Gamification in Education: A Systematic Mapping Study

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ABSTRACT

While gamification is gaining ground in business, marketing, corporate management, and wellness initiatives, its application in education is still an emerging trend. This article presents a study of the published empirical research on the application of gamification to education. The study is limited to papers that discuss explicitly the effects of using game elements in specific educational contexts. It employs a systematic mapping design. Accordingly, a categorical structure for classifying the research results is proposed based on the extracted topics discussed in the reviewed papers. The categories include gamification design principles, game mechanics, context of applying gamification (type of application, educational level, and academic subject), implementation, and evaluation. By mapping the published works to the classification criteria and analyzing them, the study highlights the directions of the currently conducted empirical research on applying gamification to education. It also indicates some major obstacles and needs, such as the need for proper technological support, for controlled studies demonstrating reliable positive or negative results of using specific game elements in particular educational contexts, etc. Although most of the reviewed papers report promising results, more substantial empirical research is needed to determine whether both extrinsic and intrinsic motivation of the learners can be influenced by gamification.

Keywords

Gamification in education, Game design elements, Systematic mapping study, Literature review

Introduction

Traditional schooling is perceived as ineffective and boring by many students. Although teachers continuously seek novel instructional approaches, it is largely agreed that today's schools face major problems around student motivation and engagement (Lee & Hammer, 2011). The use of educational games as learning tools is a promising approach due to the games' abilities to teach and the fact that they reinforce not only knowledge but also important skills such as problem-solving, collaboration, and communication. Games have remarkable motivational power; they utilize a number of mechanisms to encourage people to engage with them, often without any reward, just for the joy of playing and the possibility to win. Creating a highly engaging, full-blown instructional game however is difficult, time consuming, and costly (Kapp, 2012a), while typically targeting only a single set of learning objectives as chosen by the game designer. In addition, their effective classroom adoption requires certain technical infrastructure and appropriate pedagogical integration. As opposed to using elaborate games requiring a large amount of design and development efforts, the "gamification" approach suggests using game thinking and game design elements to improve learners' engagement and motivation.

Gamification, defined by Deterding et al. (2011) as the use of game design elements in non-game contexts, is a fairly new and rapidly growing field. The concept of gamification is different from that of an educational or serious game. While the latter describes the design of full-fledged games for non-entertainment purposes, "gamified" applications merely employ elements of games. The term "gamification" is quite recent: According to (Deterding et al., 2011) its first documented use is in 2008 but it did not see widespread adoption before the second half of 2010. Nevertheless, the concept itself is not new. For example, badges and ranks have been long used in the military, in the early Soviet era, game elements were used by the Soviet Union leaders as a substitute for monetary incentives for performing at work, etc.

In recent years gamification has seen rapid adoption in business, marketing, corporate management, and wellness and ecology initiatives. This is driven by its potential to shape users' behavior in a desirable direction. Loyalty programs such as the frequent-flyer programs, Foursquare, and Nike+ are often given as examples of successful gamified mass-market products. Stackoverflow.com provides another example in which users' reputations increase as

they answer questions and receive votes for their answers. Online education sites such as codeacademy.com and khanacademy.org use game elements to better engage users. The more courses and lessons that users complete, the more badges they earn. Sites like eBay and Fitocracy use game elements to keep people engaged and to encourage friendly competition between users.

Gamification is still rising in popularity. According to Gartner's Hype Cycle (Gartner, 2013), a research methodology that outlines an emerging technology's viability for commercial success, gamification is at the peak of the Hype Cycle in 2013, with an expectation for reaching the productivity plateau in five to ten years. This position, however, mainly reflects its use in business contexts. The penetration of the gamification trend in educational settings seems to be still climbing up to the top, as indicated by the amount and annual distribution of the reviewed works.

This paper presents the results of a study of the published works on the application of gamification to education, which aims to shed light on the tendencies and emerging practices in this area. There are few literature reviews on gamification (see Xu, 2012; Hamari, Koivisto, & Sarsa, 2014; Nah, Zeng, Telaprolu, Ayyappa, & Eschenbrenner, 2014), with only the last one focusing on education. This study differs from the latter by presenting a thematic analysis instead of narrative summaries that focus on a qualitative review.

Systematic mapping study design

The main research questions behind this study were: "What educational contexts has gamification been applied to?" and "What game elements have been used in gamifying educational systems?" We used a systematic mapping design for the study. Systematic mapping studies are similar to systematic reviews, except that they employ broader inclusion criteria and are intended to map out topics rather than synthesize study results. A systematic mapping study provides a categorical structure for classifying the published research reports and results. The study presented here covers the existing work in the field of gamification in education: articles and conference papers published and indexed until June 30, 2014. The recency of the interest in conducting research on this topic is demonstrated by the distribution of the studied papers by year of publication, presented in Figure 1.

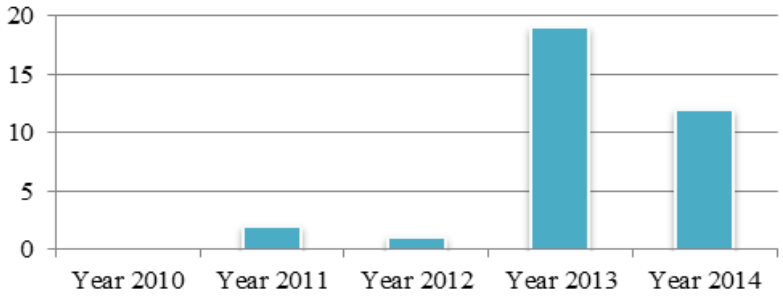

Figure 1. Work distribution by year of publication

Inclusion, search, and screening

The inclusion criterion for the papers was to discuss explicitly the use of game elements in educational contexts. Note that motivation is a very central and fundamental topic in education (different from other contexts of application of gamification), and a lot of research has been done on it. Also, techniques such as feedback, ordering learning tasks by their complexity, personalization, etc., are as fundamentally essential for games as they are for education. Therefore, from an educational point of view, it would be unnatural to consider them as "game mechanisms" making their way to education. There is substantial motivation-related research, for example, on pedagogical methods such as inquiry-based learning, psychological research on intrinsic and extrinsic motivation, and self-regulation (see, for example, Deci & Ryan, 1985; Lei, 2010), on motivation for participation in social networks (see, for example, Vassileva, 2012), or technological approaches, such as course sequencing (see, for example, Brusilovsky & Vassileva, 2003), or adaptive learning systems (see, for example, Brusilovsky, 1999), etc. Consequently, papers presenting research on such topics (although related to principles and techniques considered by the traditional computer game theorists as game elements) are not included in this study. We are targeting a more

holistic approach to the use of game design elements in education and consider them from the perspective of gamification: Can their game-like implementation motivate learners and enrich the educational experiences?

We searched seven major scientific databases: ACM Digital Library, IEEE Xplore, ScienceDirect, SCOPUS, Springer Link (books), ERIC, and Google Scholar. After searching the databases (in this order) with keywords "gamification," "gamify," and "gameful," and removing the duplicates, we obtained the following search results: ACM Digital Library (376 papers), IEEE Xplore (100 papers), ScienceDirect (119 papers), SCOPUS (405 papers), Springer Link (86 papers), ERIC (7 papers), and Google Scholar (554 papers). Based on abstracts, we first filtered out all publications that are not related to education or are not published in peer-reviewed conferences or journals and magazines (e.g., technical reports and master theses). This was followed by a second round of filtering in which, based on the full text, we removed the publications that are concerned with applying gamification for tasks that are not directly related to learning, such as university orientation for freshmen, library orientation, academic advising, etc., and those related to full-fledged educational games. We also removed early papers that only explain the concept of gamification and suggest very general possible uses in education. Meanwhile, we investigated the references of the found papers and discovered several papers relevant for the review that were not included in the databases. The resulting set contained 34 papers presenting empirical studies to be analyzed and classified (see Appendix I).

Categorization criteria

In order to answer the research questions, we performed a concept-centric review focusing on categories related to the context of use and game elements employed for gamification of education. The review of the papers provided us with information allowing the classification of the current research and work in the field along the following dimensions:

- Game elements
- Context: type of application
- Context: education level
- Context: academic subject
- Implementation
- Reported results from evaluation

With regard to the categorization of the game elements, we first surveyed the existing seminal, conceptual, and literature-review publications on gamification (not included in the 34 papers reporting empirical research). However, we discovered that there is not a commonly agreed classification of game design elements. For example, the popular game element "badges" is considered as a game interface design pattern in (Deterding et al., 2011), a game mechanic in (Zichermann & Cunningham, 2011), a game dynamic in (Iosup & Epema, 2014), a motivational affordance in (Hamari, Koivisto, & Sarsa, 2014), and a game component (a specific instantiation of mechanics or dynamics) in (Werbach & Hunter, 2012). Nevertheless, all authors define the game design elements at several levels of abstraction. For example, Zichermann and Cunningham (2011), following traditional computer game theorists, categorize game elements into mechanics, dynamics, and aesthetics. Mechanics define the way games (as systems) convert specific inputs into specific outputs. Dynamics guide how players and the game mechanics interact during the game. Aesthetics refer to the way the game mechanics and dynamics interact with the game designer's artistry, to produce cultural and emotional outcomes. Differently, Deterding et al. (2011) categorize game design elements at five levels of abstraction. Ordered from concrete to abstract, these are: interface design patterns; game design patterns or game mechanics; game design principles, heuristics or "lenses"; conceptual models of game design units; and game design methods and design processes.

For the purpose of reviewing the use of game elements in gamified educational contexts, we use a two-level framework. The first level combines the first two levels of Deterding's classification and, as most of the authors in the field, we refer to it as game mechanics. We further combine Levels 3 and 4 of Deterding's classification (game design principles and conceptual models) and call them educational gamification design principles. We use the term gamification design principles instead of game design principles to stress the fact that a number of these are not specific to games. In the education domain, some have been used in instructional systems as long as those have existed. These two categories roughly correspond to the first two components of the framework in (Zichermann &

Cunningham, 2011). The last Deterding's category "game design methods and processes," as well as Zichermann's "aesthetics," are essential for the game elements' implementation but are not relevant to this mapping study.

To further identify the second level of the classification structure, we collected game mechanics and game design dynamics, patterns, and principles used in the 34 reviewed case studies on using gamification in education. We identified the use of the following game mechanics: points, badges, levels, progress bars, leaderboards, virtual currency, and avatars. Point systems manage the acquisition and spending of points that quantify user performance. Badges are given for special achievements. Based on the received points and badges, users are ranked on leaderboards that reflect their performance in comparison to other users. Levels show the user's expertise and progress and where the player is in the game. Progress bars provide a percentage-based graphical representation of the players' progress. Virtual currency is used for purchasing in-game (virtual) goods.

Table 1 below presents the identified educational gamification design principles with, where appropriate, the game mechanics typically used to implement them. For each principle, corresponding references are presented. Some of the listed educational gamification design principles are fundamental and always present in educational systems but may need to be adapted to fit the gamification paradigm. For example, the feedback should be immediate or with shortened cycles (not as in the current educational practices). Others have been used individually and sporadically by some instructors but still need re-thinking in light of gamification, and some are new design elements borrowed from video games.

Table 1. Educational gamification design principles

Design principles	Used game mechanics	Papers
Goals: specific, clear, moderately difficult, immediate goals		Lee & Hammer, 2011 Kapp, 2012b
Challenges and quests: clear, concrete, actionable learning tasks with increased complexity		Lee & Hammer, 2011 Zichermann & Cunningham, 2011 Deterding, 2013 Simões, Díaz, & Fernández, 2013
Customization: personalized experiences, adaptive difficulty; challenges that are perfectly tailored to the player's skill level, increasing the difficulty as the player's skill expands		Lee & Hammer, 2011 Zichermann & Cunningham, 2011 Simões, Díaz, & Fernández, 2013 Gordon, Brayshaw, & Grey, 2013
Progress: visible progression to mastery	Points, progress bars, levels, virtual goods/currency	Zichermann & Cunningham, 2011
Feedback: immediate feedback or shorten feedback cycles; immediate rewards instead of vague long-term benefits		Lee & Hammer, 2011 Nah et al., 2014 Zichermann & Cunningham, 2011 Kapp, 2012b Simões, Díaz, & Fernández, 2013 Gordon, Brayshaw, & Grey, 2013
Competition and cooperation/social engagement loops	Badges, leaderboards, levels, avatars	Zichermann & Cunningham, 2011 Iosup & Epema, 2014 Deterding, 2013 Simões, Díaz, & Fernández, 2013
Accrual grading	Points	Simões, Díaz, & Fernández, 2013
Visible status: reputation, social credibility and recognition	Points, badges, leaderboards, avatars	Lee & Hammer, 2011 Deterding, 2013 Simões, Díaz, & Fernández, 2013
Access/unlocking content		Iosup & Epema, 2014
Freedom of choice: multiple routes to success,		Lee & Hammer, 2011

allowing students to choose their own sub-goals within the larger task		Iosup & Epema, 2014 Deterding, 2013 Simões, Díaz, & Fernández, 2013
Freedom to fail: low risk from submission, multiple attempts		Lee & Hammer, 2011 Kapp, 2012b Deterding, 2013 Gordon, Brayshaw, & Grey, 2013
Storytelling	Avatars	Nah et al., 2014 Kapp, 2012b Simões, Díaz, & Fernández, 2013
New identities and/or roles	Avatars	Lee & Hammer, 2011 Simões, Díaz, & Fernández, 2013
Onboarding		Zichermann & Cunningham, 2011
Time restriction	Countdown clock	Kapp, 2012b

Each of the 34 papers presenting empirical studies was evaluated to examine which of these defined categorization criteria were discussed.

Mapping study results

This section describes the distribution of published work on each classification criterion. As proposed above, the criterion of game elements is divided into two: gamification design principles and game mechanics.

Gamification design principles. Figure 2 shows the number of papers discussing each of the identified educational gamification design principles (see Table 1).

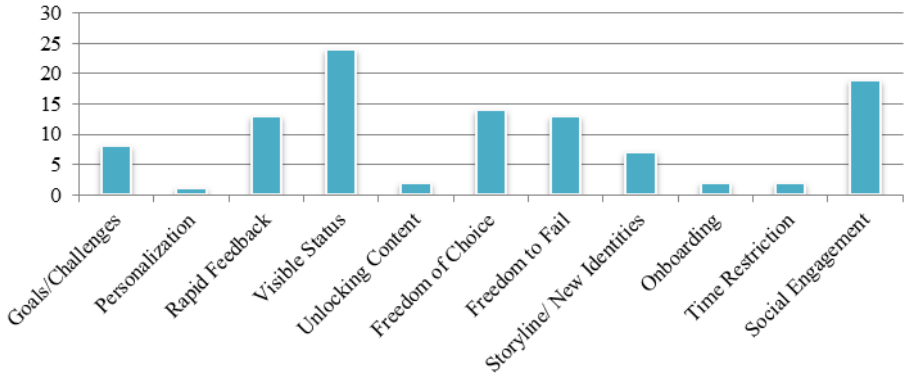

Figure 2. Work distribution by gamification design principles

As we can see, the most used gamification design principles in educational context are visual status, social engagement, freedom of choice, freedom to fail, and rapid feedback. Papers that discuss the principles of goals and personalization are rare. The likely reason for this was mentioned before: these are fundamental principles for instruction and educational applications being the target of a long-standing pedagogical and educational computing research. So advancements related to them would not be considered a result of gamifying education.

Examples of applying the principle "freedom of choice" include the possibility for students to choose. For example, what type of challenges to complete: writing traditional essays, completing an open-ended group project, completing an open-ended individual project, or contributing to the class blog (Holman, Aguilar, & Fishman, 2013); writing academic papers, creating an instructional YouTube video, or developing an educational game design (De Schutter & Abeele, 2014); and taking tests or completing artistic assignments (Mak, 2013). Other examples include choices of specific challenges to complete (e.g., Barata, Gama, Jorge, & Gonçalves, 2013; Haaranen, Ihantola, Hakulinen, &

Korhonen, 2014), the order and/or speed of completing the challenges (e.g., Berkling & Thomas, 2013; Todor & Pitica, 2013), the choice of selecting skill goals, how the challenges or their types are weighted (e.g., Holman, Aguilar, & Fishman, 2013; Gibbons, 2013), customizing assignment deadlines (Gibbons, 2013), and voting on the extent of the marks deduction for penalties for absences or non-completion of assigned tasks by a team member (Caton & Greenhill, 2013).

The principle "freedom to fail" presumes no penalties on poor task performance and typically includes allowing students to revise and re-submit assignments (e.g., Haaranen, Ihantola, Hakulinen, & Korhonen, 2014; Berkling & Thomas, 2013; de Byl & Hooper, 2013; Hentenryck & Coffrin, 2014) or re-take quizzes (O'Donovan, Gain, & Marais, 2013). Although this principle is perhaps one of the most controversial for applying in a conventional classroom, there are no empirical studies carrying out specifically its controlled evaluation.

Social engagement includes individual and team competitions (e.g., O'Donovan et al., 2013; Li, Grossman, & Fitzmaurice, 2014), taking part in group "guild" learning activities and work on team projects (e.g., Mak, 2013; Caton & Greenhill, 2013; Mitchell, Danino, & May, 2013; Burkey, Anastasio, & Suresh, 2013), cooperation and interaction with other students (e.g., Giannetto et al., 2013; Landers & Callan, 2011), etc.

Only six studies were found to investigate the impact of the use of a single game technique: one of a leaderboard (Hentenryck & Coffrin, 2014) and all the others of badges (Anderson, Huttenlocher, Kleinberg, & Leskovec, 2014; Hakulinen & Auvinen, 2014; Haaranen, Ihantola, Hakulinen, & Korhonen, 2014; Denny, 2013; Abramovich, Schunn, & Higashi, 2013). Only one study was identified to evaluate the effect of different type of game elements (badges) on different type of learners (Abramovich et al., 2013).

Game mechanics. Figure 3 shows the number of papers reporting the use of each of the identified game mechanisms. It confirms that the most popular game mechanisms are points, badges, and leaderboards.

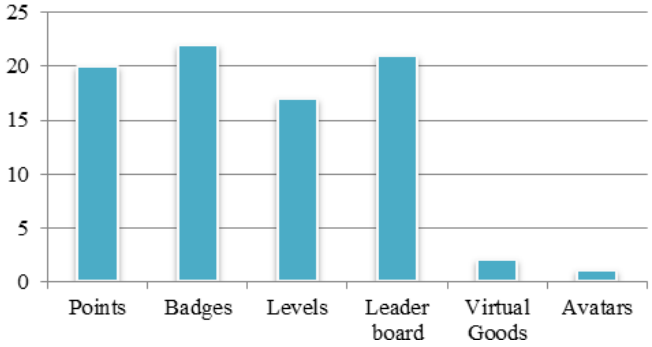

Figure 3. Work distribution by game mechanisms

Regarding the use of badges, in some of the case studies their assignment does not affect student grading, but is aimed at triggering competitive motivation (Pirker, Riffnaller-Schiefer, & Gütl, 2014). Badges are given for different achievements, for example, for challenge achievements and participation achievements (Domínguez et al., 2013), for learning, time management, and carefulness (Hakulinen & Auvinen, 2014), for contributing to threads and reading/voting on content (Anderson et al., 2014), or for performance and fun (Bartel & Hagel, 2014). As to levels, (Kapp, 2012b), for example, considers three types of levels: game levels, playing levels, and player levels. Goehle (2013) recommends choosing levels so that initially levels are earned quickly but become increasingly difficult to obtain later on. Examples for using virtual (in-game) currency include spending it on puzzle hints, assignment extensions, quiz do-overs (allowing the buyer another three chances at a quiz) (O'Donovan, Gain, & Marais, 2013), or getting help on certain homework problems, extending a due date with no penalty, using a larger index card for notes on a test (Goehle, 2013), etc.

Type of application. This criterion is about the context of the gamification application, that is, where gamification is applied. The papers were grouped in the following categories: for gamifying courses without online gamification support, for gamifying MOOCS or online courses, for gamifying blended learning courses, for gamifying e-learning

sites, and for developing gamification support platforms. Figure 4 shows the number of papers in each category. As it can been seen, the majority of the reported case studies are on gamification of blended learning courses.

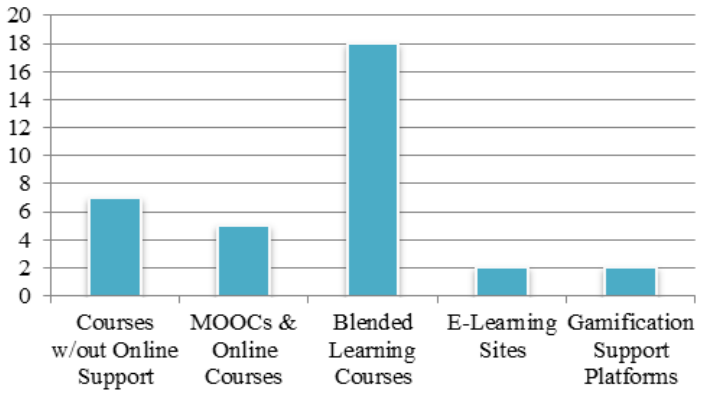

Figure 4. Work distribution by type of application

Education level. This criterion is about the targeted educational level. Only two papers consider gamification for the K12 education (Abramovich, Schunn, & Higashi, 2013; Morrison & DiSalvo, 2014), while the remaining articles target higher education and training.

Subject. This criterion is related to the subject domain of the application of gamification. The following categories were identified here: computer science (CS); information technology (IT); game programming, math/science/ engineering, and subject-neutral (see Figure 5). Most of the papers report gamifying of computer science or IT courses.

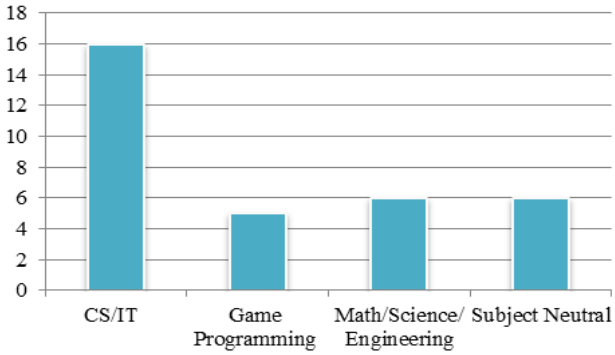

Figure 5. Work distribution by subjects

Implementation. A spectrum of implemented support for the instructors introducing gamification approaches in their teaching framework was identified, varying from no automated support at all to the use of standalone gamification platforms. The papers were grouped in the following categories (see Figure 6, where the first and second options are combined):

- No e-learning platform or other software used (Mak, 2013; Caton & Greenhill, 2013; Mitchell, Danino, & May, 2013; Burkey, Anastasio, & Suresh, 2013). For example, Mitchell et al. (2013) report that only teacher efforts and a leaderboard have been used.

- Manual collection of data on student performance and processing it with a computer program. Barata et al. (2013) report collecting data from lectures and labs by faculty on Excel sheets and downloading data logs from Moodle followed by running a Python script to process the data and generate the leaderboard webpage (two to three times a day to track major updates with low response time).

- Software for supporting gamification implemented as a plug-in or extension of a learning management system (LMS) or other online learning environment in use at the university. Examples include extending Moodle (Pirker, Riffnaller-Schiefer, & Gütl, 2014), A+ (Haaranen, Ihantola, Hakulinen, & Korhonen, 2014), Vula Sakai environment (O'Donovan, Gain, & Marais, 2013), Blackboard 9 (Domínguez, et al., 2013), QizBox (Giannetto, Chao, & Fontana, 2013), and the online homework platform WeBWorK (https://github.com/openwebwork, Goehle, 2013).

- Third-party software used to support some aspect of gamification. Examples include using Moodle (Thomas & Berkling, 2013); the Diagnosys tool for assessment of basic mathematical skills, which includes lives, time limits, and adaptive difficulty (Gordon, Brayshaw, & Grey, 2013); the collaborative learning environment Curatr (curatr3.com), which uses gamification principles (Betts, Bal, & Betts, 2013); BadgeVille (badgeville.com); WordPress (http://wordpress.org/), with its Achievements plug-in (WordPress Achievements, 2014) (Werbach & Johnson, 2012); and the free hosted online platform CourseSites (https://www.coursesites.com/webapps/Bb-sites-course-creation-BBLEARN/pages/index.html), which provides an integration of Mozilla Open Badges (Thomas & Berkling, 2013). Thomas & Berkling state that the multi-platform approach of using Moodle, along with a combination of online quiz-taking tools and another platform for gamification aspects, proved to be very difficult for the students. These authors also provide a comparison of using different software platforms to support course gamification. After comparing Moodle, Sakai (http://www.sakaiproject.org), and CourseSites, the authors chose and recommended CourseSites.

- Software for supporting gamification implemented as standalone applications. The authors of the corresponding papers report the development of tools to support some aspects of gamification in educational contexts (Hakulinen & Auvinen, 2014, Berkling & Thomas, 2013, Todor & Pitica, 2013, and Landers & Callan, 2011).

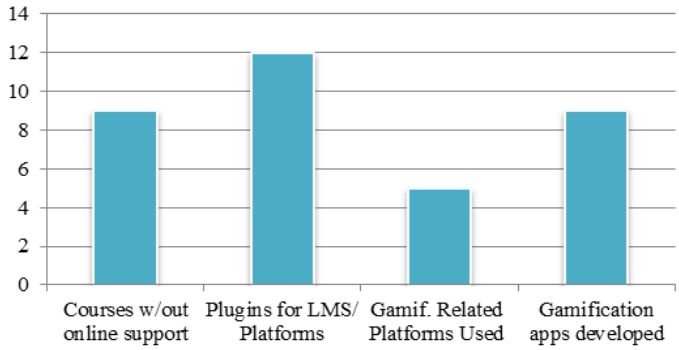

Figure 6. Work distribution by implementation

Reported Results. Figure 7 shows the paper distribution by the type of the results from the reported case studies' evaluation, grouped in the following categories: positive, positive first impression but not properly evaluated, mixed or suggestive, negative, and not evaluated yet or results not accessible.

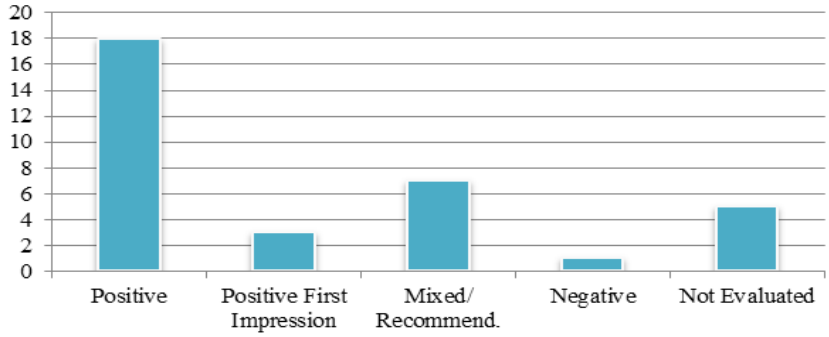

Figure 7. Work distribution by reported results

The majority of the papers report encouraging results from the experiments, including significantly higher engagement of students in forums, projects, and other learning activities (e.g., Anderson, Huttenlocher, Kleinberg, & Leskovec, 2014; Caton & Greenhill, 2013; Akpolat & Slany, 2014); increased attendance, participation, and material downloads (Barata, Gama, Jorge, & Gonçalves, 2013); positive effect on the quantity of students' contributions/ answers without a corresponding reduction in their quality (Denny, 2013); increased percentage of passing students and participation in voluntary activities and challenging assignments (Iosup & Epema, 2014); and minimizing the gap between the lowest and the top graders (Barata, Gama, Jorge, & Gonçalves, 2013). Hakulinen & Auvinen (2014) conclude that achievement badges can be used to affect the behavior of students even when the badges have no impact on the grading. The papers of this group also report that students considered the gamified instances to be more motivating, interesting, and easier to learn as compared to other courses (Mak, 2013; Barata, Gama, Jorge, & Gonçalves, 2013; de Byl & Hooper, 2013; Mitchell, Danino, & May, 2013; Leong & Yanjie, 2011).

Most of the mixed/suggestive evaluations point missed critical motivational elements in the application of gamification (Morrison & DiSalvo, 2014), sensitivity of the outcomes to small changes in the implementation, a requirement for an ongoing monetary and time investment (O'Donovan, Gain, & Marais, 2013), and the need of strong teaching staff able to design effective assignments, grade students' work relatively quickly, and interact with students closely (Leong & Yanjie, 2011). Abramovich, Schunn, and Higashi (2013) advise that educational badge designers must consider the ability and motivations of learners when choosing what badges to include in their curricula. Berkling and Thomas (2013), however, report a somewhat negative experience: "Students did not seem to be ready for autonomy, mastery was not perceived to be relevant, and the purpose of starting project work as well as good preparation for the exam seemed unattainable to the students." The authors suggest that gamification elements be used without being named explicitly, and that the change from the traditional style classroom to the new learning environment be introduced very slowly. In the same vein, Michigan University's Prof. Lampe is concerned that course gamification could be "whitewashed" by merely masking the terms, for example, by calling assignments as quests and scores as experience points, without contributing to the student's learning goals (Mak, 2013).

Conclusion

The goal of this study was to review the directions and tendencies of the conducted research on the application of gamification to education and, more specifically, to shed light on the context of application and game elements used. Concerning the limitations of the review, as we stated, the selection criteria included only papers that clearly studied the effects of implementation of game elements in educational contexts. Similarly to (Hamari, Koivisto, & Sarsa, 2014), we excluded research on topics conceptually or theoretically close to gamification (such as intrinsic motivations) or with similar measured outcomes, and papers discussing similar topics but with different terms. Thus, this review provides a fresh, in-depth look on the empirical research being done particularly on the topic of gamification in education.

The study revealed that there are many publications on the use of gamification in education but the majority describe only some game mechanisms and dynamics and re-iterate their possible use in educational context, while true empirical research on the effectiveness of incorporating game elements in learning environments is still scarce. In addition, most of the empirical studies do not include a proper evaluation, which makes it difficult to conduct a meta-analysis of the results of these studies and speculate on general reasons for their successes or negative results. While the mapping study identifies some emerging tendencies in utilizing certain configurations of game mechanics and gamification design principles, their effect in learning context remains to be demonstrated in practice.

Although proper evaluation is mostly missing, the majority of the authors of the reviewed papers share the opinion that gamification has the potential to improve learning if it is well designed and used correctly. Therefore, more substantial empirical research is needed to investigate, in particular, the motivating effects of using single game elements in specific educational contexts and for particular types of learners. This would inform instructors who are interested in gamifying their courses and help them in deciding what game elements to use in their specific context.

The study also shows that the early adopters of gamification are mostly computer science/IT educators. Our speculative explanation is that utilizing gamification assumes a certain type of environment that supports incorporating and visualizing the selected game mechanisms and dynamics. We believe that the effective classroom adoption of gamification implies both certain technological infrastructure coupled with an appropriate instructional

framework. Today's course management systems, however, still offer restricted support for gamifying courses. Since the general population of instructors lacks the necessary skills and time for creating, adapting, and/or maintaining an appropriate supportive technological infrastructure, the early application of gamification to learning emerged mainly in CS/IT disciplines. The lack of proper technological support is one of the major obstacles for applying game elements to education. Thus, the development of software tools that can efficiently support gamification in various educational contexts would contribute to a larger-scale adoption as well as to research on the feasibility and efficacy of the gamification of education.

Last but not least, finding and sharing of new ways of applying gamification to learning contexts that are not limited to extrinsic rewards like achievements and badges and that are more meaningful to the students is very important for increasing the application of this emerging technology in education. While the concept of gamification may look simple, the analyzed work demonstrates that gamifying learning effectively is not.

Acknowledgments

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Appendix 1

Overview of the studied publications on applying gamification to education

Paper	Type/Target of application	Game mechanics	Gamification design principles	Evaluation	Implementation
Abramovich, Schunn, & Higashi, 2013	Blended learning course	Badges	Status	Mixed/ proposing	Added to the CS2N intelligent tutoring system
Akpolat & Slany, 2014	Traditional course	Badges, leaderboard	Status, social engagement	Positive	Course without online support
Anderson, Huttenlocher, Kleinberg, & Leskovec, 2014	MOOC	Badges	Social engagement	Positive	Added to a discussion forum in Coursera
Barata, Gama, Jorge, & Gonçalves, 2013	Blended learning course	Points, badges, levels, leaderboard	Status, choice, onboarding, social engagement	Mixed/ proposing	Data collected manually and then processed with a program
Bartel & Hagel, 2014	Blended learning course	Points, badges, leaderboard	Feedback, status	Not evaluated	Gamification application developed
Berkling & Thomas, 2013	Blended learning course	Points, levels	Goals, status, choice, freedom to fail, social engagement	Negative	Gamification application developed
Betts, Bal, & Betts, 2013	Online course	Points, levels	Unlocking content, social engagement	Positive	Using Curatr
Burkey, Anastasio, & Suresh, 2013	Traditional course	Points, levels, leaderboard	Feedback, status, storyline, social engagement	Positive	Course without online support
Caton & Greenhill, 2013	Traditional course	Badges, leaderboard	Status, choice, social engagement	Positive	Course without online support
de Byl & Hooper, 2013	Traditional course	Points, leaderboard	Goals, feedback, status, choice, freedom to fail	Positive	Course without online support
de-Marcos, Domínguez, Saenz-de-Navarrete, & Pagés, June 2014	Blended learning course	Badges, levels, leaderboard	Status	Mixed/ proposing	Plug-in for Blackboard
De Schutter & Abeele, 2014	Blended learning course	Points, levels, leaderboard, avatars	Goals, feedback, status, choice, storyline, social engagement	Mixed/ proposing	Gamification application developed
Denny, 2013	Online course	Points, badges	Social engagement	Positive	Added to PeerWise
Domínguez, et al., 2013	Blended learning course	Badges	Goals	Mixed/ proposing	Plug-in for Blackboard
Giannetto, Chao, & Fontana, 2013	Gamification platform	Points, badges, levels	Social engagement	Not evaluated	Added to QuizBox
Gibbons, 2013	Blended learning course	—	Choice, freedom to fail, social engagement	Positive	Course without online support
Goehle, 2013	Blended learning course	Points, badges, levels, virtual currency	Feedback, visual progress	Positive first impression	Added to WeBWorK
Gordon, Brayshaw, & Grey, 2013	Blended learning course	Leaderboard	Goals, adaptation, feedback, status, freedom to fail, time restriction	Positive	Using Diagnosys

Haaranen, Ihantola, Hakulinen, & Korhonen, 2014	Blended learning course	Badges	Goals, choice, freedom to fail	Mixed/ proposing	Added to A+
Hakulinen & Auvinen, 2014	Blended learning course	Points, badges, leaderboard	Status	Positive	Added to TRAKLA2 learning environment.
Hentenryck & Coffrin, 2014	MOOC	Leaderboard	Status, freedom to fail, social engagement	Positive	Added to a MOOC
Holman, Aguilar, & Fishman, 2013	Gamification platform	Points, badges, levels, progress bar, leaderboard	Status, choice, freedom to fail	Not evaluated	Gamification application developed
Iosup & Epema, 2014	Traditional course	Points, badges, levels, leaderboard	Status, unlocking content, choice, freedom to fail, onboarding, social engagement	Positive	Course without online support
Landers & Callan, 2011	Blended learning course	Badges, Levels	Goals, feedback, status, choice, freedom to fail, social engagement	Positive	Gamification application developed
Leong & Yanjie, 2011	Blended learning course	Points, badges, levels, leaderboard	Goals, feedback, status, storyline	Positive	Gamification application developed
Li, Grossman, & Fitzmaurice, 2014	E-learning site	Levels, leaderboard	Status, social engagement	Positive	Gamification application developed
Mak, 2013	Traditional course	—	Feedback, choice, new identities, social engagement	Positive	Course without online support
Mitchell, Danino, & May, 2013	Traditional course	Points, leaderboard	Status, choice, new identities, social engagement	Positive	Course without online support
Morrison & DiSalvo, 2014	E-learning site	Points, badges, levels, progress bar	Feedback, choice, freedom to fail	Mixed/ proposing	Gamification application developed
O'Donovan, Gain, & Marais, 2013	Blended learning course	Points, badges, levels, progress bar, leaderboard, virtual currency	Feedback, status, freedom to fail, time restriction, storyline	Positive	Added to Sakai
Pirker, Riffnaller-Schiefer, & Gütl, 2014	Blended learning course	Badges, leaderboard	Feedback, status, freedom to fail	Positive first impression	Added to Moodle
Thomas & Berkling, 2013	Blended learning course	Points, levels, leaderboard	Status, social engagement	Not evaluated	Using CourseSites
Todor & Pitica, 2013	Online platform	Points, badges, levels, leaderboard	Feedback, status, choice, freedom to fail, new identities, social engagement	Positive first impression	Gamification application developed
Werbach & Johnson, 2012	Blended learning course	Points, badges, leaderboard	Status	Not evaluated	Using BadgeVille/WordPress with Achievements plug-in