, 167 men, $M_{age} = 18.83$ years, range: 17–34 years). A quasi-experimental design was used (Fig. 4). Students decided in which group to enroll and experimental conditions were randomly assigned to groups. Students' choice was based mostly on schedule and proximity issues since different groups took place in different campuses and terms. Students did not know what experimental condition was

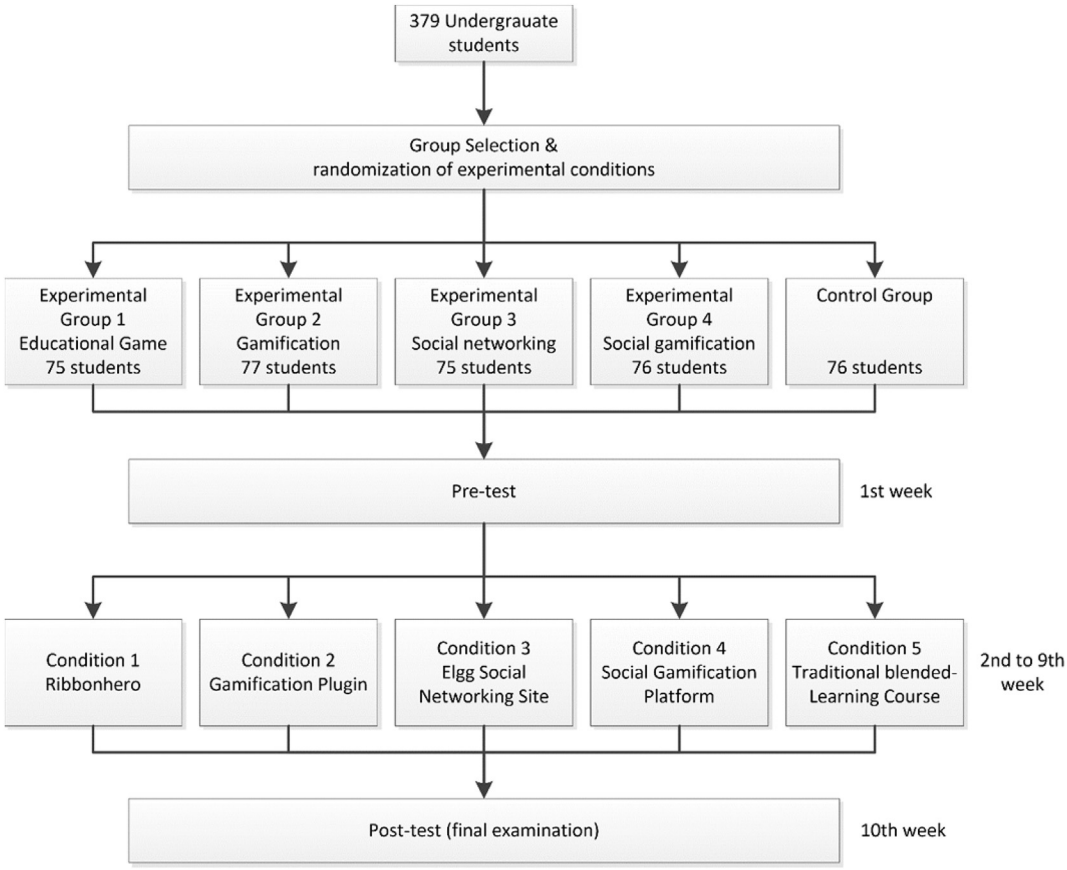

Fig. 4. Experimental design with four experimental groups and a control group.

going to be used on each group and they were not aware of experimental conditions being used in other groups. The educational game was administered to a group of 75 students (37 women, 38 men, $M_{age} = 18.68$ years, range: 17–32 years). The gamification plugin was administered to a group of 77 students (47 women, 30 men, $M_{age} = 18.57$ years, range: 17–34 years). The social networking site was administered to a group of 75 students (43 women, 32 men, $M_{age} = 18.97$ years, range: 17–24 years). The social gamification platform was administered to a group of 76 students (43 women, 33 men, $M_{age} = 18.99$ years, range: 17–23 years). An additional group of 76 students was the control group (42 women, 34 men, $M_{age} = 18.95$ years, range: 17–25 years).

2.6. Procedure

Experimentation took place during Spring 2014 and Autumn 2014. The control group and the experimental groups using gamification and social networking took place during Spring 2014 from February till May. Students of the experimental groups using the educational game and social gamification took the course during Autumn 2014 from October till December. All instances of the course run for 10 weeks from the start without breaks. Learning modules were delivered sequentially. On the first week of the course, students took a multiple-choice computer pre-test. Experimental conditions were then deployed (weeks 2–9). Students in the control group used a traditional e-learning approach in which all educational contents and activities were available in the learning platform, as well as traditional communication tools including forum or chats. After completing each learning unit (weeks 3, 5, 7 and 9), students had to submit an individual assignment that was assessed by lecturers and that was used to measure their learning performance. Final examination was a 15-question written examination comprising multiple choice, fill-in-the-blank and short answer questions. The final examination was designed to assess conceptual learning and it was delivered in week 10.

2.7. Educational strategies

There was basically no educational strategy behind including Ribbonhero in the course. The aim was to test an off-the-shelf software product and to analyze how it compares with other gameful and social approaches that are aligned with

learning objectives. A few Ribbonhero challenges were aligned with learning content and learning objectives, but others were not aligned and not even included in the course. For example, students could also explore other tools of the Microsoft Office suite. Ribbonhero was introduced in the second lecture and students were given supporting information and tutorials about how to use it. Students had to work on Ribbonhero on their own. Activities were introduced in lectures and students worked on them but had to complete them at home. Activities and progression on Ribbonhero were reported by students and monitored by lecturers. Students were asked to gain one level each week.

In the gamification plugin, a set of trophies was designed taking learning activities and breaking them down into smaller chunks. Therefore learning objectives were aligned with trophies. Between six and eight trophies were designed for each learning module. For each trophy, students have to complete a part of the activity and submit it. Two activities were delivered every two weeks including instructions that described the requirements to get the trophies. Activities were introduced during lectures and students started working on them. Students then had to complete and submit them for evaluation using the learning management system. Lecturers reviewed each submission and decided to award the trophy or return the activity to the student. Badges were also included to motivate participation encouraging students to complete more activities and get more trophies. The leaderboard was the first element displayed in the gamification plugin. It showed the total number of trophies and badges earned by each student stressing the competitive nature of the instrument. The goal was to analyze the impact of competitive approaches of gamification in learning performance.

The social networking platform was introduced in the course to foster participation and collaboration between students around course materials and activities. Two learning activities and the corresponding learning materials were published every two weeks for each learning module. Students were then asked to cooperate to complete the activities. Cooperative activities included finding or creating supportive materials such as videos or descriptions of how to perform important tasks. Questions could also be asked and collaboratively answered in the platform. For each activity, lecturers initiated the discussion, for example suggesting what skills students have to master and encouraging them to practice and share their approaches or problems. After that, discussion was mostly driven by students and lecturers only had to intervene to guide learning if necessary. Activities and initial discussion were presented during the lecture. Then students had to work on their own and continue the conversation in the social networking platform. Each student uploaded a final version of each activity to her personal blog in the platform. Finally students were asked to review and provide feedback to the activities of other two students. There were no particular instructions about the format of the review. Lecturers did not participate in the reviewing process, except in particular cases where there were contrasting opinions, no agreement or wrong common assumptions made by students. All contents in the platform were available to all students. Students could like or comment any item, so most popular items representing most relevant pieces of information were given higher visibility. Lecturers were also considered participants having the same weighting in liking or content creation than students. A dashboard showed recent activity. And finally students could create their network of friends to communicate and collaborate with them.

The social gamification instrument aimed to combine the benefits of gamification and networking in a single instrument. Activities were gamified in a social networking environment addressing the specific needs for both competition and cooperation. Every two weeks two activities were published. Students could then cooperate to complete them, create and share contents in the same way that they did with the social networking site. The main difference with the social networking site in terms of educational strategy was in the reviewing process and feedback for activities. Peer-review was introduced to provide room for meta-reflection. Students were given points for submitting activities and also for reviewing the submissions of their classmates. For each learning module, students had to complete two activities and provide feedback to other two submissions. Reviewers were automatically decided by the platform and reviews were initially blind. After initial feedback, conversation followed between students around their solutions and how to improve them. A set of achievements was also introduced. Achievements were aligned with learning objectives giving students recognition for completing sets of activities and also for making significant contributions to the social network.

Supporting materials included learning modules, descriptions of the activities and videos were the same for all conditions (experimental and control). Particularly in the educational game, students have access to learning materials online. As for control group, a traditional blended-learning approach was used. Materials and further communication tools were available on the BlackBoard e-learning platform. We want to stress that students were required to complete the same learning activities in all cases and the experimental conditions determined the way in which contents and activities were delivered. In the control and educational game group, learning modules and activities were delivered as documents, while in the rest of experimental groups, activities were delivered as we have just described. Students in all groups had five 2-h lectures, one lecture every two weeks, including one introductory lecture and one specific lecture for each module. Lectures introduced the learning goals, main theoretical concepts and practical skills that students had to learn and practice. Activities were introduced in the lectures and students had to work independently the rest of the time to achieve the learning goals and complete the assignments.

2.8. Measures and data analysis

Pre-test results were returned from computers in a numeric scale. Assignments and the final examination were assessed by lecturers using a numeric assessment scale. All marks were normalized to a 0–100 scale. The same conditions and evaluation criteria were used in all groups.

There was enough evidence that learning performance data gathered did not follow a normal distribution so non-parametric tests were used. Kruskal–Wallis tests were used to compare pre-test and post-test results. Mann–Whitney tests with multiple comparisons were used to analyze post-test differences between pairs of groups. Bonferroni corrections were used to adjust for the inflation of type I error in multiple comparisons.

3. Results

Experimentation took place during spring 2014 and autumn 2014. Data was gathered for appraisal by researchers as described in the previous section. Pre-test results (Table 2) suggest that there was no significant difference between the experimental and control groups. Table 3 presents post-test results. Significant differences were found for all evaluation items. Results of the four practical assignments are summarized graphically in Fig. 5 showing that all experimental groups outperformed the control group in three evaluation items (word processing, spreadsheets & presentations). For the evaluation item on databases, analyses between groups (Table 4) return that there was no significant difference between the control group and the educational game group ($W = 2739$, $p = .346$), and that all three other experimental groups (gamification, social & social gamification) outperformed both the control and educational game group. As Ribbonhero did not provide support for the learning module on databases, students of the educational game group completed this learning module without instrumental support. This suggests that lack of support for the learning module on databases implies that learning performance returns to a level that is comparable to the control group when the instrument does not offer support for a given module. Thereby results suggest that all experimental conditions impacted on learning performance so the answer to the first research question is positive (RQ1. Do experimental conditions impact on learning performance?) for the practical assignments of the experiment.

As for RQ2 (Is there any difference in terms of learning performance between experimental conditions?) pairwise comparisons between groups are presented in Table 4. Significant although moderate differences were found in five cases. For the word processing evaluation item, the group using the educational game performed worse than the social group ($W = 3446$, $p = .016$, $r = -.19$) and the social gamified group ($W = 3415$, $p = .034$, $r = .17$) suggesting that social approaches yield better results in initial stages. As learning modules were delivered sequentially, results suggest that social approaches (social network and social gamification) yield better results in terms of learning performance as early as week 3 when compared with the educational game. No significant differences were found for the evaluation item on spreadsheets (week 5). As for the evaluation item on presentations (week 7), the social group performed worse than all other experimental groups: social vs educational game ($W = 2817$, $p = .04$, $r = -.31$), social vs gamification ($W = 1935$, $p < .001$, $r = .28$), social vs social gamification ($W = 3910$, $p < .001$, $r = .32$). For this evaluation item, the majority of students in the experimental conditions performed particularly well and a low level of variability can be observed resulting in moderate effect sizes that, in our opinion, are not representative of the general trend. This general trend suggests that initially socially approaches (social and social gamification instruments) produce better results but then such differences tend to disappear and all experimental groups can be found in the higher end of the spectrum by week 5. Also, when treatment did not offer support for the learning module in databases in the group with educational game, the effects disappeared and the group returned to a level similar to the control group in terms of learning performance.

Table 2
Pre-test results of the control and the four experimental groups.

Evaluation item	Group	N	Mean	Std err.	Std dev.	Significance
Word Processing	Control	76	47.92	1.79	15.59	$H = 2.14$
	Ed. Game	75	45.17	2.31	20.02	$p = .71$
	Gamification	77	44.75	2.05	17.96	
	Social	75	44.44	2.43	21.05	
	Social Gamif.	76	45.16	1.77	15.41	
Spreadsheets	Control	76	50.45	1.90	16.56	$H = 1.76$
	Ed. Game	75	51.77	1.79	15.53	$p = .78$
	Gamification	77	53.86	2.02	17.72	
	Social	75	52.07	1.89	16.41	
	Social Gamif.	76	51.39	2.10	18.30	
Presentations	Control	76	44.18	1.60	13.91	$H = .86$
	Ed. Game	75	44.44	1.41	12.19	$p = .93$
	Gamification	77	45.43	1.55	13.63	
	Social	75	45.76	1.63	14.13	
	Social Gamif.	76	44.58	1.37	11.90	
Databases	Control	75	51.80	2.09	18.06	$H = 3.88$
	Ed. Game	75	56.33	2.07	17.93	$p = .42$
	Gamification	77	55.01	2.00	17.52	
	Social	75	54.43	2.11	18.29	
	Social Gamif.	76	51.38	2.01	17.54	

Significance is computed using Kruskal–Wallis tests.

Table 3
Final (post-test) results of the control and the four experimental groups.

Evaluation item	Group	N	Mean	Std err.	Std dev.	Significance
Word Processing	Control	76	63.99	1.96	17.13	H = 53.06
	Ed. Game	75	78.11	1.99	17.21	p < .001
	Gamification	77	75.02	2.73	23.96	
	Social	75	84.27	1.89	16.34	
	Social Gamif.	76	83.99	1.75	15.26	
Spreadsheets	Control	76	61.45	3.01	26.27	H = 43.18
	Ed. Game	75	80.93	2.78	24.04	p < .001
	Gamification	77	80.06	2.71	23.79	
	Social	75	85.73	2.01	17.40	
	Social Gamif.	76	79.80	2.14	18.67	
Presentations	Control	76	75.75	1.44	12.52	H = 82.41
	Ed. Game	75	91.16	1.41	12.22	p < .001
	Gamification	77	91.21	1.19	10.47	
	Social	75	86.32	1.30	11.23	
	Social Gamif.	76	89.87	1.83	15.96	
Databases	Control	76	52.28	2.41	21.04	H = 37.96
	Ed. Game	66	55.48	3.94	31.97	p < .001
	Gamification	76	73.62	2.61	22.74	
	Social	71	66.85	3.15	26.57	
	Social Gamif.	74	70.86	2.41	20.75	
Final Examination	Control	76	74.77	1.57	13.64	H = 55.97
	Ed. Game	73	66.30	1.46	12.47	p < .001
	Gamification	74	59.50	1.60	13.79	
	Social	74	61.24	1.83	15.79	
	Social Gamif.	76	72.00	1.76	15.37	

Significance is computed using Kruskal–Wallis tests.

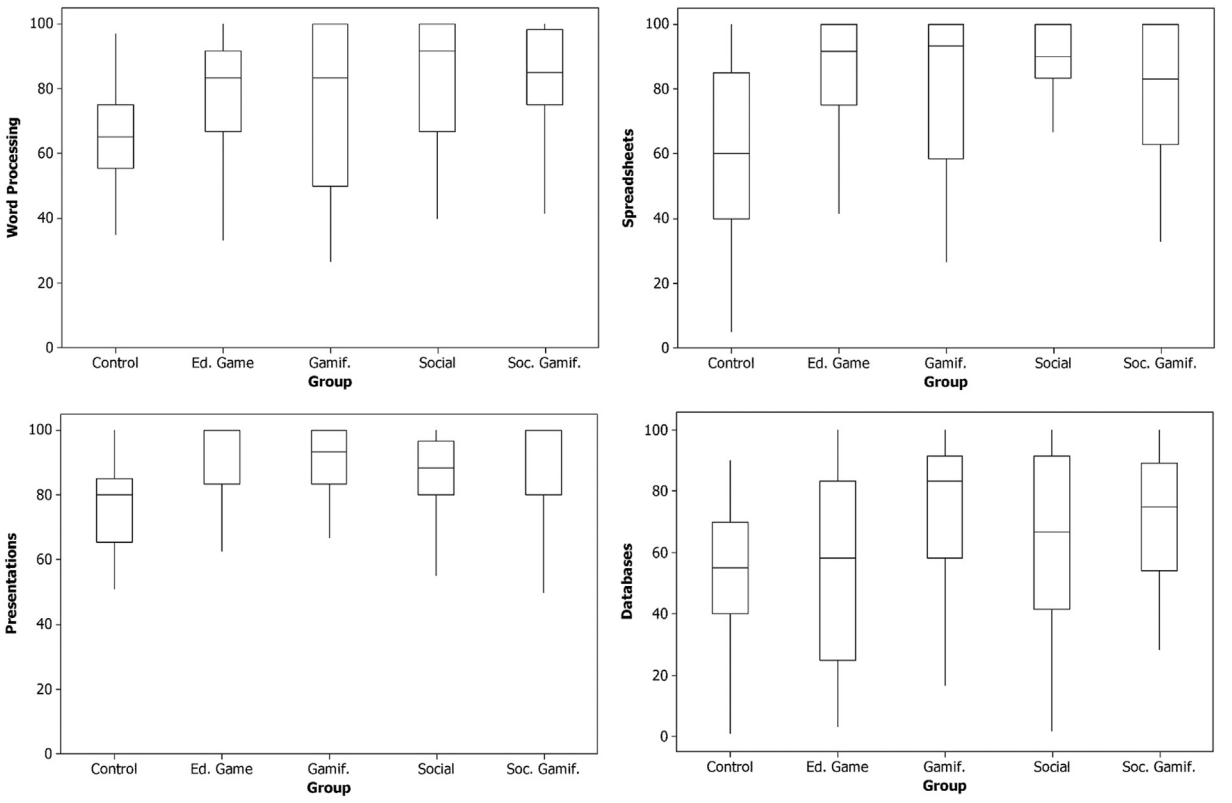

Fig. 5. Box-plots of post-test evaluation items of the control and four experimental groups.

Results of the final examination are presented graphically in Fig. 6 and unexpected differences were found. Results between groups (see also Table 4) show that the control group outperformed three experimental groups: educational game (W = 1778, p < .001), gamification (W = 1236, p < .001) and social (W = 1443, p < .001). No statistical difference is found

Table 4
Comparison between groups of all evaluation items.

Groups compared		Evaluation item (post-test)				
		Word processing	Spreadsheets	Presentations	Databases	Final examination
Control	Ed. Gam	W = 4080 p < .001*	W = 4144 p < .001*	W = 4729 p < .001*	W = 2739 p = .346	W = 1778 p < .001*
Control	Gamif	W = 3788 p = .002*	W = 4207 p < .001*	W = 4807 p < .001*	W = 4360 p < .001*	W = 1236 p < .001*
Control	Social	W = 4574 p < .001*	W = 4467 p < .001*	W = 4275 p < .001*	W = 3662 p < .001*	W = 1443 p < .001*
Control	Social Gamif	W = 4715 p < .001*	W = 4070 p < .001*	W = 4588 p < .001*	W = 4122 p < .001*	W = 2593 p = .278
Ed. Gam	Gamif	W = 2881 p = .981	W = 2878 p = .973	W = 2806 p = .755	W = 3310 p = .001*	W = 1879 p = .002*
Ed. Gam	Social	W = 3446 p = .016*	W = 2944 p = .616	W = 2817 p = .040*	W = 2817 p = .041*	W = 2170 p = .004*
Ed. Gam	Social Gamif	W = 3415 p = .034*	W = 2497 p = .182	W = 2869 p = .940	W = 3044 p = .012*	W = 3446 p = .001*
Gamif	Social	W = 2406 p = .051	W = 3001 p = .671	W = 1935 p < .001*	W = 2317 p = .140	W = 3059 p = .218
Gamif	Social Gamif	W = 3377 p = .100	W = 2622 p = .260	W = 3140 p = .406	W = 2478 p = .211	W = 4122 p < .001*
Social	Social Gamif	W = 2710 p = .596	W = 2972 p = .630	W = 3910 p < .001*	W = 2730 p = .685	W = 3876 p < .001*

Significance is computed using Mann–Whitney tests with Bonferroni corrections to adjust for the inflation of type I error.

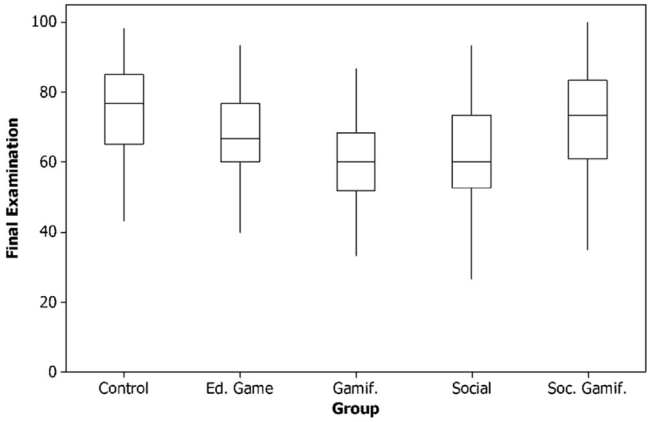

Fig. 6. Box-plot of the final score of the control and four experimental groups.

between the control group and social gamification group (W = 2593, p = .278). The gamification group and the social group performed similarly (W = 3059, p = .218) but also poorly averaging 15 points less than the control group and the social gamified group (W = 4122, p < .001 for gamified vs social gamified; W = 3876, p < .001 for social vs social gamified). The educational game group can be found in-between performing better than the gamified (W = 1879, p = .002) and social groups (W = 2170, p = .004) but worse than the control and social gamified (W = 3446, p = .001) groups. Thus in terms of final examination, none of the experimental groups performed better than the control group, and the control group performed better when compared with three experimental conditions. Therefore and as for RQ3 (Does the kind of evaluation item influences results on learning performance for the different experimental conditions?), results suggest that experimental tools impact on learning results as measured by evaluation items that assess practical skills (assignments) but do not impact on examinations that primarily assess knowledge acquisition. No relevant differences between experimental conditions are found when assessing practical assignments. However when it comes to the final examination, the social gamification tool returned better results, but similar to the control group. It was followed by educational gaming, whereas gamification and social approaches yielded the worst results in terms of learning performance.

4. Discussion

Results of the present study in an undergraduate course on ICT qualification suggest that the Ribbonhero educational game can be integrated into a learning experience that is related with the topics presented in the game boosting learning

performance if learning modules are supported by the game. Competition reward-based gamification also produces benefits suggesting that gamified approaches based on extrinsic motivators also boost learning performance when learning activities and learning objectives are carefully aligned with the instrument. Similarly, cooperative and collaborative student work supported by an educational social network also produces comparative results, as does an instrument that combines gamification and social networking. Results also show that social approaches (social networking and social gamification) yield benefits in terms of learning performance sooner when compared with approaches that are only based on games suggesting that the cooperative and collaborative nature of social networks can be better harnessed to produce short term results. In terms of the type of evaluation item, a traditional blended-learning approach still produces better results than the educational game, competitive-driven gamification and social networking in a final examination. Results of blended-learning only compare with social gamification for the final examination item. Therefore, combining gamification and social approaches produces the better outcomes in terms of learning performance across the different evaluation items considered in this study. So harnessing the motivational potential of both approaches (gamification and social networking) seems to be the most promising way to address the needs of young undergraduate students producing significant results in gameful educational settings. We conjecture that the combination of social and game-like approaches promotes interaction and discussion around both conceptual constructs and practical artifacts resulting in better outcomes as measured by learning performance.

When the educational game did not offer support for the learning module on databases, the benefits in terms of learning performance disappeared evidencing that learning effects are short-lived, as previous studies in non-educational settings have also showed (Denny, 2013; Koivisto & Hamari, 2014; Thom, Millen, & DiMicco, 2012). This suggests that educational games non-specifically aligned with learning objectives may produce a kind of shallow gamification (Dichev, Dicheva, Angelova, & Agre, 2014) that yields short-term results but does not promote long-term motivational outcomes. As it has been also pointed, gamification approaches can motivate participation by increasing the number of interactions but not their quality (Halan et al., 2010). Nevertheless, our results also evidence the positive (although short-lived) effects that such shallow gamification approaches convey. A recent study by Lieberoth (Lieberoth, 2014) argues that it is enough to "dress" an activity as a game in order to facilitate motivational affordances. So, already available educational games can still produce cost-efficient boosts on learning performance that can be harnessed by educators and easily implemented. Similar conclusions cannot be drawn for the other experimental conditions (gamification, social networking and social gamification) as they were used for all learning modules and duration of the learning action.

On the other hand, recent results of gamification in education (Hanus & Fox, 2015) suggests that as the novelty of the new technology expires, excitement decreases resulting in decreasing motivation. In our study we did not find any decrease in terms of learning performance when instruments provided support for the learning modules over a period of ten weeks. Hanus & Fox concluded that gamification undermines motivation, effort and empowerment resulting in lower grades in a final exam. Our study suggests that instruments and the kind of evaluation items are relevant for gamification in education and that gameful approaches have the potential to impact on learning performance. Still, contrasting results found here for different evaluation items raise concerns about the kind of learning that each instrument promotes, particularly when results of the final examination are observed, as only the performance of the social gamification group compared with the control group while students in all other experimental conditions performed particularly poorly. When relating the educational means with the kind of competences and targeted competencies, we found that new media facilitated skill acquisitions as measured by a set of assignments that assessed proficiency with computational tools for producing informational artifacts and assets. Conversely, we also found that traditional media (blended-learning) improved knowledge acquisition as measured by a written examination designed to assess the meaning and practical application of different concepts that were used in applications and that were particularly relevant to understand how informational artifacts work and are produced efficiently. Consequently, the effectiveness of new gameful approaches to convey traditional conceptual knowledge can also be questioned. Our results point to the strengths and weaknesses of blended-learning and new (game-based and social) media providing advice about how and for what different means and instruments can be used. Yet in another recent study Su & Cheng (Su & Cheng, 2014) reported positive results with mobile gamification in children, suggesting that the age of participants, the learning topic, or the nature of technology (context-awareness) can also be relevant for the success of educational gamification approaches. As such results contrast with our findings, these factors require further enquiry. Also, another possible limitation of this study has to do with the simplicity of the design of the gamification tool. Only challenges, trophies, badges and a leaderboard were included resulting in a simple reward-based approach to gamification. Best practice theories like meaningful gamification (Nicholson, 2012, 2015) may provide the theoretical background to design engaging gamified experiences that produce long-term benefits.

As for social networking, our study supports previous literature on the positive effects of social networking in education (Cho et al., 2007; de-Jorge-Moreno, 2012; Thoms, 2011) but it also provides additional insights when comparing such results with other novel approaches like gamification, and also when both are combined. In terms of comparative results, this work supports previous studies that compared gamification and social networking (de-Marcos, Dominguez, Saenz-de-Navarrete, & Pagés, 2014) which also found that similar experimental conditions produced benefits in terms of learning performance. The present study also includes new experimental conditions suggesting that benefits are similar in educational games, gamification and social networking, but also that social gamification presents higher potential to yield benefits for both knowledge and skill acquisition. Critical accounts on the effects of social networking in education (Tess, 2013) mostly point to methodological concerns and experimental design issues. Although in technical terms our method was not a randomized control trial, we think that such concerns are mitigated with a careful experimental design, but eventually this is a threat to validity.

Other limitations of our study are concerned with generalization. Although sample sizes were reasonable (about 75 participants per experimental condition), the effects of lack of support of instruments for specific learning objectives were only assessed incidentally for one experimental condition due to the nature of the instrument (the educational game did not support the learning module on databases), so further research has to be conducted in order to determine the long-term educational effects of the gamified and social networking approaches. Also, in terms of the analysis of the impact of instruments for different evaluation items, four practical assignments and only one final examination were included in the present study. To make any claim for generalization, more cases should be included and pedagogical concerns about the kind of learning that each evaluation item conveys should also be addressed. The possible biases of different assessments towards instruments (e.g. skill evaluation towards social aspects) can also be accounted as possible limitations. Concerns about generalizability also include the demographics and the context of use of the different instruments. Participants were solely undergraduate students and the educational setting was a 10-week undergraduate course on ICT. Young adults interested in ICT may feel particularly attracted by technology and game-like gadgets biasing the results of the study. Learning objectives were aligned with instruments and content delivered for the gamification, social networking and gamified social networking instruments. The educational game was not aligned with the learning objectives. Although it would be tempting to suggest that the mere presence of technology suffices to boost learning performance, present results are circumscribed to this particular instance and such claims are questionable without further research.

5. Conclusions and future research

This work studied the effect that an educational game, gamification, social networking and social gamification have on learning performance in an undergraduate course. Our aim was to study the four experimental conditions on the same educational setting to facilitate comparative analysis. Results suggest that all experimental conditions significantly impact on learning performance. Moderate differences were also found when experimental conditions were compared suggesting that social networking and social gamification produced better results even at early stages of the course (week 3). The effects on the different kinds of evaluation items were also studied and we found that in a final examination designed to assess conceptual knowledge, the new approaches did not yield any benefit when compared with a control group. Students that used the educational game, the gamification plugin and social network performed poorly when compared with the social gamification and control (blended-learning) groups. Social gamification returned better results in terms of immediacy across different evaluation items. This study then stresses the difference between practical skills, where new media resulted appropriate, and conceptual knowledge, where blended-learning resulted better, highlighting the necessity of complementarity for balanced teaching and learning, and providing insights about how and for what use the different tools. Results are circumscribed to a very specific population of young adult undergraduate students in an undergraduate course on ICT qualification. With these caveats about generalization in mind, we can also suggest that already available educational games have the potential to be easily integrated in educational settings producing boosts in terms of learning performance of practical skills. Reward-based competitive gamification or social networking can also be integrated with comparable results, although social networking is effective sooner. Finally social gamification produces better results across all evaluation items and also at earlier stages.

Incidentally, our work also studied the effects of the lack of support in one of the experimental conditions, namely the educational game. Results showed that the positive effects disappear when learning module is not supported by the treatment. This questions the effectiveness of gameful approaches to afford long-term intrinsically motivating and sustained engagement. Contrasting opinions suggest that gamification fosters shallow learning. But ultimately the question of retention and how gamification supports or undermines long-term learning still remains open and further enquiry is needed. Also, combining gamification and social networks provides an interesting ground to study the structure of the underlying social network, how gamification influences the social network and also the effects that the position in the social network can have on learning performance of each participant.

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