

A Systematic Mapping on Gamification Applied to Education

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ABSTRACT

Gamification is a term that refers to the use of game elements in *non-game contexts* with the goal of engaging people in a variety of tasks. There is a growing interest in gamification as well as its applications and implications in the field of Education since it provides an alternative to engage and motivate students during the process of learning. Despite this increasing interest, to the best of our knowledge, there are no studies that cover and classify the types of research being published and the most investigated topics in the area. As a first step towards bridging this gap, we carried out a systematic mapping to synthesize an overview of the area. We went through 357 papers on gamification. Among them, 48 were related to education and only 26 met the criteria for inclusion and exclusion of articles defined in this study. These 26 papers were selected and categorized according to their contribution. As a result, we provide an overview of the area. Such an overview suggests that most studies focus on investigating how gamification can be used to motivate students, improve their skills, and maximize learning.

Categories and Subject Descriptors

H.5.m [Information Interfaces and Presentation (e.g., HCI)]: Miscellaneous; K.3.0 [Computers and Education]: General; K.8.0 [Personal Computing]: Games; K.8.m [Personal Computing]: Miscellaneous

General Terms

Design, Human Factors.

Keywords

Gamification, education, systematic mapping, survey, literature review, persuasive computing, motivation, engagement.

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1. INTRODUCTION

The term Gamification originated in the digital media industry, however, such a term only gained widespread acceptance after late 2010 [5]. Gamification refers to the use of game-based elements such as mechanics, aesthetics, and game thinking in *non-game contexts* aimed at engaging people, motivating action, enhancing learning, and solving problems [5][16]. There has been a growing interest in applying gamification to education. To some extent, this growing interest has been influenced by other efforts that have successfully used gamification in other settings [6]. Since the eighties, researchers have been investigating the benefits of game and game-based approaches in education [24][12][30][19].

Nevertheless, in recent years, the interest in the topic has increased at a fast pace [16]. Despite this recent growth, to the best of our knowledge there is no comprehensive overview about gamification and education. In order to give an overview of the field, we have carried out a systematic mapping study of research into gamification applied to education. Systematic mapping is a method that involves searching the literature for gauging the extension and the amount of published articles (i.e., primary studies, as they are called in this context) in a given field of interest [26]. Using this systematic method it is possible to aggregate and categorize primary studies, creating an overview of the research area in question. This study describes the results of our systematic mapping, the essential steps of the protocol we devised, and how we carried out the process.

In this study, we are focusing on providing an overview of the research on *gamification* applied to education [5][16]. Furthermore, it is worth mentioning that this mapping study is part of an ongoing project whose purpose is to investigate gamification and Computer Supported Collaborative Learning (CSCL). Thus, as a secondary objective of this systematic mapping, we also aim to identify the existence of initiatives that use gamification in CSCL environments.

2. BACKGROUND

There has been some controversy over the concept of gamification. This has led several researchers to coin different terms for their own arguably highly related practice [5]. Thus, before detailing our systematic mapping, we will define some concepts related to the

term "game". The following discussion is not comprehensive, it is only intended to clarify and narrow down our definition of gamification. Although there are studies investigating the use of related concepts (e.g., serious games) in educational contexts, these studies were not included in our systematic mapping because they neither comply with our definition of gamification nor explicitly use the keyword *gamification*.

Playful design

Playful design is using game-based aesthetics or limited usability based on game elements in non-game contexts with the purpose of drawing the user's attention [1]. These elements are used to amuse users and cause an emotional response. One successful example is Twitter's page known as "Fail Whale" (Figure 1-a). Whenever there is an overload on the servers, instead of a boring page with some standard error message, users are presented with a drawing of a dozen birds, twitters, trying to lift a whale.

Serious games

Serious games are games designed for non-recreational environments and for educational purposes [16]. The term "serious" is employed because these games can focus on areas as diverse as economics, education, health, industry, military, engineering, and politics. In environments created by applying serious game concepts, it is possible to simulate real-world situations without incurring in eventual costs and risks. The main goal of this sort of training-environment is to convey information to the user [31]. The Virtual Incident Management Training System (Figure 1-c) is a multiplayer training environment designed for training professionals that need to act swiftly in case of accident on highways, such as paramedics and policemen [37].

Video games or digital games

Video Games or Digital Games are systems in which users are engaged in resolving abstract conflicts and challenges, under predetermined rules [36]. In this scenario the game continuously offers interactivity and feedback to the user, which often result in an emotional reaction. Figure 1-d shows a screenshot of the game New Super Mario Bros. Wii© whose main character, Mario, is considered one of the most iconic video game characters.

Gamification

As mentioned, it consists of using game developing techniques in non-game environments, such as social networks [16]. The techniques and resources used in digital games have elements capable of motivating the user, hold his interest and challenge him to solve problems. In gamification approaches, these elements are not the center of the system, but have the purpose of motivating users to use it [28]. Foursquare application (Figure 1-b) is an example of a gamified system. Foursquare is a location-based social network, which reached one billion "check-ins" in 2011. Foursquare allows users to check-in at venues using a device-specific front-end to the application (e.g., mobile website), each check-in might award the user with user-points or "badges".

It is worth to point out that the current work focus on covering research that explicitly match our definition of Gamification. Therefore, we are *not* considering research based on serious games, video games, playful design and other uses of game concepts in educational contexts.

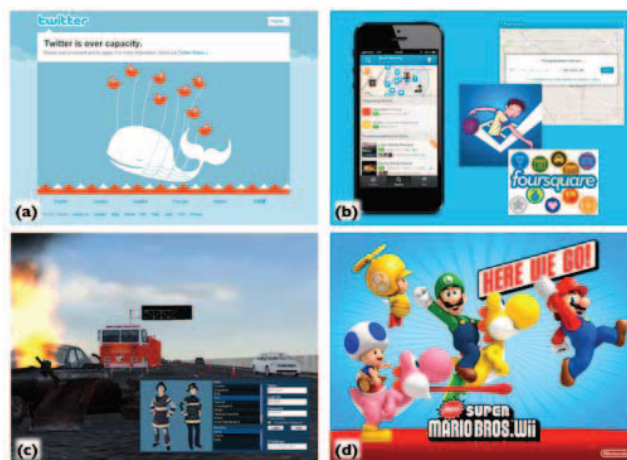


Figure 1. Examples of (a) playful design, (b) gamification, (c) serious games and (d) digital games.

3. THE SYSTEMATIC MAPPING PROCESS

We carried out our study by following the process described by [26]. According to them, systematic mappings are a fivefold process: (i) definition of research questions, (ii) performing the search for relevant primary studies, (iii) screening of papers, (iv) keywording of abstracts, and (v) data extraction and mapping. Research questions have to incorporate the study purpose. Thus, since we set out to ascertain what aspect of gamification applied to education has been most investigated by researchers, our three research questions (RQs) reflect this purpose as the following:

RQ1: In what educational contexts and levels has gamification been most investigated?

RQ2: What types of studies have been most investigated in gamification and education?

RQ3: What gamification approaches have been most investigated in the field of computer-supported collaborative learning (CSCL)?

Based on these questions we defined inclusion and exclusion criteria. These criteria are important to identify relevant primary studies that answer the RQs. We devised the following inclusion criteria:

- If several papers reported the same study, only the most recent paper was selected;
- If the paper describes more than one study, each study was assessed individually.

And the following exclusion criteria:

- Papers that do not present studies relating to education;
- Papers in languages other than English;
- Technical reports and documents that are available in the form of summaries or presentations (*gray literature*) and secondary studies (i.e., systematic literature reviews and mapping studies).

At first, we ran some searches using a combination of candidate keywords. These trial searches combined the keyword gamification with some synonyms related to education and learning. Due to the

small number of papers returned from the resulting strings, we decided that only the keyword **gamification** should be used.

This decision allowed us to analyze a greater number of papers, lowering the odds of leaving relevant studies out of our final set. Using gamification as keyword, we performed searches on electronic databases that are known to cover relevant scientific journals and articles from a wide variety of domains such as Computer Science, Education and Educational Research, Science, Engineering, Medicine and Psychology. Initially, we retrieved 357 primary papers. However, only 48 candidate papers were obtained after applying the inclusion and exclusion criteria based upon title and abstract. Finally, after going over introductions and conclusions, we ended up with a final set of 26 primary papers as shown in Table 1. The complete list of these papers can be obtained at: <http://goo.gl/KUH1m>.

Table 1. Distribution of primary studies by electronic database

Database	Quantity
ACM Digital Library	144
Elsevier (Science Direct)	32
IEEE Xplore	31
Scopus	95
Springer	55
Total	357
Candidates	48
Final Selection	26

We read all 26 papers in full and applied a *keywording* strategy to devise our classification scheme and categories for the selected primary studies. At first, abstracts were read in order to find keywords and concepts that reflect the contribution of the studies. After reading the papers, the keywords and concepts were combined to synthesize the nature of the selected contributions. Finally, the final set of keywords was used to define representative categories. As a result, the following categories were defined to better understand and classify the primary studies:

Mastering Skills: in this category we included all studies that propose the use of gamified systems as a means to improve students' ability to perform activities considered complex or repetitive.

Challenging: this category includes studies whose authors claim that gamified systems that implement challenging activities can contribute to the improvement of learning.

Guidelines: this category includes studies whose authors consider how gamification can be applied in educational settings. These studies, however, do not provide empirical evidence that backs up the authors' claims. Usually, these papers are built on results of other researchers.

Engagement: studies in this category describe approaches or strategies to arouse and maintain students' interest in learning a given subject.

Improving Learning: this category includes studies that propose gamified solutions to enhance the way students learn, maximizing the results of the learning process.

Behavioral change: this category includes studies that propose using gamified systems in order to foster behavioral changes in students.

Socialization: studies in this category discuss that learning can take place under more favorable conditions when supported by gamified social tools.

4. ANALYSIS

In this section we analyze the results of our mapping study. The purpose of this section is to give an overview of how gamification has been used to support education. The information drawn from the selected primary studies is also used to answer our mapping study's research questions.

To answer our first question (i.e., *in what educational contexts and levels have gamification been most investigated?*) we analyzed the primary studies and categorized them according to the target audience (Table 2). In Table 2 we can observe that most primary studies present gamification approaches tailored towards supporting higher education students (46%). Thus, we can conclude that the answer to RQ₁ is that gamification has been mostly applied in approaches to teaching students in higher education. On the other hand, among the selected primary studies, elementary education is the stage of education drawing less attention: only two primary studies, which accounts for only 8% of the selected studies, discuss gamification-based approaches for teaching elementary students.

As for the other studies, six primary studies (23%) describe the benefits and shortcomings of gamification-based models and educational strategies. These six studies, however, fail to position themselves in "the big picture". In other words, the authors do not mention in which educational level (e.g., elementary or higher education) their approaches should be incorporated so that one can best grasp the benefits of such approaches in particular educational contexts. In fact, none of these six primary studies mention whether or not gamification can be applied in educational level curricula.

Table 2. Primary studies categorized according to target audience or subject matter

Target audience	Number	Frequency (%)
Higher Education	12	46.15%
Non-specific context/level	6	23.08%
Training and Tutorials	3	11.54%
Languages	2	7.69%
Elementary Education	2	7.69%
Lifelong Education	1	3.85%

The other studies either discuss or propose using gamification models with the following purposes: training and tutorials (12%), teaching and learning languages (8%), and supporting students tackling lifelong education* projects (1%). It is worth mentioning that none of the selected studies described gamification approaches

* Further Education in Great Britain.

whose target audience is preschool, high school, or disabled students.

There has been a recent growing interest in research on developing eLearning environments that are equipped with gamification elements and techniques. Table 3 presents the primary studies clustered by date of publication. Although the first publications appeared only in 2011, the number of studies on gamification more than doubled from 2011 to 2012. As for 2013, taking into account only January and February, the months during which this study was carried out, three studies had already been published. It is important to note that several articles related to gamification have been published before 2011. Nevertheless, most of them were not related to education and none of them met the inclusion/exclusion criteria defined in our study. This result reveals that gamification applied to education is becoming a new research trend with room for new findings and improvements. To proper understand the impact (positive or negative) and implications of using gamification in educational contexts there is a need for more research and empirical data.

Table 3. Overview of the distribution of the selected studies throughout the years

Year	Quantity	Frequency (%)
2011	7	27
2012	16	62
2013	3	12

Most primary studies were published by either ACM DL (ACM Digital Library) or Springer, as shown in Table 4. The electronic databases, Elsevier (ScienceDirect) and IEEE (IEEE Xplore) had five and three selected studies, respectively. We also searched through Scopus, however, given that it was the last electronic database to be examined, most primary studies it indexes had already been selected from one of the aforementioned electronic databases. Four studies were selected from Scopus; these studies had not been returned by the other electronic databases.

Table 4. Distribution of the primary studies according to electronic database

Electronic Database	Number	Frequency (%)
ACM Digital Library	7	27%
Springer	7	27%
Elsevier	5	19%
Scopus	4	15%
IEEE Xplore	3	12%

By analyzing where the primary studies were published, we found that there is no specific venue whose purpose is to bring together research on gamification applied to education. The most notable publication forums according to the number of selected primary studies are the following: the American Society for Engineering Education Annual Conference (ASEE) (two studies were published in 2012) and the ACM eLearn Magazine (two studies as well). Furthermore, three primary studies were book chapters from the book *Serious Games and Edutainment Applications* published in 2011 by Springer [22].

Regarding the publication types, we have selected studies that have been published in journals, magazines, conferences, workshops,

symposia, and books. Table 5 gives an overview of the primary studies distributed according to publication type. As shown in Table 5, most selected studies are conference publications. Journal publications are the second most common publication type. It is worth mentioning that most of these journals have a multidisciplinary scope.

Table 5. Primary studies organized by publication type

Publication Type	Number	Frequency (%)
Conference	11	44%
Journal	7	28%
Book Chapter	3	12%
Periodical	2	8%
Symposium	1	4%
Workshop	1	4%

Primary studies frequently use the term “motivation” to justify the research in question or the main reason behind investigating gamification. Nevertheless, after an in-depth analysis of these studies, we found that several objectives fall under the term “motivation”. Thus, we were able to identify seven different objectives: (i) Mastering skills: improving certain abilities of the students; (ii) Challenging: proposing challenges that give extra meaning to the learning process; (iii) Engagement: engaging students in learning activities that are more interesting and easier to follow; (iv) Improving learning: maximizing the acquisition of knowledge; (v) Behavioral change: fostering changes of behavior by rewarding adequate actions and penalizing unsatisfactory ones; (vi) Socialization: allowing for both socialization mechanisms and group learning; and (vii) Guidelines: discussing the benefits of gamification as a means to motivate students and deal with some of the learning process problems. Our results demonstrate that there are some overlaps between these seven classification categories.

Apart from identifying the objectives of the primary studies, it is also important to characterize the type of research that was carried out and reported in these studies. Towards this end, we applied the classification proposed in [26]. Such a classification comprises the following research types.

Validation Research, studies that fall into this category describe a novel technique, approach, or strategy that has not been implemented in practice, but whose effectiveness has been evaluated to some degree through laboratory studies.

Evaluation Research, this category contains studies that empirically evaluate a technique, approach, or strategy in practice or real settings.

Position Papers, these studies report the authors' point of view. Research in this category does not contain evidence that backs up the authors' opinion.

Philosophical Papers, studies in this category are similar to position papers, however, they shed light on new ways through which educational approaches can benefit from gamification.

Solution Proposals, studies that describe a solution technique, approach, or strategy and argue for its usefulness, such a solution is either novel or extends an existing approach; studies in this category usually present examples and good line of argumentation (but not strong empirical data).

Experience papers, these studies are concerned with reporting the author's experience during the implantation of a new approach.

Rather than plotting frequency tables to illustrate the distribution of the studies according to research type and objectives, we decided to generate a bubble plot (Figure 2), but the primary studies summarized in Figure 2 are also shown in Table 6. The resulting bubble plot is intended to be seen as a map of research on gamification used in conjunction with education. A bubble plot has two x-y scatter plots containing bubbles in category intersections. The size of these bubbles is determined by the amount of primary studies that have been classified in the pair of categories in question.

Such a visual summary gives an overview that enables researchers to pinpoint categories that have been drawing most attention as well as the ones that have not been much investigated. Therefore, by analyzing such a map it is possible to identify gaps and opportunities for future research. The bubble plot generated from our selected studies is shown in Figure 2.

By analyzing Figure 2, we can identify that the research objective of most studies is to evaluate (Evaluation) the engagement (Engage) of the students through gamification (13 studies). It is also possible to identify that there are no studies on Experience or Validation, which answers RQ₂ (*What types of studies have been most investigated in gamification and education?*). This indicates there is a lack of validation research that helps to propose novel techniques/methods and test them in well-thought-out controlled laboratory experiments. Similarly, it is necessary for more research to be done with the help of end users, i.e. teachers, to report personal experiences regarding the application and implications of using gamification in learning environments.

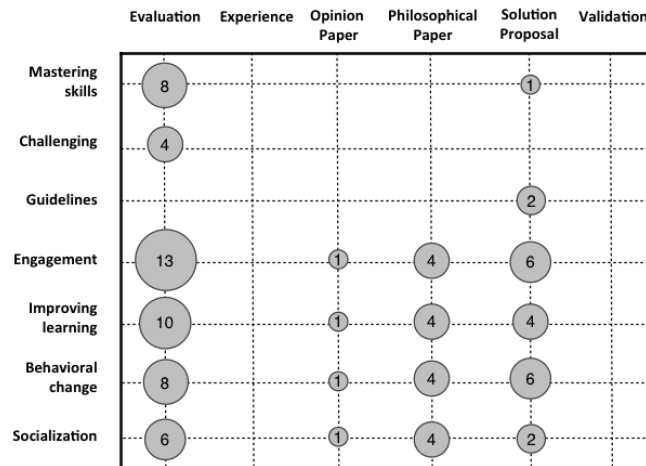


Figure 2. Map containing the distribution of gamification research by study type (x axis) and research objectives (y axis)

Table 6 also synthesizes the frequency of primary studies according to research objective. The numbers in parenthesis represent the number of papers in the category, while the numbers in square brackets are the papers' references. 24 of the 26 studies have *Engagement* among students as their main objective. Only two studies do not directly approach such an objective, discussing motivation in a higher abstraction level. Contributing to further improvement in how students socialize is mentioned by 13 studies (*Socialization*). Nevertheless, only eight primary studies report practical solutions to achieving such an objective, four encourage

group activities, and one highlights the importance of this sort of activity.

A Venn diagram was drawn to clarify the distribution of the overlapping studies (Figure 3). For simplicity's sake, we decided to include only four categories in the diagram. As shown in the diagram, 9 papers overlap 4 research objectives. Some studies encompass only two or three research objectives: (i) engagement and behavioral change; (ii) socialization and engagement; and (iii) improving learning, behavioral change, and engagement. This suggests that motivating students is not a straightforward task that can be accomplished by employing only one strategy. However, the amount of studies that employ the four main research objectives indicates that researchers have been striving to come up with more sound solutions to motivate students.

Only one study mentions that computer-supported collaborative learning (CSCL) is suited to develop applications that help students to socialize and organize themselves in groups. However, this study does not cover how to undertake the integration of computer-supported collaborative learning, gamification, and educational approaches. Therefore, the answer to RQ₃ (*What gamification approaches have been most investigated in the field of CSCL?*) is that there is a lack of approaches that combine gamification and computer-supported collaborative learning.

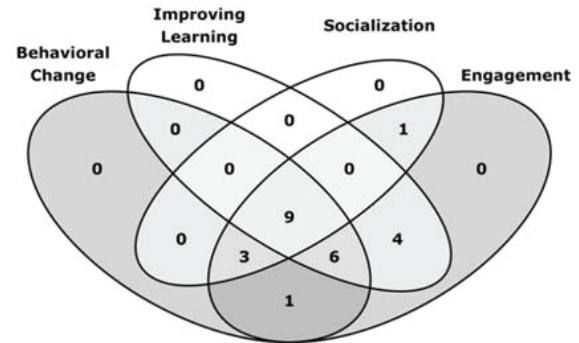


Figure 3. Overview of the four categories with the highest number of papers and the overlap among them

5. THREATS TO VALIDITY

In order to ensure an unbiased selection process, the RQs, inclusion criteria, and exclusion criteria were established before the conduction of the systematic mapping. Furthermore, the selection process was carried out in an independent fashion by each involved author. To mitigate any selection bias and improve validity, the inclusion or exclusion of controversial studies was jointly decided. Nevertheless, we cannot rule out threats from a quality assessment perspective because during the selection process no scores were assigned to studies.

Another threat to validity consists of whether we selected all relevant studies in the area. Although such a threat cannot be ruled out, we tried to mitigate it by taking into account several important search engines. Therefore, we surmise that these search engines are prone to contain the majority of the relevant studies. In the future, we intend to update this scoping study by taking into account more search engines. The coherency of our classification scheme also represents a threat to the validity of this mapping study. As pointed out by [27], one of the problems of mappings studies is how to determine the proper way to categorize the resulting studies.

Table 6. Distribution of gamification research by study type and research objectives

	Behavioral Change (19)	Challenging (4)	Engagement (24)	Improving Learning (19)	Mastering Skills (13)	Guidelines (2)	Socialization (13)
Evaluation	[2] [4] [9] [14] [18] [32] [33] [34]	[6] [9] [10] [33]	[2] [3] [4] [6] [9] [10] [14] [18] [20] [21] [32] [33] [34]	[2] [3] [4] [6] [10] [14] [18] [21] [32] [34]	[6] [9] [10] [14] [20] [21] [32] [33]		[2] [9] [18] [20] [32] [34]
Experience							
Opinion	[8]		[8]	[8]			[8]
Philosophical	[1] [7] [11] [23]		[1] [7] [11] [23]	[1] [7] [11] [23]			[1] [7] [11] [23]
Solution	[13] [15] [25] [29] [31] [35]		[13] [15] [25] [29] [31] [35]	[15] [25] [29] [35]	[15]	[17] [28]	[13] [31]
Validation							

6. CONCLUDING REMARKS

The main purpose of our mapping study is to provide an overview of what has been investigated in the context of gamification applied to education. To fulfill our goal, we followed a systematic methodology, i.e., systematic mapping. We defined three research questions to be answered by our mapping. **RQ₁**: In what educational contexts and levels has gamification been most investigated? **RQ₂**: What types of studies have been most investigated in gamification and education? **RQ₃**: What gamification approaches have been most investigated in the field of CSCL?

According to our results, most studies were published in conferences and have focused on Higher Education (RQ₁ – see Table 2) to foster the engagement of students through learning activities that build on gamification concepts (RQ₂ – see Table 6). We also identified that there is a lack of approaches that combine gamification and CSCL (RQ₃).

The novelty of this research is that, to the best of our knowledge, this is the first systematic mapping covering research into gamification applied to education. Another contribution of this research is the map (Figure 2) we have created. By analyzing such a map it is possible to identify in which way gamification has been explored in educational contexts; thereby determining research gaps and future research opportunities.

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