Pontifícia Universidade Católica
do Rio de Janeiro

**Cláuvin Erlan José da Costa Curty de Almeida**

# Gamification guidelines to prevent negative effects in digital education/learning systems

**Dissertação de Mestrado**

Dissertation presented to the Programa de Pós-graduação em Informática of PUC-Rio in partial fulfillment of the requirements for the degree of Mestre em Informática.

Advisor : Prof. Bruno Feijó
Co-advisor: Prof. Marcos Kalinowski

Rio de Janeiro
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To my family, for all the support and encouragement.

To everyone who, in the middle of a pandemic, when having to choose between the easy and the right route, chose the right one.

That those who chose the easy route and harmed others through it have justice fall upon them.

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# Abstract

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While most research shows positive effects of gamification, the focus on its adverse effects is considerably smaller. Having this in mind, we conducted a systematic mapping study of the negative effects of game design elements on education/learning systems. The study revealed 77 papers reporting undesired effects of game design elements. We found that badges, competitions, leaderboards, and points are the game design elements most often reported as causing negative effects. The most cited negative effects were lack of effect, lack of understanding, irrelevance, motivational issues, and worsened performance. The ethical issue of cheating was also often reported. Then we used the data gathered to create 7 guidelines about some of the negative effects found and how to deal with those. This dissertation can help gamification designers make more informed decisions when selecting game design elements to be included in education/learning systems, raising awareness on potential negative effects.



## Keywords

Gamification; Education; Learning; Systematic Mapping; Guidelines; Negative Effects;

## Resumo

Almeida, Cláuvin Erlan José da C. C. de; Feijó, Bruno; Kalinowski, Marcos. **Guidelines de gamificação para prevenir efeitos negativos em sistemas digitais de educação/aprendizagem**. Rio de Janeiro, 2021. 104p. Dissertação de Mestrado – Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

Enquanto a maioria da pesquisa relata efeitos positivos de gamificação, o foco em seus efeitos adversos é consideravelmente menor. Tendo isso em mente, conduzimos um mapeamento sistemático dos efeitos negativos de elementos de game design em sistemas de aprendizado/educação. O estudo revelou 77 papers reportando efeitos não desejados de game design. Descobrimos que badges, competição, leaderboards e pontos são os elementos de game design mais encontrados sendo declarados como causadores de efeitos adversos. Os efeitos mais citados foram falta de efeito, falta de entendimento, irrelevância, problemas motivacionais e performance piorada. Então usamos os dados recolhidos para criar 7 diretrizes sobre alguns dos efeitos negativos encontrados e como lidar com eles. A dissertação pode ajudar designers de gamificação a tomarem decisões mais bem informadas quando selecionando elementos de game design a serem encontrados em sistemas de educação/aprendizado, criando percepção de efeitos adversos.



## Palavras-chave

Gamificação; Educação; Aprendizagem; Mapeamento Sistemático; Guidelines; Efeitos Negativos;

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*Remind yourself that overconfidence is a slow, and insidious killer.*

**Narrator**, *Darkest Dungeon.*

# 1
# Introduction

## 1.1
## Context and Motivation

There are plenty of digital platforms for education with a massive number of users, as Duolingo (`https://en.duolingo.com/`) (figure 1.1), a language teaching service used by 300 million people worldwide. It boasts that it gives opportunities for people to learn new languages, no matter their financial standing (Duolingo, 2020).

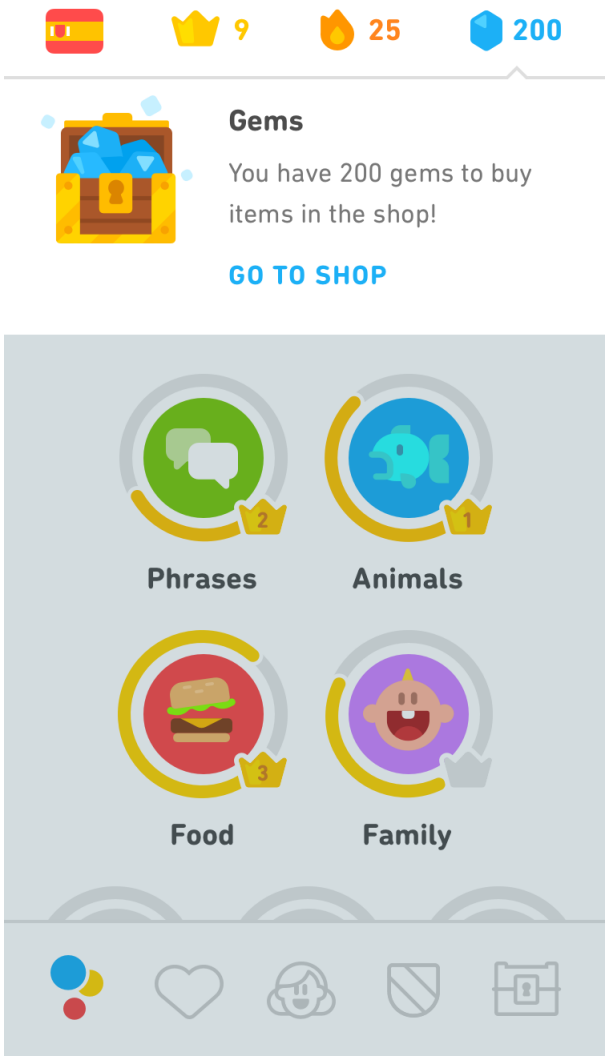


Figure 1.1: Duolingo app's main screen, giving focus to the gems the user has.

Another example is Khan Academy (`https://www.khanacademy.org/`) (figure 1.2), which advertises its mission as being providing free, world-class

education for anyone, anywhere. It represents a massive online learning system, with more than 10 million unique users per month (Murphy, 2014).


Figure 1.2: Khan Academy's badge types available to the users.

As a last example of a non-exhaustive list, Habitica (`http://www.habitica.com`) (figure 1.3) is a video game to improve people's real-life habits by turning their tasks into little monsters to conquer. If players slip up in life, their characters start backsliding in the game (Habitica, 2020). Habitica may also be used for more complex tasks, as demonstrated by (Barik et al, 2016).

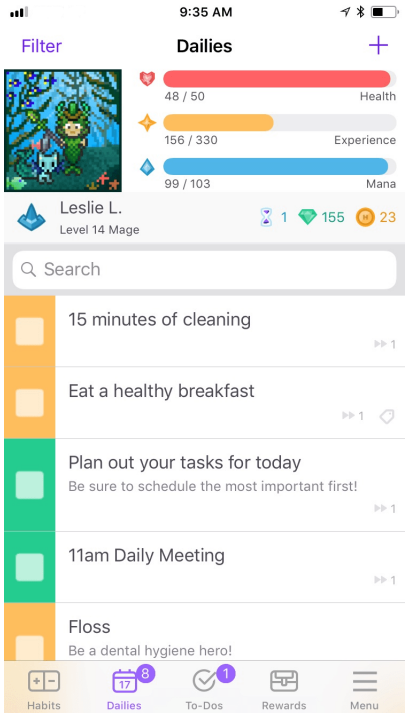


Figure 1.3: Habitica user's main screen.

All these three services have in common the use of gamification - applying game-playing elements to non-game contexts (Deterding, 2011) that are typically tedious, discouraging, or inefficient - as a strategy to make their objectives more achievable. It's a strategy with a strong presence in education and also in other domains (Rapp, 2019), representing a market predicted to grow over 30% through 2019-2025, with an expected value of more than 32 billion in 2025 (Research, 2019).

This context means that a big demand of digital gamified systems exists, which call for software engineers and their teams to create them.

Software development is not a trivial task, and it is more complicated in the case of gamified software solutions. These cases require specialized expertise, going beyond what is expected by an average software engineer (Piras, 2017), for instance:

- Effective gamification require knowledge of human psychology, similar to how serious games require knowledge regarding the subject they deal with (Almeida, 2016). This necessity arises because gamified software aims to change human behavior (see Volkswagen's Fun Theory videos ((Volkswagen, 2009),(Volkswagen, 2009a),(Volkswagen, 2009b));
- Software engineers need a good understanding of the game design mechanics used as tools and how they contribute to functional and non-functional requirements;

– Software engineers face the fact that gamified software has a more limited design space and different objectives to focus on than a game (Morschheuser, 2017).

Hence, selecting the correct gamification elements when designing gamified systems is strongly related to requirements engineering and can affect the overall project success (Fernandez et al, 2017). Moreover, defects in requirement are the most expensive to fix when found in production (Boehm, 2001) (Menzies, 2016a). Indeed, given that gamification deals with changing human behavior, when gamified software is ill-specified, the system may not hit the intended target or even be counterproductive, which can have serious consequences when applied to education.

Education software is the main target of the present work, for an important reason: approximately 617 million children and adolescents of primary and lower secondary school age have not reached minimum reading and mathematics proficiency in 2015 (Nation, n. d.). The reasons for this global learning crisis are manifold, such as inequality and poverty, but the poor quality of education is one of the critical causes. In this context, applying gamification to education and learning systems represents a promising means to allow educators to make learning fun, contextualize learning quickly, speak the language of young people, and directly deal with soft skills, improving education quality.

For that, of course, adverse results of gamification efforts - typical harmful effects that are unknown by the designers of gamified software - should be avoided. These unexpected effects can happen because current gamification research lacks a critical lens capable of exploring unintended design consequences (Rapp, 2019).



## 1.2 Objective

To shed new light on unexpected adverse effects and help designers of gamified systems avoid them, this paper presents the following contributions: (a) a systematic mapping on negative effects of digital game design elements (from here onwards called GDE) applied in education and learning that presents valuable information for software engineers and designers of gamified education/learning systems, such as the game design elements that have most often been reported to cause adverse effects; the most common negative effects on students; the adverse consequences affecting teachers, etc; (b) a set of 7 guidelines to avoid negative effects, such as cheating and a sense of fatigue due to extra tasks related to gamification, compiled based on the results of

the systematic mapping; (c) an article accepted by the Technical Track @ 47th EUROMICRO SEAA Conference in Palermo / Italy; (d) all the extracted data, available for future research in https://zenodo.org/record/4702399.

## 1.3 Organization

The remainder of this dissertation is organized as follows. Section 2 defines what is gamification and related concepts. Section 3 presents our systematic mapping. Section 4 presents the 7 guidelines compiled based on the systematic mapping results. Finally, section 5 contains the concluding remarks.

# 2
# Gamification and Games

## 2.1
## Gamification Definition

Gamification can be found in history before it was named as such: in the past, the Union of Soviet Socialist Republics (USSR) used Lenin's theory of "socialist competition" and later "socialist emulation". Both involved factories and workers would compete for points against each other to inspire greater production, even in creative endeavours, through winning medals and other stimulus (Nelson, 2012).

Such medals were varied, and could also be gained in other fields. Examples are:

- *Hero of the Soviet Union*, the highest honorary title that could be given to Soviet civilans and soldiers for a heroic act;
- *Mother-Heroine*, for mothers bearing and raising 10 or more children[1];
- *Honoured Blood Donor of the USSR*, for blood donors;
- *People's Architect of the USSR*, for those who reached stunning results in urban planning or the design of important buildings;
- *Order of Friendship of Peoples*, for persons, military units, as well as administrative subdivisions of the USSR for "accomplishments in strengthening of inter-race and international friendship and cooperation, for economical, political, scientific, military and cultural development of the Soviet Union";
- *Order of the Red Banner of Labour*, for exceptional working achievements. (Wikipedia, 2020a) (Figure 2.1)

[1]This medal is similar to the Order of Maternal Glory medal, that had 1st, 2nd and 3rd classes, for respectively bearing and raising 10, 9 and 8 children.


Figure 2.1: Soviet medals. From left to right, Hero of the Soviet Union, Mother-Heroine, Honoured Blood Donor of the USSR, People's Architect of the USSR, Order of Friendship of Peoples and Order of the Red Banner of Labour. (Collect, n.d.) (Wikipedia, 2020a)

Another similar initiative appeared in the 1990s-2000s at North America. It tried to add "fun to work", reimagining the workplace as a fun and playful locale rather than one of work and drudgery, using many game-like elements. (Nelson, 2012)

The term gamification started to be used in 2002 by Nick Pelling with his "one-man consultancy" (Pelling, 2011). After 2002, the field had many terms to define itself, such as productivity games, surveillance entertainment, funware, playful design, behavioral games, game layer and applied gaming. Yet, gamification is the one that stuck, seeing widespread adoption after the first half of 2010 (Deterding, 2011).

Yu-Kai Chou (Chou, 2015) defines gamification as the craft of deriving fun and engaging elements found typically in games and thoughtfully applying them to real-world or productive activities. He calls this process Human-Focused Design, where it optimizes what it intends to do and the humans' feelings, motivations and engagement in the experience.

His definition of gamification is similar to the one in Gamification, Inc.: "The gamification matches the use of game mechanisms oriented to the objective of solving practical problems or unleashing engagements between a specific public." (Vianna, 2014) Yet another definition can be found by Deterding (Deterding, 2011): "the use of game design elements in non-game contexts".

Unfortunately, since "(. . . )the term remains mired in diverse meanings and contradictory uses, while the concept faces division on its academic worth, underdeveloped theoretical foundations, and a dearth of standardized guidelines for application.(...)" (Seaborn, 2015), we, aware of many different definitions, discrepancies, distinctions and discretionary delimitations, will pick the following definition for it in this work:

*Gamification is the act of using game design elements in non-game contexts with the objective of solving a problem.*

To allow a more precise understanding of this definition, we will provide a basic definition of game design elements.

### 2.1.1 Game Design Elements

Going backwards, to define game design elements, we need to define first what a game is, and skipping most of the mandatory "games also have a fuzzy, evolving definition through time and space" (see (Molleindustria, n.d.) for proper examples of it), we will use a variant of the definition from Jane McGonigall (McGonigal, 2011): *games have an objective, rules, a space and time defined for them, answers to the player's actions and voluntary participation, besides a focus on the ludic.*

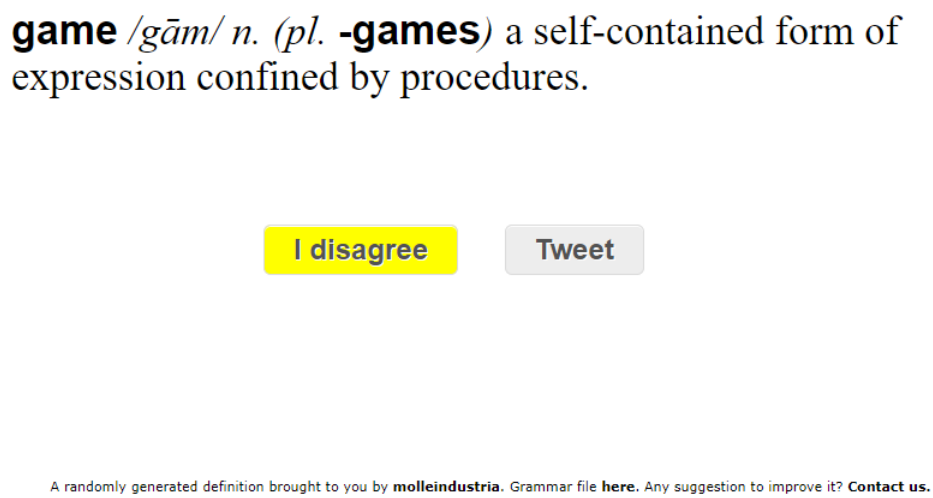


Figure 2.2: `http://www.gamedefinitions.com`. Clicking on the "I disagree" button generates another definition. The site description is "What is a game? An inclusive, algorithmic, ever-changing definition for an inclusive, algorithmic, ever-changing form." (Molleindustria, n.d.)

Now, we can define game design, using Brathwaite's definition, "*Game design is the process of creating the content and rules of a game. Good game design is the process of creating goals that a player feels motivated to reach and rules that a player must follow as he makes meaningful decisions in pursuit of those goals.*" (Brathwaite, 2009)

If the definition of what is a game is fuzzy and evolving, this means that the definition of game design elements is also fuzzy and evolving, and

unfortunately even using as a basis our game definition above, we can't escape completely from the fuzziness.

Still, we will try through Deterding's (Deterding, 2011) definition, which embraces it:

"*(. . . ) elements that are characteristic to games – (. . . ) that are found in most (but not necessarily all) games, readily associated with games, and found to play a significant role in gameplay.*."

Following that description, game design elements can be diverse as dices, points, cards, leaderboards, quick time events [2] and a system that tweaks the difficulty of the game as the player plays, keeping up with his perceived skill to always give him a challenge if he's getting better, and make things easier if he is getting stuck. [3]

Finally, to make our game design element definition clearer, we need to define what gameplay is. According to Fabricatore, gameplay is *"the set of activities that can be performed by the player during the ludic experience, and by other entities belonging to the virtual world, as a response to player's actions and/or as autonomous courses of action that contribute to the liveliness of the virtual world."* (Fabricatore, 2007)



## 2.2 Positive Effects Of Gamification

Ian Bogost stated that gamification is a marketing strategy used to conceal or impress and facilitate sales (Bogost, 2011) and (Seaborn, 2015) points that perhaps what drives users of gamified systems is not the gamified part, and that gamification gets the least important part of gaming and puts at the core of the experiences offered.

Despite these criticisms, research through the years found that gamification does bring benefits when properly used. Through an action research made with gamified workshops for students, Putz et al. (Putz, 2020) found that gamification has "a positive effect on students' knowledge retention, independent of age and gender". Positive effects on gamification enhancing interaction with the learning materials, performance on the studies and use of other gamification elements were also found by Klock et al. (Klock, 2018).

[2] As explained by Wikipedia, it's a "method of context-sensitive gameplay in which the player performs actions on the control device shortly after the appearance of an on-screen instruction/prompt. It allows for limited control of the game character during cut scenes or cinematic sequences in the game." (Wikipedia, 2020b)

[3] This system can be found both in digital games as Crash Bandicoot 1 and Resident Evil 4, and also in physical games, as Go, where weaker players receive extra pieces when playing against a stronger player.

The use of game design elements such as badges, points, trophies, leaderboards, avatars, and virtual gifts not only promotes students' extrinsic motivation but also increases their intrinsic value for learning (Zaimudin, 2020). (Johnson, 2016) conducted a systematic literature review of empirical studies on gamification for health and well-being. From the papers identified, the impact of their gamified interventions was found to be positive by 59% of the articles reviewed, with effects including empowerment, motivation, health monitoring, and more healthy habits taken. However, 41% - a significant portion of the studies - reported mixed or neutral effects.

(Hamari, 2013) corroborate the point about mixed effects: "most of the quantitative studies concluded positive effects to exist only in part of the considered relationships between the gamification elements and studied outcomes." Also, they observed (through qualitative analysis) that gamification is more manifold than previous studies often assumed. (Koivisto, 2018) reaches the same conclusion, having found articles pointing to a mixed effect of gamification and a small amount of purely negative results, which they attributed to a possible confirmation bias.



## 2.3 Negative Effects Of Gamification

Games and gamification manipulate human psychology through game design elements, and such manipulation can have negative effects. Those effects can be bothersome, as in the Akoha case, a gamified task system where the users could buy or receive from others cards with missions of goodwill, as "Surprising a friend with a mystery gift", "Giving flowers to a stranger" or "Buying someone a compact florescent light bulb" (Akoha, 2010) (Figure 2.3)


Figure 2.3: Akoha cards. (Beekmans, 2009)

That task system created to spread goodwill ended sabotaging a friendship, as one of the users had a card mission to "take coffee with a friend" to gain points and levels, and after the friend had the explanation about Akoha and the mission itself, he answered furiously with "Have you any idea how degrading that is, being invited not because you care about me, but because you want to progress in some game?" (Deterding, 2010) (Figure 2.4)


Figure 2.4: More Akoha cards. (Flickrive, 2009)

Worse negative contributions can be found in California, at the Disneyland Resort Hotel. The hotel decided to use leaderboards updated in real-time to stimulate its workers to clean sheets and towels more efficiently. The initiative backfired hard, as being constantly reminded if the worker's cleaning quota per time was acceptable or not, and the constant framing of the workplace as a competition degenerated the quality of the environment, caused extra stress and increased the amount of injuries on the job. (Gabrielle, 2018)

One game design element causing negative effects is not something unexpected or even ignored on the academic research of gamification in Collaborative Information Systems (Algashami, 2019). There, its author catalogs various negative effects which he calls "risks", dividing those in five categories: performance, societal & personal, goal, task and gamification design. Examples of those "risks" include, but do not cover all mentioned: free riding, lowering self-esteem, anchoring bias, lack of group coherence, lack of engagement, quality reduction and joy killing.

Not mentioned so far above were cases of unsolicited tracking and perceived exploitation, as it happened with Go365, a gamified app given to teachers in West Virginia, USA, that used points, milestones and rewards, given through objectives completed involving wearables that counted how many steps the user did each day.

Failure to reach milestones and not being healthy enough resulted in extra fees varying from monthly 25 dollars to even annually 1000 dollars, and teachers weren't able legally to not use the app, having to give sensitive medical data and having their positions tracked daily. All that resulted in a strike that ended the state contract with Humana, the business creator of Go365. (Gabrielle, 2018) (Education, 2018)

In two cases, the consequence was the death of the users of the gamified systems. The first happened involving Strava, a smartphone app that can be used to track runs and bike rides, using GPS to map the route. It also could be used for competitions with other users through time comparison on particular routes and high scores. (Hill, 2012) (Figure 2.5)

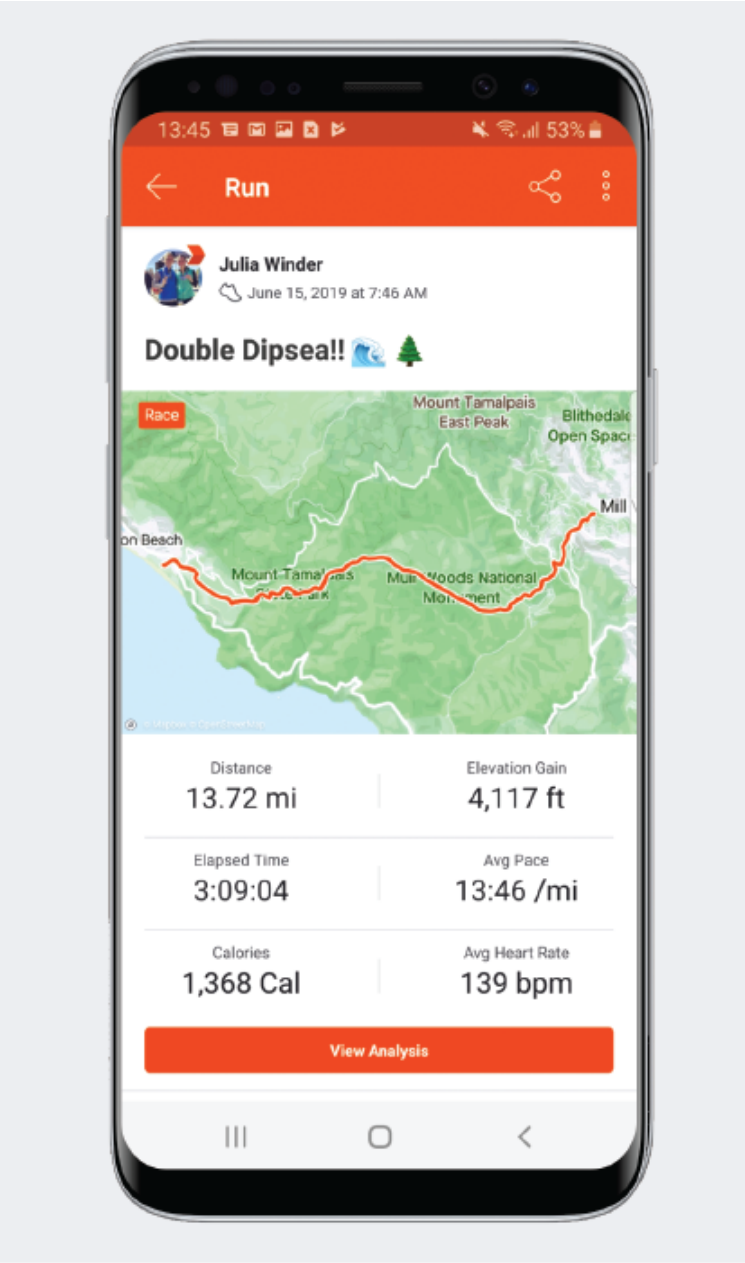


Figure 2.5: Strava's app screen. (Mapbox, 2021)

William "Kim" Flint decided to retake his place as first in a steep route in Berkley, California, reaching 64 km/h, having to break suddenly, flipping over a car and dying. The family's lawyer said that Flint was obsessed with his scores, and after the incident, Strava got updated with the ability of flagging routes as dangerous and forbidding the Berkeley road to be used as competitive. (Hill, 2012)

Finally, there's the case of Robinhood, a gamified stock trading app available since 2015. It uses positive reinforcement through confetti falling with successful trading, and a lack of explanation of some features plus pushing customers to the riskiest trading options (Popper, 2020).

This combination resulted in Alexandre Karns killing himself when he saw his Robinhood account with a total value of negative 730 thousand dollars, which were temporary. (Banker, 2020) (Figure 2.6)

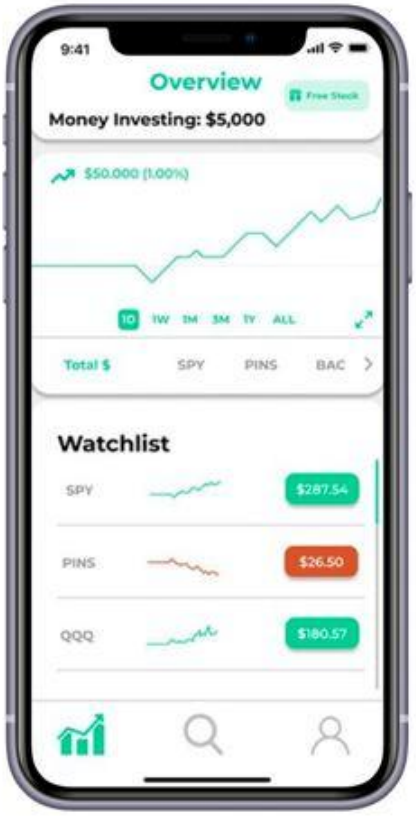


Figure 2.6: Robinhood's app screen. (Potoska, 2021)

# 3
# Systematic Mapping

## 3.1
## Definition of Systematic Mapping

As (Kitchenham, 2007) defines, a systematic mapping is "a broad review of primary studies in a specific topic area that aims to identify what evidence is available on the topic." The resulting maps created by systematic mappings are useful for many reasons (Bates, 2007):

- being searchable databases for stakeholders;
- serving as transparent evidence bases for practicioners and policy issuers;
- working as question raisers;
- being gap identifiers.



## 3.2
## The Motivation

The academic gamification research does not ignore game design elements causing negative effects. As mentioned before, Algashami (Algashami, 2019) cataloged various negative effects, which the author called "gamification risks." However, his research is not focused on gamification elements and neither on gamification applied to education but on risk factors' identification and management strategies in large-scale businesses using gamification in their workplaces. Besides, the proposed taxonomy requires further improvement.

Hyrynsalmi et al. (Hyrynsalmi, 2017) pointed a lack of secondary studies about the negative effects of gamification. They categorized adverse gamification implications into limiting and harmful issues: the first category discusses gamification limiting the full capabilities of an artifact, and the second concerns the harmful consequences of gamification. We also found examples of both in (Diefenbach, 2019)).

Trying to find more information about our topic, we searched for related secondary studies (e.g. systematic mapping or review studies), but noticed variations concerning our purpose. We found significant differences for at least one of the following: subject, data analysis, date range, or a lack of focus on the negative effects of game design elements in gamification.

(Majuri, 2018) present a review of 128 empirical research papers on gamification of education and learning and point out an excessive focus on

quantifiable performance metrics and positive aspects. However, their work is not focused on negative effects and only covers the literature until 2015. Also, Klock et al. (Klock, 2018) did also not focus on negative effects, besides having a data range that goes from 2013 to 2016. Alhammad and Moreno's secondary study (Alhammad, 2018) had its scope limited to gamification in software engineering education.

Finally, the secondary study by Toda et al. (Toda, 2018) is the work closest to ours, as they also focus on negative effects. However, as we noticed a significant amount of work in recent years, and their study reports on only 17 papers within the date range from 2012 to the first half of 2016, we identified the need for an update (Mendes, 2020).

Nevertheless, we decided to run a new and more complete mapping study to address our specific purpose more precisely, e.g., focusing directly on game design elements and identifying the type of empirical studies that revealed the negative effects.

## 3.3 The Planning

A systematic mapping demands a thorough planning, since as a secondary study which draws from an unknown (until they are properly found and filtered) number of primary studies to answer the mapping's questions, many things can go wrong: missing important articles from the literature about the subject, not having well defined inclusion and exclusion parameters, problems with the programs used to organize the mapping, and so on. To avoid such problems, we use the methodology from (Kitchenham, 2007) regarding systematic mapping, with improvements from (Peixoto, 2017) and a hybrid search strategy (Mourao, 2020), combining database search with one iteration of backward and forward snowballing.

### 3.3.1 The Research Questions

Our goal was to organize evidence regarding negative effects of game design elements in the context of gamified education/learning systems. Therefore, we derived the following research questions:

RQ1 - *What game design elements cause which negative effects in the field of digital education/learning?*

RQ2 – *In what fields of digital education/learning were the negative effects of game design elements found?*

RQ3 – *Which types of empirical studies were conducted to assess the negative effects?*

To properly answer RQ1, we divided it into three more focused questions, organizing information on the game design elements causing negative effects (RQ1.A) and also on which negative effects affect which kind of user (RQ1.B and RQ1.C):

RQ1.A – *What game design elements caused negative effects in the field of digital education/learning?*

RQ1.B - *What negative effects of game design elements were found affecting those using the digital system or being in the role of a student?*

RQ1.C – *What negative effects of game design elements were found affecting those keeping the digital system or being in the role of a teacher?*

Finally, we answered RQ1 by mapping the GDEs against their reported negative effects, once we had the information of RQ1.A, B and C.

### 3.3.2 Search Strategy



We decided to use a hybrid search strategy, combining a database search with forward and backward snowballing (Mourao, 2020). Hybrid strategies were found to be capable of achieving an appropriate balance of precision and recall when looking for primary studies (Mourao, 2020).

To design the search string for the database search on Scopus, we used the PICO (*Population, Intervention, Comparison, Outcome*) criteria (Roever, 2018) as follows:

- *Population*: gamification in the context of education/learning.
- *Intervention*: game design elements
- *Comparison*: none.
- *Outcomes*: negative effects.

After that, we extracted the terms from the PICO criteria (gamification, education/learning, negative effects) and added synonyms and related terms. We decided to not include the intervention in the terms, as our database search was conducted based on title, keywords and abstract, where details on game design elements could have been omitted.

Once the terms were defined, we added the following synonyms and related terms:

- Gamification: *gamify, gamified, gamifying.*

– Education/learning: *information, teaching, curriculum, pedagogy, didatics, training, instruction.*

– Negative: *damaging, prejudicious, detrimental, prejudicial, counterproductive, inappropriate, harmful, perilous, limiting.*

Finally, we applied logic AND and OR operators to connect the terms and their synonyms, resulting in the following search string:

*(gamification OR gamify OR gamified OR gamifying) AND (education OR learning OR information OR teaching OR curriculum OR pedagogy OR didatics OR training OR instruction) AND (negative OR damaging OR prejudicious OR detrimental OR prejudicial OR counterproductive OR inappropriate OR harmful OR perilous OR limiting)*

As tool support for snowballing, we used Publish or Perish (Figure 3.1), a software program that allows retrieving academic citations using information from Scopus and Google Scholar (Harzing, 2016).

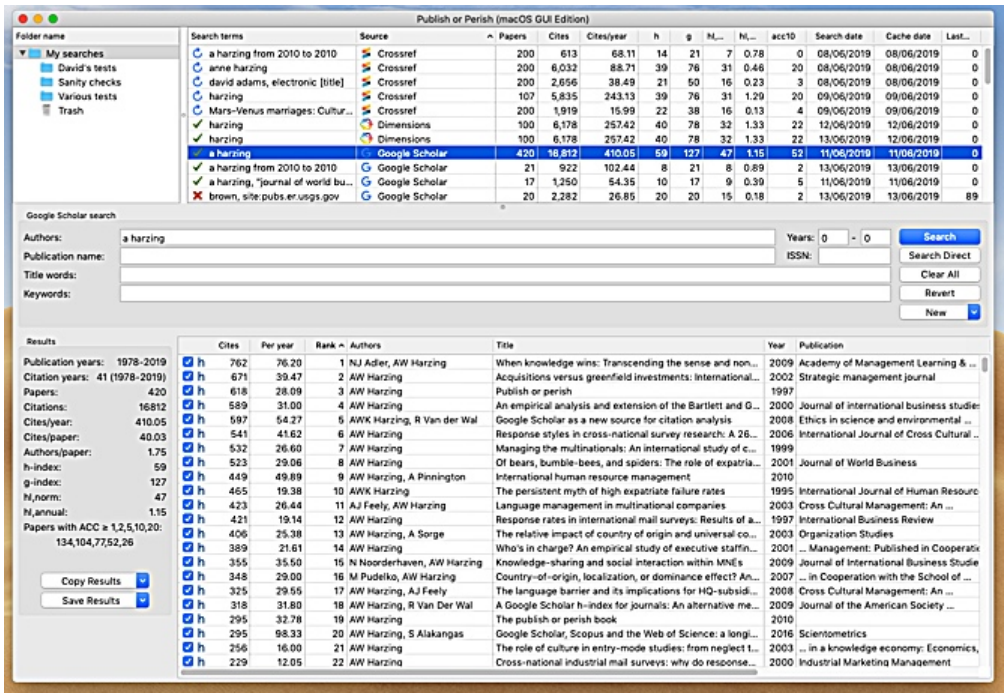


Figure 3.1: Publish or Perish. (Harzing, 2016b)

### 3.3.3 Inclusion and Exclusion Criteria

The inclusion and exclusion criteria can be found in Tables 3.1 and 3.2. The exclusion criteria also provide details on our three-phase filtering procedure.

To organize and filter the documents throughout the systematic mapping, we used Rayyan, which is a free web application to support systematic review authors. (Analytics, 2020) (Figure 3.2)

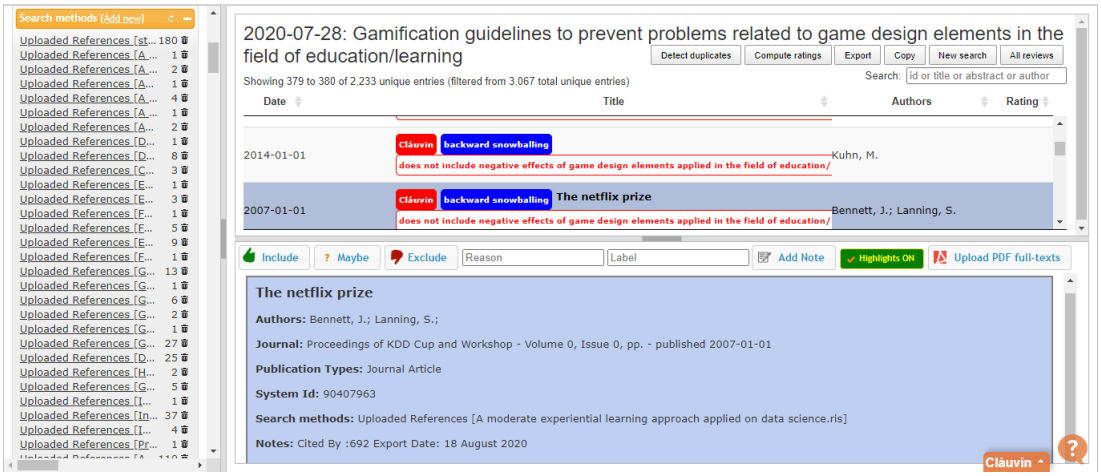


Figure 3.2: Rayyan. (Rayyan, 2020)

Table 3.1: Inclusion Criteria

| **Inclusion Criteria** | **Reasoning** |
|---|---|
| IC1 - Papers which include negative effects of GDE[1] applied in the field of education/learning in the context of gamification | *Research subject* |
| IC2 - Papers which passed through peer review | *To ensure a minimum level of quality* |
| IC3 - Papers in English | *Quality verifiable by other researchers* |

[1]Game design elements.

Table 3.2: Exclusion Criteria of the Three Filter Phases.

| **Exclusion Criteria** | **Filter Phase** | **Reasoning** |
|---|---|---|
| EC0 – Papers not in English | First Filter Phase | *Quality not verifiable by other researchers* |
| EC1 - Paper which were not about effects of GDE applied in the field of education/learning | First Filter Phase | *Not about the research subject* |
| EC2 - Duplicated papers | First Filter Phase | *Duplicated* |
| EC3 - Papers that did not report negative effects | Second Filter Phase | *Not about our research subject* |
| EC4 - The paper has a more up to date version (e.g., journal extension) | Second Filter Phase | *Between two peer-reviewed versions reporting the same results, the most recent is to be used* |
| EC5 - The paper is grey literature | Second Filter Phase | *Typically not peer reviewed* |
| EC6 - The paper represents a secondary or tertiary study | Third Filter Phase | *Our study is a secondary study* |
| EC7 - The paper is mainly about the non-digital use of GDE | Third Filter Phase | *Focus of this paper is on digital artifacts* |
| EC8 - The paper is a short paper (less than 4 pages) | Third Filter Phase | *Typically does not represent complete research results* |
| EC9 - The paper was inaccessible to the authors | Third Filter Phase | *No means to access the paper* |
| EC10 - Books and chapters are off | Third Filter Phase | *Problems with verifying the quality* |

## 3.4 Applying the Search Strategy

The search string was applied on Scopus on July 28th, 2020, searching within the title, abstract, and keywords. It returned 180 documents, based on title, abstract, and keywords, which were filtered as described in Table 3.3. After this initial filtering a set of 64 papers remained.

Finally, we used Google Sheets (https://workspace.google.com/intl/pt-BR/products/sheets) to organize the extracted data (Sheets, 2021).

Table 3.3: Filtering after Scopus database search based on title, abstract, and keywords.

| **Scopus database search** | *180* |
|---|---|
| **Removed because of** | **Amount** |
| EC0 | *3* |
| EC1 | *88* |
| EC3 | *6* |
| EC5 | *5* |
| EC6 | *9* |
| EC7 | *1* |
| EC8 | *1* |
| EC10 | *3* |
| Remnants of the Initial Search Phase and the Filter Phases | 64 |



### 3.4.1 Applying Filters

After the initial filtering, we conducted backward and forward snowballing on the 64 included articles, both on August 18th, 2020. The forward and backward snowballing using Scopus citation information were merged with the seed set, resulting in a total of 2338 unique entries.

Additionally, as Mourão et al. (Mourao, 2020) suggest using Google Scholar for forward snowballing, besides doing it using Scopus citation information, we also conducted forward snowballing using citation information from Google Scholar (on September 4th, 2020). The forward snowballing through Google Scholar found 738 additional entries. Hence, we ended up with 3076 unique entries (including the seed set of 64 entries).

We applied our inclusion and exclusion criteria to the title, abstract, and keywords of the remaining 3012 papers, as shown in Table 3.4.

Table 3.4: Filtering of 3076 unique entries retrieved from snowballing

| **Removed because of** | **Amount** |
|---|---|
| EC0 | *113* |
| EC1 | *2192* |
| EC2 | *83* |
| EC3 | *28* |
| EC4 | *1* |
| EC5 | *27* |
| EC6 | *177* |
| EC7 | *1* |
| EC8 | *6* |
| EC9 | *20* |
| EC10 | *288* |
| **Articles to read (including the seed set of 64 articles)** | 140 |

After the title, abstract, and keyword filtering, we conducted full-text-based filtering for the remaining 140 papers. The result of this full-text-based filtering is shown in Table 3.5, resulting in a set of 68 included papers. Out of those, 32 were found by the initial Scopus search, 18 by forward snowballing, 15 by backward snowballing, and 3 were retrieved by both forward and backward snowballing. These numbers also help to illustrate how snowballing can be complementary to database searches.

Table 3.5: Full-text-based filtering of 140 papers

| **Articles to read** | 140 |
|---|---|
| **Removed because of** | **Amount** |
| No access (even after requesting authors) | *6* |
| EC1 | *45* |
| EC3 | *13* |
| EC6 | *5* |
| EC6 | *1* |
| EC8 | *1* |
| EC10 | *2* |
| **Articles included** | 68 |

It is noteworthy that we conducted the full-text-based assessment only after snowballing on purpose, as we thought that applying snowballing on some

additional closely related papers would not be detrimental. Nevertheless, this decision surely increased our snowballing effort.

Finally, to complement our search strategy, we compared our set of included papers against the 17 papers included by (Toda, 2018).

While our set of 68 papers to be included comprised 29 papers ranging from 2012 to 2016, only seven of them were also included by (Toda, 2018). I.e., their search strategy did not retrieve 22 papers reporting negative effects of gamification in education/learning systems that were retrieved by our search strategy. On the other hand, our search strategy missed nine papers included in their mapping (the remaining one was retrieved but eliminated from our mapping for not being related to "digital" GDEs – EC7). As a result of this comparison, to present a mapping including all papers that we were aware of, we decided to manually include the papers found by Toda et al. that were missed by our search strategy, ending up with a final set of 77 included papers.

The differences could be explained by using a different and independently elaborated search strategy. It is also noteworthy that we applied only one iteration of forward and backward snowballing. We are confident that most of the missed papers would also have been retrieved by subsequent snowballing iterations. For instance, we verified that five out of the nine missed ones would have been retrieved as part of the second iteration (i.e., they cited or were cited by papers retrieved through our first snowballing iteration).

Nevertheless, considering the effort (3192 papers were analyzed as part of our search strategy) and added value (we extend the previously mapped evidence from 17 to 77 papers), we decided to make these results available to the community, as they already allow providing an unbiased and meaningful overview on the adverse effects of game design elements in gamified education systems.



## 3.5 Data Extraction

We extracted data from the 77 included papers focusing on answering our research questions. We used Google Sheets to organize the extracted data. The spreadsheet with all the extracted data is available in an online Zenodo open science repository (`www.doi.org/10.5281/zenodo.4702399`).

We answered RQ1 by extracting data for RQ1.A, RQ1.B, and RQ1.C and connecting the game design elements with their respective negative effects.

For RQ1.A, we extracted the game design elements that were related to negative effects. For RQ1.B, and C, we respectively extracted the negative effects caused to main users (in this case, students) and those keeping the

system working or in the position of teachers. We followed the open coding guidelines proposed in (Saldana, 2021) to assign the text of the papers to design elements and negative effects. During this process, different terms perceived as related to the same element or effect were associated with a single code. In case of doubt concerning coding, discussions were held among the three involved researchers.

To answer RQ2, we extracted the fields of education/learning where the gamified systems were used (e.g., computer science, medicine). Finally, to answer RQ3 we extracted the types of empirical studies conducted within each paper reporting the negative effects.

## 3.6 Results

Figure 3.3 shows the distribution of the 77 included papers throughout the publication years (search strategy applied during the second semester of 2020). Results for each of our research questions based on the extracted data follow.



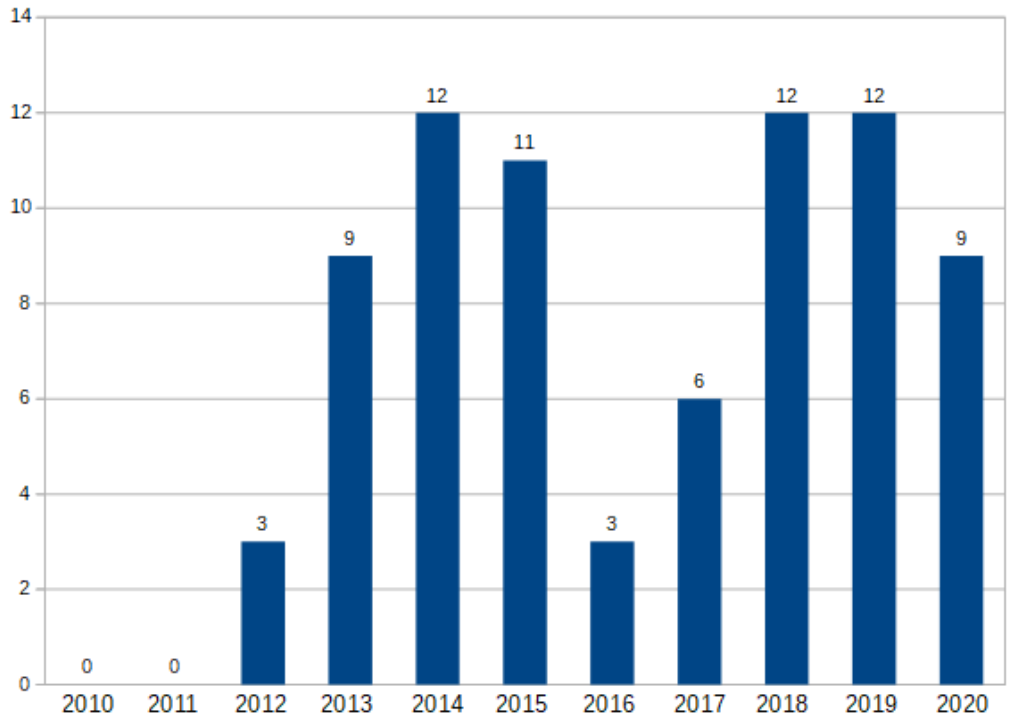


Figure 3.3: Publication years of the included papers

### 3.6.1 RQ1 - What game design elements cause which negative effects in the field of digital education/learning?

Overall, the papers reported 88 different GDEs, 64 different negative effects caused to the user, and 10 different negative effects caused to the person maintaining the system or in the role of a teacher. Considering this huge amount of GDEs and effects, we decided to conservatively ground the answer to this question on observations reported by more than one paper, strengthening our confidence in the results. The complete extracted data, allowing different kinds of analyses, can be found in our open science repository.

We must mention about RQ1 and the derived questions (RQ1.A, .B and .C) that, as we extracted data from the articles to answer it, we found that most of the articles found weren't analyzing one GDE alone, but a group of them. This meant that we couldn't define a direct relation between one GDE by itself and a negative effect caused by it, preferring to show the relation between both by how many times we found each pair in the articles. For a detailed table informing which GDEs were used grouped or not that resulted in which negative effects, check our database at Zenodo. (https://zenodo.org/record/4702399).

#### 3.6.1.1 RQ1.A – What game design elements caused negative effects in the field of digital education/learning?

Table 3.6 lists the GDEs mentioned the number of papers that referred to each of them as causing negative effects, by themselves or combined with other effects.

The list of papers referring to each element can be identified in the online repository. It is possible to observe that most of the reported negative effects were associated with the use of badges, leaderboards, competitions, and points. This makes sense given that these are GDEs commonly used in gamification, which may be related to creating competitive environments.

It is also noteworthy that there were fifty nine other GDEs, which had only one paper each indicating negative effects. Further analysis is required to answer whether this can be explained by the lack of negative effects caused by these elements or the lack of investigations involving them.

Table 3.6: RQ1.A - Game design elements and the amount of times they were reported being involved in negative effects.

| **Game design elements** | **Amount** |
|---|---|
| Badges | *27* |
| Competitions | *22* |
| Leaderboards | *21* |
| Points | *17* |
| Challenges | *11* |
| Achievements | *10* |
| Quizzes | *10* |
| XP | *10* |
| Levels | *9* |
| Feedback | *6* |
| Scoreboards | *6* |
| Reward | *5* |
| Goals | *4* |
| Avatars | *3* |
| Immediate feedback | *3* |
| Teams | *3* |
| Virtual Currency | *3* |
| Collaboration | *2* |
| Enjoyment | *2* |
| Luck | *2* |
| Progression | *2* |
| Quests | *2* |
| Rankings | *2* |
| Rewards | *2* |
| Score | *2* |
| Simulations | *2* |
| Skill trees | *2* |
| Tutorials | *2* |
| Virtual goods | *2* |
| Others | *59* |

#### 3.6.1.2
#### RQ1.B - What negative effects of game design elements were found affecting the users in the field of digital education/learning?

Table 3.7 shows the negative effects caused to the user mentioned by at least two papers and the number of times that papers referenced those negative effects.

It is possible to observe that the most cited negative effects concern the lack of effect, lack of understanding, irrelevance, motivational issues, and worsened performance. The ethical issue of cheating was another recurrent effect, usually motivated by creating competitive reward environments and/or systems with failures that enable users to easily score by cheating. Again, forty-four other negative effects caused to the user were mentioned only once.

Table 3.7: RQ1.B - Negative effects caused to the user.

| **Negative effects caused to the user** | **Amount** |
|---|---|
| Lack of effect | *16* |
| Lack of understanding | *9* |
| Irrelevance | *8* |
| Lack of motivation | *8* |
| Demotivation | *6* |
| Loss of performance | *6* |
| Cheating | *5* |
| Gaming the system | *5* |
| Reduction of intrinsic motivation | *5* |
| Alienation or confusion for non-gamers | *3* |
| Anxiety | *3* |
| Dislike of gamification | *3* |
| Lack of improvement | *3* |
| Time constraints | *3* |
| Dislike of competition | *2* |
| Discouragement | *2* |
| Lack of flow | *2* |
| Lack of granularity on grading | *2* |
| Sabotaged cooperation | *2* |
| Unintentional sabotage of weaker students | *2* |
| Novelty effect[2] | *2* |
| Perception of high workload[3] | *2* |
| Others | *51* |

Hence, the most common negative effect was that using the gamified system resulted in no difference when compared to not using the gamified system.

Someone can argue that the negative effects characterized as being the "lack of" something aren't really negative, given that nothing bad effectively happened, the gamified system just didn't work.

[2]Also a negative effect, in the sense that if the source of positive effects of a gamified system it's just it, then they are temporary: as soon as the interest of the user in the new thing (in this case, the system) goes away, the positive effects won't apply anymore.

[3]The workload wasn't high but perceiving it as high stressed the users.

However, for each of such neutral results to happen, gamification elements were designed and implemented, requiring human effort, time, and money. As we mentioned on the introduction, gamification can help education where it needs to improve the most. It not working leaves learners without the improvement they, their communities, their countries and the world need.

It can also be argued that just because a literary study didn't found an effect, it doesn't mean that does not exist. We accept this argument, but prefer to err from excess than from fault removing that effect.

Another one that requires explanation is the "Novelty effect", which is a negative effect, in the sense that potential positive effects may be temporary. I.e., as soon as the user's interest goes away, the positive effects won't apply anymore, and if they weren't present using the system for enough time, the system may not be enough in terms of cost/benefit.

#### 3.6.1.3
#### RQ1.C – What negative effects were caused to those keeping the digital system or being in the position of a teacher, in the field of education/learning?

Table 3.8 shows the negative effects caused to those keeping the system or being in the position of a teacher that were mentioned more than once and the number of times those negative effects were mentioned within the analyzed papers. It is possible to observe that the most common negative effects concern technical challenges and extra required effort or resources.

Technical challenges are a part of software engineering in general and may also appear in gamified systems. Extra human effort and resources needed typically appear as a negative effect when the gamified systems imply having to create additional content and taking care of additional tasks on top of the everyday tasks related to education.

Finally, engineering problems typically appeared when learning management systems did not cover what the designers wanted them to do, leading to implementation workarounds and potentially lower quality.

Table 3.8: RQ1.C – Negative effects caused to the teacher/person keeping the system

| **Negative effects caused to the teacher/person keeping the system** | **Amount** |
|---|---|
| general technical challenges (bugs, difficulties with the software/hardware) | *7* |
| extra general human effort needed (e.g., money, time, people, effort) | *5* |
| engineering problems with the LMS (Learning Management System) used | *2* |
| Others | *7* |

To complete the answer to RQ1, we mapped the GDEs against the related negative effects. The bubble plot in Figure 3.4 shows the GDE and negative effect combinations that appeared more than once in our systematic mapping. This mapping can help to raise the awareness of gamification designers on potential undesired negative effects of GDEs on education/learning systems.

The most common mentioned combinations can be seen in the bubble plot shown in Figure. This figure subsidizes the argumentation for the guidelines. In the table 3.9, we also show which references mentioned the combinations and the whole dataset.

It is noteworthy that the primary studies included in our mapping vary in context and empirical strategy. Digging deeper into the strength of the empirical evidence and the specific contexts in which the negative effects of the GDEs were observed would require analyzing the primary studies beyond the typical scope of mapping studies.

Figure 3.4: RQ1 – What game design elements cause which negative effects in the field of education/learning? Most common correlations of individual elements (being alone or mixed with other elements)

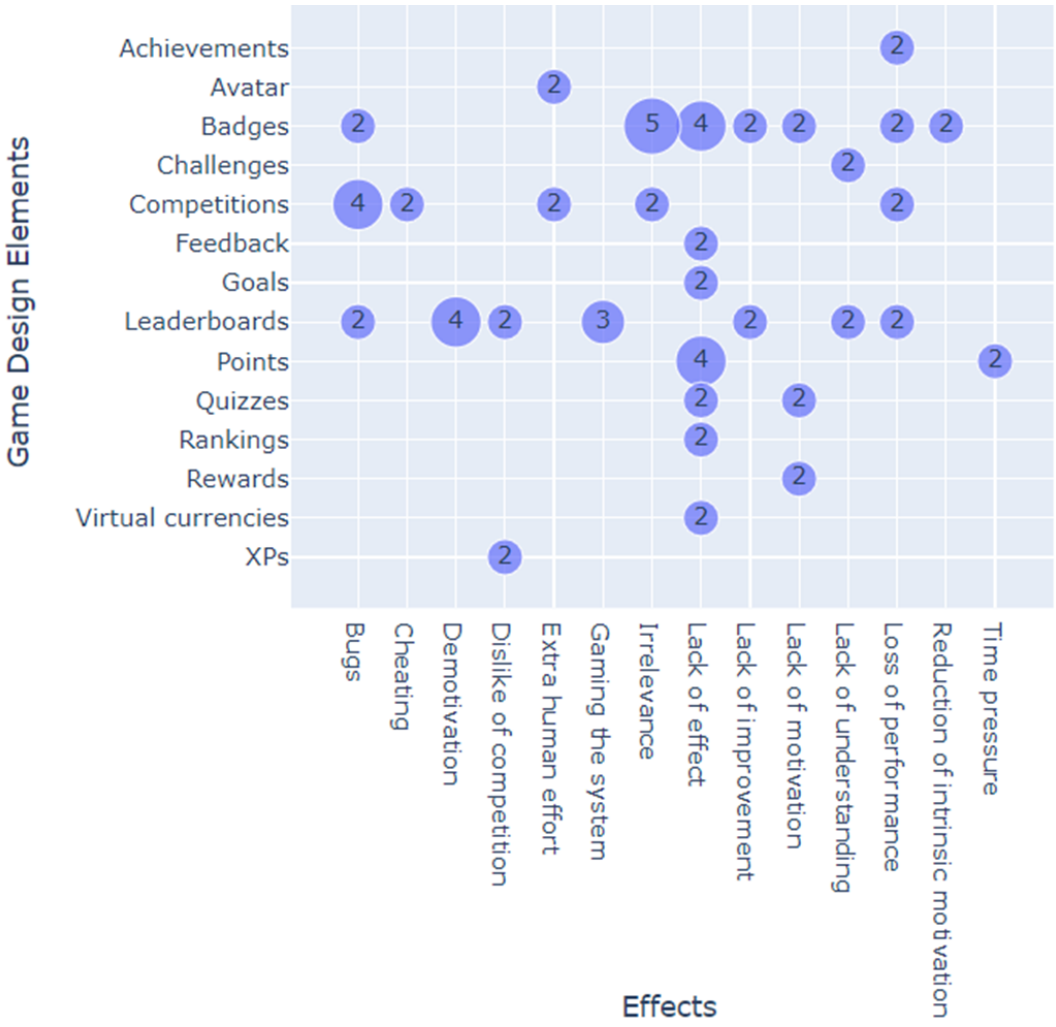

Table 3.9: References of the bubble plot

| **Game Design Elements** | **Negative Effect** | **Articles** |
|---|---|---|
| Achievements | Loss of Performance | (de-Marcos, 2014) (Dominguez, 2013) |
| Badges | Bugs Found | (Campos, 2015) (Haaranen, 2014) |
| Badges | Irrelevance | (Haaranen, 2014) (Hakulinen, 2013) (Pilkington, 2018) (Roy, 2019) (Ohn, 2019) |
| Badges | Lack of Effect | (Barata, 2013) (Morris, 2019) (OrtizRojas, 2017) (Pedro, 2015) |
| Badges | Lack of Improvement | (Barata, 2013b) (Ghaban, 2019) |
| Badges | Lack of Motivation | (DavisK, 2018) (Davis, 2015) |
| Badges | Loss of Performance | (de-Marcos, 2014) (Naik, 2012) |
| Badges | Reduction of Intrinsic Motivation | (FaceyShaw, 2020) (Hanus, 2015) |
| Challenges | Lack of Understanding | (Dominguez, 2013) (Roy, 2019) |
| Competitions | Cheating | (Dominguez, 2013) (Featherstone, 2018) |
| Competitions | Irrelevance | (Roy, 2019b) (Ohn, 2019) |
| Competitions | Loss of Performance | (de-Marcos, 2014) (Dominguez, 2013) |
| Competitions | Technical Problems/Bugs | (Babichenko, 2019) (Campos, 2015) (Martin, 2017) (Singer, 2012) |
| Goals | Lack of Effect | (Brom, 2018) (Morris, 2019) |
| Leaderboards | Bugs Found | (Campos, 2015) (Singer, 2012) |
| Leaderboards | Demotivation | (Dominguez, 2013) (Hanus, 2015) (Kocadere, 2015) (Nicholson, 2013) |
| Leaderboards | Discouragement | (Dominguez, 2013) (Pilkington, 2018) |
| Leaderboards | Dislike/resentment of Competition (1 of each) | (Barata, 2013) (DavisK, 2018) |
| Leaderboards | Gaming The System | (Barata, 2013b) (Prause, 2015) (Singer, 2012) |
| Leaderboards | Lack of Improvement | (Barata, 2013b) (Ghaban, 2019) |
| Leaderboards | Loss of Performance | (Dominguez, 2013) (Naik, 2012) |
| Leaderboards | Lack of Understanding | (Dominguez, 2013) (Singer, 2012) |
| Points | Lack of Effect | (Attalia, 2015) (Azevedo, 2018) (Brom, 2018) (Fitzwalter, 2017) |
| Points | Time Pressure | (Mahmud, 2020) (Pilkington, 2018) |
| Quizzes | Lack of Motivation | (Buckley, 2014) (Sillaots, 2014) |
| Quizzes | Lack of Effect | (Chau, 2019) (Marinho, 2019) |
| Rankings | Lack of Effect | (Oluwajana, 2019) (Papadopoulos, 2015) |
| Rewards | Lack of Motivation | (Buckley, 2014) (Kredo, 2009) |
| XP | Dislike/resentment of competition (one of each) | (Barata, 2013) (DavisK, 2018) |

### 3.6.2
### RQ2 – In what fields of digital education/learning were the negative effects of game design elements found?

The fields where negative effects of GDEs were reported more than once are shown in 3.10. Besides the listed ones, there were 25 other fields reported that were cited only once. It can be observed that the negative effects were reported in several different areas. Given the closeness between games, gamification, and digital technology, computer science being the most covered subject was expected.

Table 3.10: RQ2 - Fields of education/learning where negative effects of game design elements were found.

| **Fields** | **Amount** |
|---|---|
| Computer Science | *27* |
| Medicine | *6* |
| Business | *4* |
| Education (e.g. Pedagogy) | *3* |
| Mathematics | *3* |
| University courses | *3* |
| Game development | *3* |
| Communication | *2* |
| Multimedia content and production | *2* |
| Seventh grade (middle school) | *2* |
| Undefined[4] | *2* |
| University students | *2* |
| Others | *25* |



### 3.6.3
### RQ3 – Which types of empirical studies were conducted to assess the negative effects?

To answer this question, we used the Wohlin taxonomy (Wohlin, 2012), which divides research methods between case studies, surveys and post-mortem analyses. As can be seen in Table 3.11, most of the research was reported as concerning case studies or controlled experiments, complemented by surveys. The positive aspect is that all papers reported applying at least one empirical

[4]those three articles had information about gamified systems but not in which specific field of education/learning they were used.

strategy. This may be explained by our planned mapping outcome: to observe negative effects. It's not impossible, or even hard, to do an experiment or study and find those in our chosen field: what's needed is a protocol, a question, a system, people to test it and time. If we had chosen a theoretical field, finding similar experiments would be impossible.

Table 3.11: Empirical Studies Conducted To Assess The Negative Effects (Counting Multi-Types As Different Entries)

| **Types of empirical studies** | **Amount** |
|---|---|
| Case Study & Survey | *31* |
| Controlled Experiment & Survey | *28* |
| Controlled Experiment | *9* |
| Survey | *5* |
| Case Study | *4* |

Finally, we added on the appendix A tables for all the data retrieved from the articles mapped.

# 4
# Guidelines

After answering the research questions, we realized that some of the articles found managed to find negative effects through their research and knew (through previous study or applied methods that worked) about ways to deal with those effects.

Considering our knowledge about negative effects and why we should avoid them, we compiled the information on how to deal with these effects in the form of guidelines for those who design digital gamification systems for education/learning. When that compilation was not possible, we detailed the problem found with other references.

## 4.1
## Definition Of Guidelines

Guidelines are principles put forward to set standards or determine a course of action (TheFreeDictionary, 2014b). They are composed of generally statements of expected practice and benchmarks or standards (Kredo, 2016), and are made for a range of purposes: to improve cost-effectiveness, general effectiveness and quality; to serve as educational tools (Kish, 2001) and to prevent mistakes and adverse effects. (Kredo, 2016)

## 4.2
## Guideline Justification

We searched for guidelines regarding negative effects of game design elements on gamification focused on education/learning, and we found very little about the subject.

Peixoto and Silva's review (Peixoto, 2017) built a gamification requirements catalog - connecting game design elements to Bartle's Personality Types - but it was a positive catalog - it did not have mention to negative effects on it.

Algashami (Algashami, 2019) catalogued various negative effects which the author called "gamification risks". However his research is not focused on gamification elements, and neither on gamification applied to education but on risk factors' identification and management strategies in large-scale businesses, using gamification in their workplaces. Besides, the proposed taxonomy requires further improvement.

We also found one paper about guidelines for badges in gamification for education (Hickey, 2017). Unfortunately, their work only focused on badges and not any other game design element.

In software engineering, usually, there is a gap of 15 to 20 years between research and a practice's widespread popularization. (Heuer, 2014) This fact means that all the research about negative effects that we found would become gradually popularized between 2027 and 2040, and until that happens (if it happens...), the risks and effects uncovered would still occur, and the quality of gamified systems would still face risks. Given the importance of education to humans and their societies, plus the lack of material available, we decided to help the popularization process, creating these guidelines.

## 4.3 Guideline Protocols

Here we specify the protocols used to create the guidelines. Doing it encourages transparency, prevents research waste, and provides critical protocol review through established publication or registration processes. (Johnston, 2016) The works by (Heuer, 2014) and (Kish, 2001) are the basis of our protocols.

## 4.4 Choosing Our Guideline Topics

Guideline topics should be chosen focusing on the impact that they will have. We chose "negative effects of game design elements applied to digital gamification systems for education/learning", because:

- As shown by our systematic mapping, this topic is still an important research issue with a lot to be uncovered yet, including adverse effects and elements mentioned only once through the mapped articles;
- Negative effects in education have long term detrimental impacts for the individual, as poor initial education and lack of opportunities to improvement generate a vicious cycle where both feed each other (Unesco, 2020);
- Knowing about negative effects and how to mitigate them will, in the worst-case scenario, improve the awareness of the effects and motivate future work in the field; and, in the best-case scenario, the knowledge in our guidelines will mitigate risk, improve quality and as a result, help people's education.

There's also the need of enough evidence being available. While most of the research uncovered is still in its starting stages, there are effects and elements that have enough information to justify the creation of guidelines.

Finally, the scope of the topic should be narrow enough to be thoroughly explored with the time and resources available. While the pandemic and other issues were a challenge in the development of this work as a whole, we believe that we managed to do a proper exploration of the field using the systematic mapping.

## 4.5 Choosing Participants

Participants of the guidelines' development process should form a range of experts broad enough to explore the topic. This serve the enhance the validity and credibility of the guidelines.

In a certain point of the development process, we realized that too much focus was given to the academic side of the chosen topic (since all participants were academics) and not enough towards the professionals who work with it. We plan to solve this in our future works.

## 4.6 Choosing Our Audience

It's important to define who will use the guidelines created, as different audiences result in a different focus for the guidelines. In software engineering three groups are identified as the audience. Given the narrow scope of our work, we tweaked the groups towards definitions more useful to us:

- Decision makers, who decide whether the proposed technology should be introduced in a company/school/community or not. Thus, relevant information for decision makers includes, e.g., benefits, risks, challenges, required effort, etc.
- Managers, responsible for preparing the terrain for the use of a novel technology after a positive decision has been made by the decision makers. Relevant information for the coordinators includes, e.g., the required technical infrastructure, organizational context, etc.
- Designers are those employees who have to apply a new technology in the company/school/etc. Relevant information includes, e.g., required input artifacts, steps to be conducted, etc.

Our audience is composed of mainly managers and designers: our topic is not about something that must be introduced in a company, but problems that are already in it and need to be dealt with.

That said, some negative effects found involve the scope of decision makers, as the decision of which technologies to choose when creating a gamified software, or how to make it integrate with the systems around it.

## 4.7 Protocols For Individual Guidelines

So far we wrote about guidelines as a whole. There are also protocols to consider for individual guidelines, that we list and comment about below.

### 4.7.1 Desired Outcome

It's important to consider the desired outcome from the guideline: what is expected to happen if the guideline is followed?

### 4.7.2 Size

Texts of extraordinary size will not encourage reading, and the guideline should not be a review or meta-analysis of the topic. Depending of size, it should begin with an executive summary that states concisely the major recommendations. Then, as revisions and updates are made, the guidelines can become proven standards of the field.

### 4.7.3 Evidence Review

The method used to collect and identify the scientific evidence should be specified. If scientifically rigorous material is not available, expert opinion can be used as long as is attributed and indicated.

### 4.7.4 Performance and Outcome Measures

Each guideline should suggest at least 1 or 2 performance measures to help guideline users measure the extent of implementation and the effect of implementation of the guideline within their practice or organization. The measures can be process or outcome indicators, or both.

### 4.7.5
### Areas For Future Research

Each guideline should comment on what's missing from existing evidence and suggest future areas for research.

### 4.7.6
### Deadline for Update

As research and industry move forward, new knowledge comes that can make a guideline obsolete. This protocol deals with that, specifying when and how often the guideline should be reviewed for changes. The average time suggested by (Kish, 2001) is of two years and we will push it further or sooner depending of our evaluation.

## 4.8
## Warning Toward Future Users Of These Guidelines

The guidelines presented are the result of research regarding negative effects of game design elements applied on gamification systems geared toward education/learning, focusing on the academic discoveries made. As we point at least once through our protocols, the guidelines don't cover all the possible solutions to the problems presented, just ones that we found with our best effort.

This means that there may be other solutions that we didn't found out and can be as or more useful than ours.

## 4.9
## The Guidelines

We propose seven guidelines, summarized in Table 4.1. This table makes explicit the target audiences from section 4.6.

Table 4.1: Guidelines, their subjects and target audiences

| **Title** | **Summarized Guideline, About...** | **Decision Makers** | **Managers** | **Designers** |
|---|---|---|---|---|
| Regarding System Implementation | Adjacent systems to the gamified system being made and how they can negatively influence it. | Y | N | N |
| About the Human Types | The need of understanding the users and ways to classify them. | N | Y | Y |
| Be Aware That Users Can Be Ignorant About Parts of Your System | The need to teach the users about how the system works. | N | Y | Y |
| Functionalization Makes Everyone Have Their Own Point Of View | The user's perspective changes how they see the system and the consequences of that. | Y | Y | Y |
| Destructive Consequences of GDE - Cheating | How cheating can sabotage your system. | Y | Y | Y |
| Destructive Consequences of GDE - Rivals | How destructive competition can sabotage your system. | Y | Y | Y |
| About Digital Badges | The myriad of ways that bad badge implementation can make a system fail. | Y | N | Y |

In this section, we present each guideline following the protocols discussed in section 4.7.

### 4.9.1 Regarding System Implementation

**Group For Who This Guideline Is Intended:** Decision Makers.

**Desired Outcome:** Systems with fewer problems caused by difficulties from the system as a whole or clashes with adjacent systems, be they technological or bureaucratic.

**Evidence Review:** information came from the systematical mapping that had exclusion criteria to cut articles that weren't about negative effects for game design elements – most of it from articles involving empirical research about the topic. Also, one source is an article referenced through backwards snowballing from the mapping.

**Executive Summary:**

- Don't ignore systems adjacent to your gamified system. Those include those that it will have to interact with in an organizational level (school management, laws and rules, previous structures in place) and in a technological sense (the codebase or Learning Management Systems used to build the gamified system). Doing it so will add extra obstacles to the development as a whole and reduce the system's quality.
- Stay in contact with stakeholders and test as soon as possible to find unforeseen problems in your design.
- If constant testing is not an option, have a plan, just in case your gamification system ends up being detrimental.
- These guidelines have a dataset in Zenodo with sets of game design elements and negative effects found that can help towards avoiding already known problems. The same can be done looking for published academic research.

The creation of a gamified system does not start just with its design, but with what and how it will interact with the other systems around it. Let's say that a gamified system uses badges instead of grades to measure how well its students know the content taught: how do you contest a badge not given? How do you allow a student to take an extra task to get a badge, if to get the badge it is necessary to do more tasks than the score of a recovery test would allow to?

And more important, as those and other questions are made, how the managers of the school will make – or accept - the changes that the gamified system tries to bring to the rest of the school itself? As (Bajko, 2016) points:

"A major challenge when designing gamification for education is the limits imposed by the structure and rules implemented by the program department. Sometimes what professors want to do and what they are allowed to do are mismatched, which can result in a restriction on innovation and academic freedom and/or a disregard for departmental/institutional norms, depending on the point of view."

The same applies to cases where instead of creating a new system, an option is to get a digital system and gamify it: the code of it will easily allow the changes you want to do? If not, how much extra work and time will be needed and do you have that time? Not considering these questions toward this other adjacent system that you will have to deal with – the chosen codebase to modify - can also reduce the quality of your gamified system as a whole, and a lower quality will harm the value and credibility of the system. That results in less stakeholder investment, which concludes with less general awareness and use of the system (Pitt, 2019).

Still on the topic of the administration, you may need to convince those who will interact with the system that it is useful for them – if they don't see the value of a gamification system, they will just not use it.

As examples found,

– (Bajko, 2015) and (Bajko, 2016) dealt with gamification in two courses using a mix of analog and digital, with the digital part being an adaptation of a Learning Management System (LMS) to deliver quests and accept the submission of completed quests, what resulted in challenges to delivery as the Blackboard LMS was not optimized for the gamification intended. Also, they tried to use experience points in one of the courses, instead of the usual percent per assignment measures employed, and to avoid a influx of student final grade challenges from those taking the course, ended up using two concurrent measures of student success, with XP being used but having no correlation with the percent per assignment measure.

– (Dominguez, 2013) also tried to use a Blackboard plugin and faced network overloading slowing down screenshot uploading (with that uploading being necessary thanks to a lack of automatic checking if a student made a task, that the developers weren't able to implement), that couldn't be fixed since Blackboard has proprietary code and a workaround wasn't found. The screenshot uploading was also seen as

a waste of time that was a part of many students not completing gamified exercises – in other words, the motivational effect of the gamified system was diminished by technical issues and limitations.

– In an apparent ignorance about the needs of the students, The National Manufacturing Institute created a Computer Integrated Manufacturing (CIM) badge for students who completed a standardized curriculum and attained a passing score on the end of a course assessment. The badge was ignored by the students as it was completely redundant with the grading structure of the course. (Hickey, 2017)

– To be able to implement digital gamified badges in a science center in the Northwest United States, the responsible for the gamification system had to spend a whole year in discussions with staff and administrators until they agreed to spend time and resources toward the system. (Hickey, 2017)

Given problems involving adjacent and adopted systems, the solutions found through the systematic mapping were testing the software as soon as possible and being in contact with the stakeholders. Having a test and improvement strategy to find and deal with areas needing polish is essential as, given that gamification is an area of research that is still maturing, much is not known, and this means that unforeseen problems may show up even after your best efforts.

That said, depending of your environment, testing can be hard to do: school years are very busy periods for all parts involved, even more if the ones spearheading the gamification initiative are the teachers themselves.

One of the best solutions that we found in that regard is brought from (Nicholson, 2013) – there, gamification was used in classroom for 6 weeks. After that the students could decide on group if it would be used for the remainder of the course, or if the gamification layer would be wiped and the course would start from a blank slate. Once it was clear that a leaderboard had accidentally sabotaged half of the students, a new gamified system was discussed with them and put in place, allowing those students to catch up with the rest. [1]

Also, our Zenodo dataset has the game design elements and combinations paired both with the negative effects found and the name of the source articles, which can help designers to have a head start in the problems that are more probable to be found, depending of the game design elements used.

[1]This type of testing has some parallels with game development, as Early Access (where users pay to buy a game that's unfinished to help its development, finding bugs and problems for the developers to solve) and games-as-a-service (where as long as the game is maintained as a service, bugs will be found and fixed).

**Performance and Outcome Measures:** Good measures for performance are grades, student and teacher satisfaction and qualitative feedback about the experience as a whole. Don't forget to talk with all the stakeholders to check their apprehensions regarding the gamified system – a good example of many issues found through this attitude can be found in (Davis, 2015).

**Areas For Future Research:** How is the process of adding digital gamification system in schools? How effective is the strategy of adapting digital systems vs. making systems from zero? Are there more failures of gamification on education because of a lack of understanding the stakeholders' desires and adjacent systems? How gamification deals with big data? Is there a similarity between failed gamification projects and game projects? Successes can be replicated? If they can't, why not?

**Deadline for Update:** The field covered with this guideline is important as it allows to avoid problems in development right in the most early parts of development, but the amount of data available for an update probably will take some time to grow as failures aren't studied as much as successes. So, we define a deadline of 30 months to update this guideline.



### 4.9.2 About The Human Types

**Group For Who This Guideline Is Intended:** Managers and Designers

**Desired Outcome:** A system that works better with its users.

**Evidence Review:** information came from the systematical mapping that had exclusion criteria to cut articles that weren't about negative effects for game design elements – most of it from articles involving empirical research about the topic.

**Executive Summary:**

- Know your users and their personalities, as those influence which game design elements will work well or not: there are human profile models as Marczewski's Player and User Types Hexad, Brain Hex, the Big Five Model and others that can help towards profiling them.
- Be careful with your user's data, as such profiling can be a target for ill-intentioned hackers.

Let's say that a friend makes an 100 dollars bet with you that you can't throw a dice and predict which number it will be on its upward face (humor me here, I want to make a point). You could try to guess with 1/6 chance of

success. You could also study the dice to see if it's irregular in some way, that would give you a bigger chance of guessing.

Or you could just "throw the dice" vertically, of a very small height. The dice wouldn't tumble, it would fall as you wish, and you would win the bet. Congratulations!

Now, let's say that the same friend makes another 100 dollars bet, but the objective is to predict what someone would ask if it had one genie's wish (no monkey paw here, the wish works as intended). A cold guess would be harder: maybe you have a bigger chance of guessing correctly if you said "money for life" or "world peace", but the possible wishes are very varied. You could also choose someone that you know, or try to know the person that would do the wish, to guess correctly.

Or you could just choose yourself and wish a thing. You won again!

Now, the same crazy friend makes an 100 thousand dollars bet that you would not be able to create a digital gamified system for education, that would help 100 students to learn better with it than without it. "How this is related to the other two questions?", you probably ask? (I'm not sure, I know I'm not always a good guesser)

Simple: if you are going to use digital gamification for education, there are three main possible scenarios.

- The system will be applied to an elementary/middle school. In this case, you have classes of students that you know nothing about.
- The system will be applied to a university course or a business. In this case, you may be able to guess with a bigger chance of success who the students are, but variance is a thing.
- The system is crafted toward a certain niche of people that you want to help towards learning something more specific. You are crafting a call toward a constructed ideal student, but contradicting my examples above, this does not mean only they will come.

The three cases are important because gamification is not a "one size fits all" solution. Many thought that adding points and leaderboards would result in a more engaging system, to realize that that works well... with competitive people. Or tried to give points for acts of charity, friendship and good faith... and found out that that seriously offended friends of the users when the users hung out with them for points. Or thought they done a good job with gamification... and found out later that the girls using the system were negatively affected by it.

Given that if you are creating a gamified system for education, the chances are high that you won't be able to choose the perfect users for it, it's important to consider the human drives and motivations, and pick game design elements and motivations that help all types of humans (or at the very least, those you expect to reach through your work), or else some will be left hanging.

For this, there are many human profile models – including for people who play games and use gamification systems - four of which we talk about below:

– Marczewski's Player and User Types Hexad (expansion of it on Figure 4.1) categorizes users in twelve types divided in three groups that a person may be part of one or more, in different levels: those from intrinsic motivations (Philantropists, Achievers, Socialisers and Free Spirits), extrinsic motivations (*Self-Seekers, Consumers, Networkers and Exploiters*) and those from a desire to disrupt the system as it is (*Griefers, Destroyers, Influencers and Improvers*); (Marczewski, 2015) (Tondello, 2019)

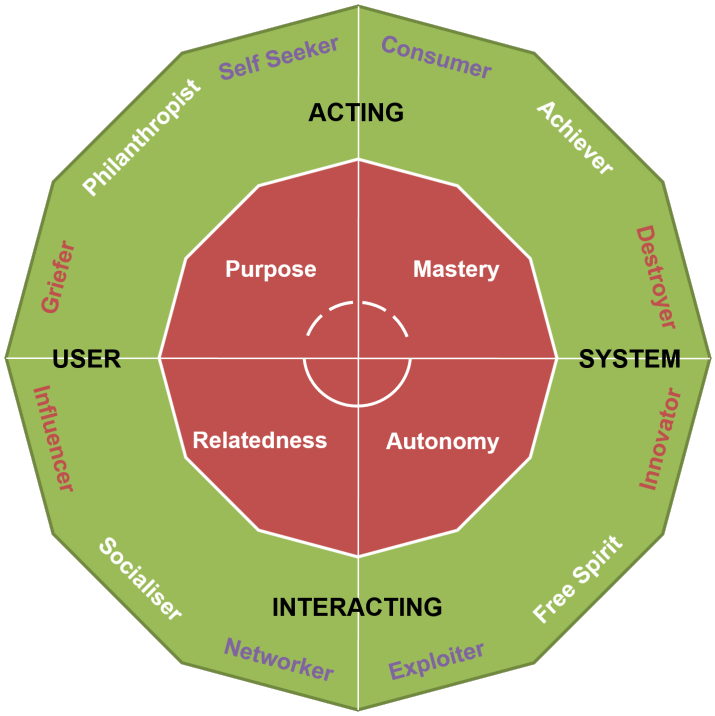


Figure 4.1: The Dodecad of User Types by Marczewski. (Marczewski, 2015)

– (Barata, 2017) measured the performance of students in gamified classes through three years and mainly grouped them in four groups: *Achievers, Late Awakeners, Disheartened and Underachievers.*

– (Odonovan, 2013) used the BrainHex player satisfaction model to determine gamer personality types from their students. It depicts game player

behaviour through seven classes (*Seeker, Survivor, Daredevil, Mastermind, Conqueror, Socialiser and Achiever*), seven exceptions (that are the opposite of the seven classes) and allow for subclasses (that are the union of two classes).

– (Ghaban, 2019) used the Big Five Model (Figure 4.2) to evaluate the learners' personalities. The model divides personalities in five traits: conscientiousness, extroversion, agreeableness, neuroticism and openness to experience.

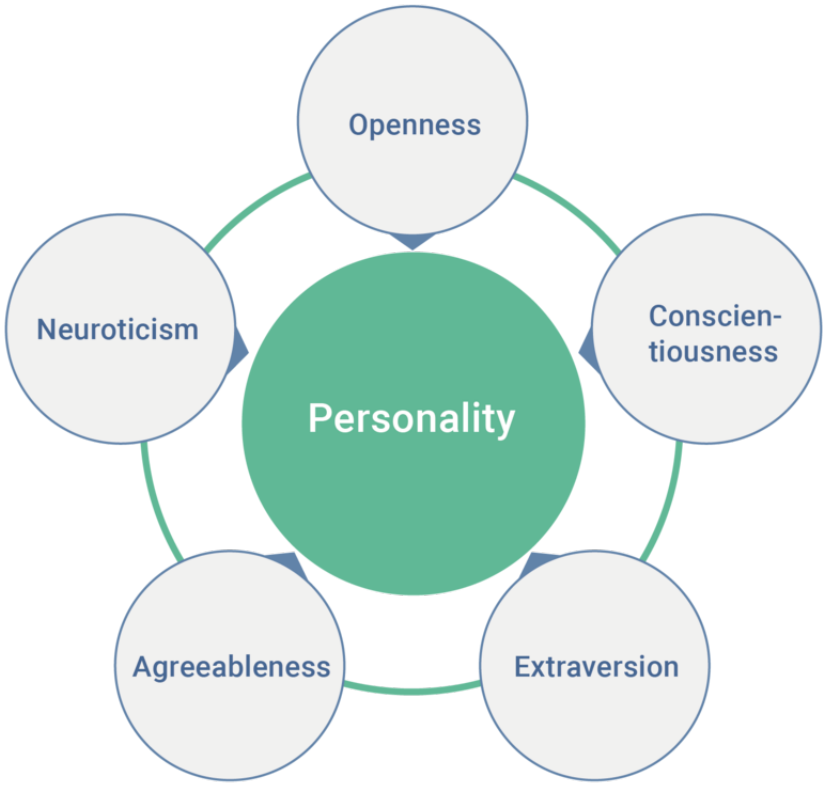


Figure 4.2: The Big Five Model. (Wikipedia, 2021b)

Marczewski's model can be used to measure students through's (Tondello, 2019) questionnaire, and the experience of (Barata, 2017) can be used to better detect groups of students that need help.

**Performance and Outcome Measures:** performance measures can be done with a before/after analysis of grades and activities done. Qualitative feedback can't be dismissed either, to catch what a quantitative data gathering may miss.

**Areas For Future Research:** How adequate user models are for users of gamified systems? How to properly do the profiling of an user and keep the profile safe from data leaks that can expose the gathered information for others?

Also, this section will be bigger than usual, because of a huge gap in research that needs to be addressed, the intersection between big data and gamification in education. It can be tempting to get data from the users of a gamified system for research and to help them improve, but the same data can be used for nefarious intentions, and if the data exists, it can be leaked.

Through our research, we found only one reference to any sort of comment even tangentially related to data security (in (Davis, 2015)) about one student wanting control of who could and could not see his academic achievements – and given the many threats that big data can bring, we will add the following questions below, in the context of gamification:

How to add "privacy by design" to gamified systems? How to avoid user profile and gathering of data to leak and reach malicious actors? How to protect information privacy and anonymity? How to use big data without the threat of a state of surveillance? How to protect the user's autonomy, avoiding the use of the data by others to make decisions in his behalf? How to avoid discrimination of users where the data gathered is used to reduce their opportunities of learning? And how to give to the users the ownership of their data?

**Deadline for Update:** 24 months.



### 4.9.3 Be Aware That Users Can Be Ignorant About Parts of Your System

**Group For Who This Guideline Is Intended:** Managers and Designers

**Desired Outcome:** A system that considers that its users will not be people who understand how it works at once, or at start.

**Evidence Review:** information came from the systematical mapping that had exclusion criteria to cut articles that weren't about the subject. Most of the information came from articles involving empirical research about the topic.

**Executive Summary:**

- Users can be ignorant about parts of your system, and that may lead to misconceptions that can harm users, and partial avoidance of use. Tutorials are a game design element that can be used to fix this, placing everyone in the same knowledge level.

Games have been with mankind as early as at least 3100 BC, accordingly to archeological evidence from Egypt (Solly, 2020) (Figure 4.3), and from that

point onwards, many ludic experiences came and went, and with them many game design elements were created and combined in novel ways. Now games are played by billions, thanks to digital innovations and the Internet...

Figure 4.3: Senet, Egyptian game from 3100 BC. (Solly, 2020)

...but this does NOT mean that the users of your gamified system will know how the elements used work, and even if they do, this ALSO does not mean that they will interact with all the elements added, thanks to apathy and lack of time, which is a problem if behind these elements is the only way to learn or engage or gain part of the grades/points needed to be approved.

This happened in (Nicholson, 2013) that had, instead of a common grade system based on means of grades achieved through tests, a point system where the more points you have, the better your grade are... but as it was structured, students were not eligible for a D until they had earned about 60% of the available points. Such points were spread out through the semester, so the students did not know how to measure their progress or how well they were going, until the realization that yes, they were going badly and at that moment many opportunities to improve their grade were already gone. The same happened with (Barata, 2013), with an experience points system.

Against this problem, we follow (Sepehr, 2015)'s suggestion, when faced with a similar problem regarding previous knowledge needed to use their system:

"[...] when designers plan to implement a gamification approach, it is necessary to define the pedagogical objectives of the system clearly and make sure the requirements can either be met by all the students, or provide proper training and education needed for completing the tasks. Otherwise, as our analyses show, students' perception of their prior knowledge in that context

would effect how they evaluate their skills in the activity, and they would perhaps have less positive learning experiences than their peers".

It's worth reminding that tutorials are a game design element that can help toward teaching users of the system about elements of it that are unknown for them, and the best tutorials are those that have the user act to make him practice the skills he will need in the future – in our case, how to deal with the GDE and understand it.

Finally, we do not recommend using questionnaires to measure the users' self-evaluation of their knowledge about a game design element or how a gamified system works thanks to the Dunning-Kruger effect – their ability to measure their own knowledge may be low, and that will leave their answers biased and wrong as a measure.

**Performance and Outcome Measures:** It's useful to ask about the users' previous experience with each GDE in your design, to try to predict which elements have to be better explained.

A performance measure of "mistakes made thanks to not knowing how things work" can be useful too in the long run.

**Areas For Future Research:** how Dunning-Kruger affects gamification use for gamers and non-gamers? How tutorials can be most effective when used as GDEs for education? Can tutorials be detrimental to the use of a gamified system for education? If yes, which alternatives can be used, how and why? How to properly determine game literacy from someone?

**Deadline for Update:** given that this guideline is about a very specific problem, when compared with the others so far, 12 months.



### 4.9.4 Functionalization Makes Everyone Have Their Own Point Of View

**Group For Who This Guideline Is Intended:** Decision Makers, Managers and Designers

**Desired Outcome:** a design that can create more positive interactions for the users.

**Evidence Review:** information came from the systematical mapping that had exclusion criteria to cut articles that weren't about the subject. Most of the information came from articles involving empirical research about the topic.

**Executive Summary:**

– Gamification users can have different interpretations of why a game design element exists in your system, and that changes if and how they

will interact with it, with possible negative effects.

– There isn't a perfect solution for this, but you can tweak your GDEs to make certain functionalizations easier to happen, per example, badges as collectibles and milestones being realized when the system provides a visual overview of unlocked and locked badges.

Intertwined with gamification is the debate about rewards being able to positively motivate people, or if they can have negative effects. While the debate around intrinsic and extrinsic motivation is important, we will touch something deeper.

So far, all our considerations about gamification were pointing towards flawed designs, made with a lack of information about the problems surrounding them that were ignored or the users' preferences and drives that weren't considered, and if that was solved, everything would work as intended.

Unfortunately, it seems that there is no silver bullet, at least in terms of badges: (Roy, 2019) found out that people's functionalization of those can ignore the intended objective of the design – in other words, you may add badges to have them act as something interesting for social-inclined people to show to their friends, and challenge-inclined people to have something to strive for, but the user functionalizes them as part of a pavlovian[2] strategy to make people come back to the system, and understanding them as being that, becomes less motivated to use the system as a whole.

While we do not know a way to solve the functionalization problem (and even if we had, there are ethical questions about if it should be), there are ways to mitigate it: while a design can't force everyone to see something as you want them to, you can tweak it to improve the chances of it been seen in the intended positive light through design details: (Roy, 2019) points to badges as rewards requiring a sweet spot of required effort and need to be perceived as having some meaningful value; badges as contingent rewards being fostered by a balanced challenge relative to user skill; badges as collectables and milestones were realized when the platform provided a visual overview of unlocked and locked badges; badges as impression management or competition require that other people can see one's badges (and vice versa).

This design lens can also be extended toward points, being more specific, experience points: (Gehringer, 2013) used them instead of the usual grading system in schools, but it failed as a measure of learning as the feedback it should bring was not automatic, with students taking more than three months

[2]From pavlovian conditioning, also called classic conditioning, where a previously neutral stimulus comes to evoke a specific response by being repeatedly paired with another stimulus that evokes the response. (TheFreeDictionary, 2010)

to be able to know their own standing in class[3] , which made some students see it as useless (with good reason).

**Performance and Outcome Measures:** any measure of functionalization can be gathered asking to the users how they see the GDEs in the design itself.

**Areas For Future Research:** Functionalization holds regarding other game design elements? How can other GDEs be tweaked towards positive interactions? What else interferes in people's functionalization (knowledge, culture, personality)?

**Deadline for Update:** given the amount of GDEs that exist, more time than the norm should be given to proper testing and analysis. For this reason, 36 months.

### 4.9.5 Destructive Consequences of GDE - Cheating

**Group For Who This Guideline Is Intended:** Decision Makers, Managers and Designers.

**Desired Outcome:** Gamified systems that won't have destructive consequences when used.

**Evidence Review:** information came from the systematical mapping that had exclusion criteria to cut articles that weren't about the subject – most of it from articles involving empirical research about the topic.

**Executive Summary:**

- Cheating reduces the trust in the system, and if left without consequences, sabotages learning as it can lead to negative behavior involving seeing the non-cheating way as useless.
- Avoid creating rewards and incentives to cheat (as physical rewards), and be ready to fix design flaws that do that when they appear.
- Have clear rules and fair arbiters for fuzzy cheat cases (when if cheating really happened and how to deal with it is harder than a yes/no decision) and be ready that human arbiters will have to allocate extra time and energy to do the function well.

We will now deal with negative effects that can severely reduce learning and even destroy the possibility of achieving it in a satisfactory level. And the two grand culprits found are cheating and competition.

Regarding games, the problem with cheating is that games have a magic circle, an imaginary space usually maintained by the agreement regarding rules

[3]Assuming that classes started in August, as the feedback only appeared in November.

kept by all – there isn't anything in the laws of physics that say that someone can't use their hands to catch a ball in the middle of a field and throw it in a goal, but try to do that in a football game and you can expect the other players to be angry with you, your goal to be invalidated and a penalty applied (unless you have a Hand of God...[4]).

Games involve bounds and constrains to keep the experience interesting (be those held by common accord by those who play, or through digital rules enforced through coding) (Liebe, 2008) so when cheating happens, usually the magic is broken. And that gets worse in gamification because while games are spaces of play, where – unless you are a professional – you play because you want to, not because you must. But gamification is about applying game design elements in non-gaming spaces, which means that the stakes for those involved are higher – and obligations exist.

Education is about teaching something for someone else, and grading is a way to give feedback and measure the amount learned by someone. So, if someone can cheat to get a bigger grade, without having learned anything...

- The teacher is unaware of the discrepancy between what the grade says and the student knows, having bad data to work with;
- The student haven't learned what he should, and that creates a gap that will cause problems somewhere in the future to learn knowledge that depends of what shouldn't be a gap;

Users can cheat for fun, to destroy the system being used or to get an unfair advantage (we will touch the latter one later). Their cheating can also spread damage beyond themselves – back to the game analogy, if someone does a goal in football with his hands and that action is not punished somehow, then others may start to use their hands too, and then the game is not football anymore and those following the rules are basically playing with a handicap, and the motivation to play correctly gets sabotaged and any reasons for the game to exist beyond fun have a good chance of being mutated.

Back to gamification in education, this means that other students may simply start cheating if someone is and that person is not caught, and that sabotages their learning. Because of this, cheating should not be incentivized – as:

- Physical rewards if an user stays on top of a leaderboard were an incentive for students to cooperate sharing answers to puzzles and quizzes in

[4]Name given to Maradona's use of his hand to make a goal without the arbiters realizing that the hand was used, in the middle of the 1986 FIFA World Cup.

(Odonovan, 2013), or the capacity of trying quizzes that were worth grades multiple times allowing students to figure out answers outside the time allotted for them and coming back with the answers to complete those;

– (Dominguez, 2013), where the students found out that screenshots sent to the system to validate achievements were instantaneously accepted even if they were of a blank screen, what led to teachers having to spend extra time evaluating all the screenshots sent and invalidate the wrong ones.

To deal with cheating, it's important to be cautious in the design to avoid incentives to it (as in the physical rewards case) and avoid and fix design flaws that can be exploited to cheat. Also, clear rules are needed to avoid misunderstandings, and fair arbiters (being them digital or human) to deal with any fuzzy cheat cases – be aware that if in this case, a human arbiter will need to be ready to spend time, energy and dealing with possible bias in judgements.

**Performance and Outcome Measures:** it's complicated to try to measure something regard cheating, for the simple reason that the cheating that you find may not be representative of the whole – if you don't find cheating, it doesn't mean that it's not there.

That said, a measure of "how much cheating was caught" in specific periods of time it's a better measure than no measure. A better measure would be "fixed system holes found that would enable cheating " per periods of time.

**Areas For Future Research:** How to find and fix gamified systems that allow cheating? Which game design elements enable it? What can be learned from the game industry as a whole that can help to deal with the problem?

**Deadline for Update:** 24 months.

### 4.9.6 Destructive Consequences of GDE - Rivals

**Group For Who This Guideline Is Intended:** Decision Makers, Managers and Designers.

**Desired Outcome:** gamified systems that, if using competition, use it in a more virtuous and positive way.

**Evidence Review:** information came from the systematical mapping that had exclusion criteria to cut articles that weren't about the subject – most of it from articles involving empirical research about the topic.

**Executive Summary:**

- Competition can happen in a spectrum with extremes being constructive and destructive. Destructive competition leads to cheating, lack of cooperation, priorization of wrong objectives, demotivation and toxicity between gamification system users involved.
- Against negative feelings brought by failure, team based activities make the impact of losing be shared by the group; multiple winning categories can reduce the amount of losers; matching people to compete that have similar skill levels avoids losing by a large margin (as faciling a seemingly unsurmountable challenge can reduce the motivation to face it).
- To avoid toxicity, competition can be directed toward a virtual opponent (as a fantasy monstrous enemy or a long quest) that can be antagonized safely, or against personal goals. To avoid users being blocked by hard challenges, multiple measures of progress can be created so they have options to delay, bypass or navigate through those.
- Against embarrassment and tension when going badly in a leaderboard, anonymous avatars can be used to bring a degree of separation between the leaderboard and the students.



To reach new heights of ability, we need something to challenge us. The challenge can be from a record to be surpassed – as a distance ran in 2 minutes or the amount of time taken to reach a destination – a task to be achieved – to climb Mt. Fuji, to cross the oceans in a boat – or the challenge is in fact a challenger, someone striving as you to improve as both your journeys put you by choice or accident comparing your own capacities and growth. Such rivalry can nurture respect, appreciation for other people's skill and the sought betterment of oneself.

Or your rival may cheat using doping to become faster and strong than what a human would be normally able to achieve, and leave you behind as 2nd. That happens. (since cheating is a problem that happens beyond gamification – or gamification is something that is made - without we knowing about it - more than we think?)

Or your rival's husband can hire someone to break your leg since he wants his wife to be victorious and you were an obstacle. That also happens.

In its best, competition can be used in a constructive manner, as a vehicle towards a healthy relationship between winners and losers and all learn within the process – and that serves the purpose of education. But it sits in a

spectrum where the other end of it is destructive – where competitors aren't rivals or competitors but enemies to be destroyed by all means necessary to reach victory. That can be by itself an incentive towards cheating, and on that point the emotional relationship between cheater and loser is one that involves malicious joy, guilt, shame, fear and emotional detachment (from the cheater) and disappointment, sadness, desperation, anger and hopelessness (from the loser). (Fulop, 2009)

Example cases of destructive effects of competition can be found in:

- A competitive gamified course by (Barata, 2013) partially hindered people's ability to cooperate, as an achievement rewarded everyone if everyone did well – created to incentive the class to help each other – resulted in students with good lab performance complaining about groups with lower performance (it's important to add that the authors in that case point, too, that their school culture is competitive).
- (Sepehr, 2015) points that competition caused problems as lack of communication between groups that were lagging behind;
- (Diewald et al, 2014) had competition through scoring in a leaderboard make drivers prioritize scoring better than driving safely in a simulation – when driving safely was the objective of the simulation, but doing four laps in the simulation faster was a part of the simulation's point system.
- (Dominguez, 2013) adds that leaderboard competition had the opposite effect that was intended: instead of motivate students to improve, it hindered motivation as some students did not like the competition.
- The students of (EjsingDuun, 2014) were aware of that possibility, as they noted about a high score approach that "it would be difficult 'to avoid giving people already good at the subject another success experience and having the poorer students (who are the ones you most likely will want to motivate) experience yet another defeat.'"
- (Roy, 2019b) found out that group competition can hinder group performance if the groups are made of strangers that don't know each other well enough to be comfortable to criticize each other; that students inside the same group wouldn't help each other so others wouldn't benefit from their hard work without doing the same effort to get better grades; and the leaderboard used on the competition harmed motivation as those who were performing worse ceased their attempts to rise as they thought it was worthless.

The good news is that are ways to deal with such problems.

Against the negative feelings brought by failure, team based activities help, as the impact of it is shared between the group; multiple winning categories can reduce the amount of losers; and matching people that have similar skill levels avoids losing by a large margin (as we pointed more than once so far, facing an seemingly unsurmountable challenge can reduce the motivation to face it).

Competition can also be directed toward a virtual opponent, as a fantasy monstrous enemy or a long quest, that allows antagonistic feelings to be expressed safely; or against personal goals, not other students.

To avoid users being blocked by hard challenges, multiple measures of progress can be created so they have options to delay, bypass or navigate through those.

Against embarrassment and tension when going badly in a leaderboard, anonymous avatars can be used to bring a degree of separation between the leaderboard and the students. (Featherstone, 2018a)

It's also important to stress two things about competition: first, that failing has value, as it's a learning experience to apply in the future... (Fulop, 2009) and that putting effort to sabotage directly or indirectly in the place that's intended to learn about something does not makes someone more skilled, just a bit less mediocre than the others around you (Sirlin, 2008). But when students share what they learned and help each other to improve, than everyone can raise their skills to face challenges outside the learning space.

**Performance and Outcome Measures:** as the stresses caused by negative competition are many, a mix of paying attention to the quantitative signs of students lagging behind and qualitative data gained through interviews with the students should prove a good combination to find out when problems are happening and how much. Outcome measures can be the grades commonly used.

**Areas For Future Research:** how games deals with the problems of toxic competition and how they solve/mitigate/dodge the problem? How the methods of dealing with toxic competition in gamification work? Are there effective ways to measure the toxicity brought by competition in a group/a community?

**Deadline for Update:** 24 months.

### 4.9.7 About Digital Badges

**Group For Who This Guideline Is Intended:** Decision Makers and Designers

**Desired Outcome:** the use of badges in gamification systems that does not result in the system as a whole failing to achieve its desired objectives.

**Evidence Review:** information came from three articles found through references from articles of the systematic mapping about negative effects of game design elements used on gamification systems for education/learning, and an extra article from the mentioned mapping.

**Executive Summary:**

- The best way to avoid crippling amounts of time and effort needed to sustain a badge system is to focus in: systems based on a mix of group projects and social learning; crowdsourced assessment; social and cultural motivators; research and iteration to improve the badges and focus in badges given by completion of workshops, courses or projects and roles.
- Automated systems to evaluate if users fulfill the requirements for badges can reduce the amount of human effort needed to maintain the system working, which helps it to exist in the long-term.
- Privacy is an issue that must be faced, speaking with the stakeholders and giving options for the users about how much info they want to let public.
- Badges' external endorsement should be gathered as part of the user's tasks to reach what need to be done to gain the badges (and no, we aren't talking about degrees or certificates) or after the badge is gained, as people who work with the owner of the badge endorse the knowledge that he has and what the badge is a symbol of.

Badges are one of the first and most used game design elements for gamification, and even beyond gamification as it is commonly knew.

Digital badges are a more recent phenomenon... and their popularity does not exclude them of effects that can hinder the objectives of using gamification for learning, or in the worse case scenario, stop the system itself from existing.

Examples of failure brought by underestimating the work needed on are:

- The Pathways to Global Competence, LevelUp and Youth Digital Filmmaker badge systems all tried to be based on competence badges: the three reached at most pilot implementations, and were hindered by the massive amount of different competences to be assessed from student work, plus presenting all the work to experts, keeping track of all the scores and competences and representing the results in badges. (Hickey, 2017)

- Eight different badge systems as the Roadtrip Nation, Story Corps U, Earthworks Rising and others failed to thrive when trying to focus on inquiry badges - badges focused on the effort of the students regarding investigation and creation of artifacts that shown knowledge about a subject - as creating assessment systems and rubrics for assessing artifacts demands specific expertise with both assessment and the involved. (Hickey, 2017)
- The work involved around badge evaluation can also hinder efforts towards external endorsement of those, as involved business can see the evaluation as bringing a need of formal systems of credits, transcripts and etc, which can be burdensome. Organizations that refused such foreseen effort were as Cooper-Hewitt Design Prep (and their art school admissions officers) and Intel Science Fair and Planet Stewards (and their college admission officers). (Hickey, 2017)
- Privacy was a concern raised by gamification users – those from an informal science learning program located in a city in the Northwest United States had issues regarding how much information would be shared through the badge system to other students, and about a lack of control about which badges could be shared and to whom (Pitt, 2019); as said by one of the students when asked if he would post his badges in social media, "I don't want anybody to know, because like I want to keep that separate like one thing from the other." (Davis, 2015)

Regarding challenges involving evaluation of knowledge, what worked the most were systems based on a mix of

- group projects and social learning;
- crowdsourced assessment;
- social and cultural motivators;
- research and iteration to improve the badges.

Also, a focus in badges given by completion of workshops, courses or projects and roles on those were more successful. Our examples are:

- Design for America had an interdisciplinary network of university students and community members that gave badges as social impact projects were completed correctly;
- Mouse Inc. had middle and secondary students receiving badges through participation and with the use of a tracking system where groups could track their own progress.

For knowledge evaluation, automated systems demand less work of humans, which can help towards the long-term existence of the use of systems involving badges.

About badges' external endorsement, it helps if evidence is accessible through the badges and created through the process of doing what's required to gain those, or even later, as people can come and add their endorsements to that badge as witnesses that the owner of it has the skills covered. (Hickey, 2017)

Finally, about privacy - running the risk of touching upon parts of previous guidelines - it's important to listen to your users and give them options about how much info they can share to others: the developers of the science learning program case above made a feature that allowed the creation of custom badge portfolios, helping the students to make portfolios for scholarships and applications, allowing them to choose which information would be available.

**Performance and Outcome Measures**: all points touched in this guideline involve in some level the effort needed to maintain a system, so a measure of man-hours needed to give a badge to someone plus qualitative data gathered from those involved in the process should give enough information.

**Areas For Future Research**: is there other ways that badges as part of a gamification system can break or sabotage a project? Are there technological advancements that make the cases of failure mentioned above manageable? Which are the problems involving privacy and badges, and how do we deal with those?

**Deadline for Update**: 18 months.

# 5
# Concluding Remarks

## 5.1
## Limitations

Regarding our search strategy, the search string was applied on Scopus at July 28th 2020, followed by single iteration snowballing searches conducted on August 18th 2020 (backward and forward using Scopus citation information) and September 4th 2020 (complementing forward snowballing using Google Scholar citation information).

Because of that, any papers published in 2020 after those dates were not retrieved.

The complete list of our 3192 analyzed papers as part of this strategy can be found in our online repository. After analyzing these papers, based on our inclusion and exclusion criteria, we initially included 68 papers.

While our search strategy allowed identifying significantly more papers than the database search strategy employed by Toda et al. (Toda, 2018) (e.g., 29 published between 2012 and 2016 against 17), the sets had differences. Therefore, we decided to manually include the papers found by Toda et al. that were missed by our search strategy, ending up with a final set of 77 papers.

It is noteworthy that we verified that most of the missed papers would also have been retrieved by subsequent snowballing iterations. Nevertheless, an extension applying subsequent snowballing iterations and investigating different hybrid strategies (Mourao, 2020) would require significant additional effort (beyond the 3192 already filtered papers) and is planned as part of a journal extension. We are confident that our final set of included papers as part of this publication already allowed providing an unbiased and meaningful overview of the adverse effects of GDEs in gamified education systems.

A risk in systematic mappings are false negatives regarding the filtering process. We started screening all papers considering only titles, abstracts, and keywords, which may not contain sufficient information to decide upon inclusion.

To lower this risk, we avoided applying EC1 and EC3 during the initial screening, only excluding papers that we had high confidence of not investigating GDE effects (EC1) and reporting negative effects (EC3). In case of any doubt, the paper was left for full-text-based assessment. Moreover, the

application of the inclusion and exclusion criteria made by the first author was reviewed by the second and third authors in meetings: in case of doubt, during the initial screening or full-text-based assessment, discussions were held to reach a consensus.

Furthermore, we chose not to consider grey literature as part of our inclusion criteria. There is the possibility of relevant grey literature that does not have equivalent in non-grey academic papers, possibly from professional support sites like Gamasutra[1], repositories of knowledge as GDC Vault[2], Youtube channels as Extra Credits[3], podcasts as A Question Of Gamification[4] and others more. On the other hand, even though we did not explicitly evaluate the strength of evidence, the results herein reported are based on peer-reviewed research and backed by empirical studies.

Another limitation was that most papers found by the systematic review focused in groups of GDEs instead of one, which made not possible to answer the RQ1 as intended - instead, we focused in showing the relations between the GDEs and negative effects, while leaving the filtered data with exactly with sets caused which effects available for analysis in our Zenodo repository (reference at Section 1).

Finally, while research that reaches negative results is important because it shows us what does not work (Teixeira, 2014), there still seems to be a publication bias towards positive results. Research reporting negative results tends to have less scientific interest, fewer citations, and be less often published (Matosin, 2014) Hence, there may be additional negative results that weren't published and which, for that reason, couldn't be included in our mapping study.



## 5.2 Contributions

Based on data extracted from 77 identified papers, we provided a comprehensive overview with valuable information for software engineers and designers of gamified education/learning systems. For instance, we identified

[1]Gamasutra's mission is to inform, empower, and inspire our game developer readership. They do this through journalism, criticism, and providing game developers a prominent platform to discuss all matters related to the art and business of making video games. (Gamasutra, 2015)

[2]"GDC Vault is a trove of in-depth design, technical and inspirational talks and slides from the influencers of the game development industry, taken from over 20 years of the worldwide Game Developers Conferences." (GDC, 2020)

[3]Extra Credits is an educational YouTube channel made up of entertainment enthusiasts with backgrounds in game design, television production, literature and academia, creating video essays for many subjects, game design too. (Credits, 2020)

[4]A Question of Gamification is a podcast where gamification expert An Coppens talks about various gamification subjects. (Coppens, 2020)

the game design elements that have most often been reported to cause adverse effects, the most common negative effects, and the relation between game design elements and negative effects. Such information can help gamification designers to consider potential negative effects when selecting game design elements. Researchers, on the other hand, can benefit from the overview of available evidence to identify topics on which more primary studies should be conducted (e.g., effects of game design elements not considered in the mapped studies).

We also created seven guidelines that can be useful for those who work in the field of digital gamification for education/learning, and had an article accepted by the Euromicro Conference on Software Engineering and Advanced Applications 2021.

Regarding education and learning, the academic knowledge that exists about digital gamification and negative effects of it has many fields that need more research, since while game design elements as badges, leaderboards and points held researchers' interest, others as quests, skill trees and tutorials only have two articles that find negative effects and there are many other game design elements only mentioned once.

We also conclude with the current research that the use of digital gamification for education shouldn't be done without the monitoring of the system applied and those that use it, to deal with possible unforeseen negative effects. We also recommend the use of any methodologies that apply regular tests with the public on its development, to catch such problems as soon as possible.



## 5.3 Future Works

We will update the snowballing in the future, to do as many iterations as possible until we reach all related papers, given an specific and limited timeframe (probably 2012-2020).

A realization that we had through the feedback gathered is that, while we tried our best to cover as much *academic* knowledge to help solving the problem through the guidelines, we ended up leaving *non-academic* knowledge only to the evaluation of those guidelines.

Those who work on the field day after day have a lot of expertise that's not published on articles or journals, and to improve these guidelines, the next step will be to apply a survey or focus group on the guidelines, polish those with the feedback received, and then contact professionals to gather information about the negative effects of game design elements that they know through

experience, and also to open the project to allow others to give their own insights and contributions to it.

We also want to do some research about which discoveries exist on grey literature: while it does not have the same levels of protocols or scientific rigour, it can give some light towards areas that researchers can investigate.

As pointed in one of our guidelines, humans have different motivations, but they can't be neatly organized in groups of one single followed north: people naturally have multiple motivations with different levels of strength, and that makes dealing with that variation in a group focused in a main motivation something worth investigating. It's also worthy of investigation how to focus a gamification system to one specific human motivation, how that has been done before the current gamification wave, and the opposite (groups where all motivations can be found), as that's the norm with most public and private schools.

Another interesting paths to follow for future works are to research how negative effects of gamification appear in different categories of educational software (as coursewares, classroom aids and learning management systems), and to gather more data about the articles present in the systematic mapping (as genders, commercial interests of people involved, category of digital educational systems and others of a list too big to add here).

Finally, as researchers, we helped the opening of a Pandora's Box: while the knowledge found here will support those who work in the field to avoid negative effects of GDE, knowing which they are and how related they are with certain GDE will help those that want to intentionally sabotage and/or do harm to others, directly or indirectly.

For this reason, one much needed future work involves how to stop, reduce the odds and deal with the aftermath of the intentional use of GDEs to damage others. This future work can also help those who were harmed by GDEs.

## 5.4 Final Remarks

Gamification is a tool that can help mankind to learn better and in a more desirable way, but can also sabotage, hinder and make systems worse. To avoid designers accientally creating systems that sabotage their users, we created these guidelines, focusing on education.

While flawed, we expect that the guidelines created can be an important tool (for sure not the only one) to help digital gamified systems used for education/learning to be the tools that mankind needs for a better future.

# 6
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# A
# Overview Of The Mapped Publications On Negative Effects Of Gamified Systems To Education

This appendix has the info collected of the articles mapped through the systematic mapping. The same info - and all the data regarding the mapping process - can also be found on `https://doi.org/10.5281/zenodo.4702399`.

Table A.1: Overview Of The Mapped Publications, part 1

| Document Title | Authors | Game design elements... | ...that were related to negative effects | Types of empirical studies | In which fields the game design elements are used | Year of publi-cation | Country of authors' institution |
|---|---|---|---|---|---|---|---|
| Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance (Hanus, 2015) | Michael D. Hanus, Jesse Fox | Competition, badges and leaderboards. | Loss of intrinsic motivation; loss of satisfaction; loss of learner empowerment; | Controlled Experiment & Survey | Communication Courses | 2014 | USA |
| A case study in the gamification of a university-level games development course (Odonovan, 2013) | Siobhan O'Donovan; James Gain; Patrick Marais | Puzzles, quizes and prizes. | Collusion between students to share solutions; Cheating; Need to spend money and time with yearly manteinance of the structure. | Controlled Experiment & Survey | 2D Game Design Studies. | 2013 | South Africa |
| A formative evaluation of a gamification app containing asynchronous multiplayer game elements | Mark Featherstone | Achievements through tutorial completion (that or a low odd of students giving themselves achievements for classes they weren't and the admins approving those) | Cheating. | Case Study & Survey | games programming course | 2017 | United Kingdom |
| A multilevel analysis of the effects of external rewards on elementary students' motivation, engagement and learning in an educational game | Michael Filsecker; Daniel Thomas Hickey | Badges | Lack of extra participation. | Controlled Experiment | Ecological science concepts for elementary school | 2014 | USA |
| An empirical study comparing gamification and social networking on e-learning (de-Marcos, 2014) | Luis de-Marcos; Adrián Domínguez; Joseba Saenz-de-Navarrete; Carmen Pagés | Badges and achievements, competition | Loss of performance | Case Study & Survey | Qualification for Information and Communication Technologies | 2014 | USA |
| An empirical study on the use of gamification on IT courses at higher education | Balázs Barna; Szabina Fodor | Points, badged, levels; alternative learning paths; instant feedback; social interactions | Students liked the gamified course a bit LESS than the non-gamified course, and had a bit worse scores | Controlled Experiment & Survey | Information Technology Course at University | 2018 | Hungary |
| An evaluation study on gamified online learning experiences and its acceptance among medical students (Ohn, 2019) | May Honey Ohn; Khin Maung Ohn | Competition, leaderboard, badges, social interaction, and analytics | irrelevance | Case Study & Survey | Major Medical Education | 2020 | Malásia |

Table A.2: Overview Of The Mapped Publications, part 2

| Document Title | Authors | Game design elements... | ...that were related to negative effects | Types of empirical studies | In which fields the game design elements are used | Year of publication | Country of authors' institution |
|---|---|---|---|---|---|---|---|
| A Pilot Study of a Digital Skill Tree in Gameful Education | Gustavo F. Tondello; Lennart E. Nacke | Skill tree, self-evaluation | Skill tree - disconnect between assignment requirements and the point evaluation system; confusing; unfair; lack of understanding of what was being asked; lack of granularity on grading<br><br>Self evaluation - Gaming the system | Case Study & Survey | User Interface Course | 2019 | Canadá |
| A playful approach to fostering motivation in a distance education computer programming course: Behaviour change and student perceptions (Pilkington, 2018) | Colin Pilkington | journey motif, Students provided known-as names and introduced themselves, short-term goals, points, Badges, leaderboards, levels for users, feedback, motivational e-mails | Added expectations, disappointment and discouragement, time pressure, irrelevance | Controlled Experiment & Survey | Programming for Major In Computer Science | 2018 | South Africa |
| Are badges useful in education?: It depends upon the type of badge and expertise of learner (Morris, 2019) | Samuel Abramovich; Christian Schunn; Ross Mitsuo Higashi | Participatory badges | demotivation | Case Study & Survey | Math | 2013 | USA |
| Collecting Pokémon or receiving rewards? How people functionalise badges in gamified online learning environments in the wild (Roy, 2019) | Rob van Roy; Sebastian Deterding; Bieke Zaman | Badges and achievements, competition | Irrelevance; demotivation (in case of considering the badge as something to get instead of a finishing line) | Case Study & Survey | Coding, online learning | 2019 | Belgium, United Kingdom |
| Comparing badges and learning goals in low-and high-stakes learning contexts | Bradley J. Morris; Colleen Dragovich; Rachael Todaro; Sebiha Balci; Eve Dalton | Badges, goals | Lack of effect | Controlled Experiment | Educational Psychology; Turkish Culture | 2019 | USA |
| Competition as an element of gamification for learning: An exploratory longitudinal investigation (Sepehr, 2015) | Sepandar Sepehr; Milena Head | Competition | Demotivation (in case of losing the competition) | Survey | Business | 2013 | Canada |
| Designing gamification for constructive competition (Featherstone, 2018a) | Mark Featherstone | Competition | Anxiety and lower self-esteem | Controlled Experiment | Computer science | 2018 | United Kingdom |
| Demon or angel: an exploration of gamification in management | Bin Liu; Junqing Wang | Badges and simulations | Less motivation, less performance | Controlled Experiment & Survey | Business | 2019 | Hong Kong, China |

Table A.3: Overview Of The Mapped Publications, part 3

| Document Title | Authors | Game design elements... | ...that were related to negative effects | Types of empirical studies | In which fields the game design elements are used | Year of publi-cation | Country of authors' institution |
|---|---|---|---|---|---|---|---|
| Digital badges in afterschool learning: Documenting the perspectives and experiences of students and educators (Davis, 2015) | Katie Davis; Simrat Singh | Badges | Element seen as useless, it was unknown<br><br>C01. Privacy concerns; learner may not want connections to be made across contexts<br>C02. Lack of granularity, everyone gets the same badge<br>C03. Challenge of evaluating skills<br>C04. Badges not externally, easily visible to others<br>C05. Badges fail to unlock opportunities for learner<br>C06. Challenge of establishing credibility, getting stakeholders to value badges<br>C07. Motivation: either lack of motivation or places undue emphasis on extrinsic rewards<br>C08. Top-down initiative, learner doesn't get a say in the design, awarding, use of badges<br>C09. Unfair to use badges to sort people<br>C10. Social equity, accessibility due to SES factors, worsening the digital divide<br>C11. Ephemerality of digital artifacts, obsolescence<br>C12. Ends vs. means, quantification of learning<br>C13. Trivial badges, quantity vs. quality, issues of quality control<br>C14. Technical challenges<br>C15. Effort, work required, resources, time, money needed to implement, scale badges | Survey | afterschool programs serving nondominant youth | 2015 | USA |
| Do Badges Affect Intrinsic Motivation in Introductory Programming Students? (FaceyShaw, 2020) | Lisa Facey-Shaw; Marcus Specht; Peter van Rosmalen; Jeanette Bartley-Bryan | Badges | Reduction of intrinsic motivation | Controlled Experiment & Survey | introductory programming | 2020 | Jamaica, The Netherlands |
| Does Gamification Improve Flow Experience in Classroom? An Analysis of Gamer Types in Collaborative and Competitive Settings (Marinho, 2019) | Alexandre Marinho; Ig Ibert Bittencourt; Wilk Oliveira dos Santos; Diego Dermeval | Gamified quiz, made of points and badges | Lack of effect | Controlled Experiment & Survey | course of Constructive Details and Lighting | 2019 | Brazil, Canada |
| Does gamification work for boys and girls? An exploratory study with a virtual learning environment (Pedro, 2015) | Lais Z. Pedro; Aparecida M. Z. Lopes; Bruno G. Prates; Julita Vassileva; Seiji Isotani; | Environment made of points, badges, feedback, ranking, emotional results, challenge, rules | Lack of effect | Controlled Experiment | seventh grade | 2015 | Brasil |
| Does gender stereotype threat in gamified educational environments cause anxiety? An experimental study | Josmario Albuquerque; Ig I. Bittencourt; Jorge A.P.M. Coelho; Alan P. Silva | Gamified quiz | Increased anxiety | Controlled Experiment & Survey | undefined | 2017 | Brasil |
| Driven to drive? Investigating the effect of gamification on learner driver behavior, perceived motivation and user experience (Fitzwalter, 2017) | Zachary Fitz-Walter; Daniel Johnson; Peta Wyeth; Dian Tjondronegoro; Bridie Scott-Parker; | Virtual currency, points, bonus | Lack of effect | Case Study | driving lessons | 2017 | Australia |

Table A.4: Overview Of The Mapped Publications, part 4

| Document Title | Authors | Game design elements... | ...that were related to negative effects | Types of empirical studies | In which fields the game design elements are used | Year of publication | Country of authors' institution |
|---|---|---|---|---|---|---|---|
| Edugamifying Media Studies: Student Engagement, Enjoyment, and Interest in Two Multimedia and So-cial Media Undergraduate Classrooms (Bajko, 2016) | Robert Bajko; Jaigris Hodson; Katie Seaborn; Pamela Livingstone; Deborah Fels | XP, quizzes, luck group challenges, quests, teams, challenges, leaderboards, backstory, classes, mentorship, | Concerns in a management level of how the course would cause a lot of angry students questioning their grades, asking for final grade challenges; alienation from non-gamers; design criticism from gamers; problems involving the learning management system that did not support all gamification features, making the dev team work outside the box; extra human effort | Case Study & Survey | Participatory Media and Communication; Multimedia in Business | 2016 | Canada |
| Empirical study on the effect of achievement badges in TRAKLA2 online learning environment (Hakulinen, 2013) | Lasse Hakulinen; Tapio Auvinen; Ari Korhonen | badges | lack of effect on grades, novelty effect regarding motivation, irrelevance, supposed lack of carefulness | Controlled Experiment & Survey | Data Structures and Algorithms course | 2013 | Finland |
| Exploring Gamification Techniques for Classroom Management (Nicholson, 2013) | Scott Nicholson | score, narrative, rewards, option to not do work, leaderboards | confusion in understanding scoring system thanks to lack of game literacy, desmotivation through tacked-on narrative, lack of intrinsic motivation, opportunity for weaker students to fall through the cracks, extra human effort (more stuff for the teacher to solve), novelty effect, demotivation | Case Study | undergraduate and graduate courses | 2013 | USA |
| Exploring Gamification to Prevent Gaming the System and Help Refusal in Tutoring Systems (Azevedo, 2018) | Otávio Azevedo; Felipe de Morais; Patricia A. Jaques | hints, feedback, points, tutorial, difficult levels | lack of effect | Controlled Experiment & Survey | seventh grade classes | 2015 | Brasil |
| Exploring the effect of achievements on students attending university orientation | Zachary Fitz-Walter; Peta Wyeth; Dian Tjondronegoro; Daniel Johnson | achievement | lack of effect on user experience | Controlled Experiment & Survey | first year students | 2014 | Australia |
| Formative, multimethod case studies of learn to quit, an acceptance and commitment therapy smoking cessation app designed for people with serious mental illness | Roger Vilardaga; Javier Rizo; Richard K. Ries; Julie A. Kientz; Douglas M. Ziedonis; Kayla Hernandez; Francis J. McClernon | tokens, daily self-assessments | lack of user engagement apparently thanks to wrong use of Android system notifications | Controlled Experiment | nicotine addicted | 2018 | USA |
| Gamification and student motivation (Buckley, 2014) | Patrick Buckley; Elaine Doyle | rewards, group decisions | lack of motivation (both intrinsic and extrinsic) to participate | Case Study & Survey | Ireland Tax system | 2014 | Ireland |
| Gamification for Internet Gaming Disorder Prevention: Evaluation of a Wise IT-Use (WIT) Program for Hong Kong Primary Students (Chau, 2019) | Chor-lam Chau; Yvonne Yin-yau Tsui; Cecilia Cheng | competition, quiz | lack of impact to reduce the addiction risk | Case Study & Survey | children from primary schools with risk of having any Internet gaming disorder | 2019 | Hong Kong |
| Gamification in assessment: Do points affect test performance? (Attalia, 2015) | Yigal Attali; Meirav Arieli-Attali | points | lack of effect | Case Study | math | 2014 | USA |

Table A.5: Overview Of The Mapped Publications, part 5

| Document Title | Authors | Game design elements... | ...that were related to negative effects | Types of empirical studies | In which fields the game design elements are used | Year of publi-cation | Country of authors' institution |
|---|---|---|---|---|---|---|---|
| Gamification in Computer Programming: Effects on learning, engagement, self-efficacy and intrinsic motivation (OrtizRojas, 2017) | Margarita Ortiz-Rojas; Katherine Chiluiza; Martin Valcke | badges and meta-badges | Lack of effect | Controlled Experiment & Survey | engineering | 2017 | Belgium, Equador |
| Gamification of Assessment Test through Multiple Question Paths to Facilitate Participants' Autonomy and Competence | Pratama Wirya Atmaja; Eka Prakarsa Mandyartha | multiple question paths | lack of positive effect on sense of competence (in this case, because the choice was between a Medium and a Hard question, AND some medium question were harder than others, so a Medium question could be hard for some people) | Controlled Experiment | students of the Informatics Department | 2020 | Indonésia |
| Gamification of a Higher Education Course: What's the fun in That? (EjsingDuun, 2014) | Stine Ejsing Duun; Helle Skovbjerg Karoff | competition, playfulness that enhances affective and enjoyable sociability | stress and distractions | Case Study & Survey | gamification | 2014 | Denmark |
| Gamification of higher education by the example of Computer Games course | Martin Sillaots | Goals, Avatar, XP's, Scoreboard, Levels, Luck, Collaboration, Competition and Feedback | lack of deep imersion | Case Study & Survey | university students | 2015 | Estonia |
| Gamification of Higher Education by the Example of Course of Research Methods (Sillaots, 2014) | Martin Sillaots | quizzes, scoreboard | lack of interest in competition, lack of motivation | Case Study & Survey | second year master students from the curriculum of IT Management and Educational Technology | 2014 | Estonia |
| Gamification of joint student/system control over problem selection in a linear equation tutor | Yanjin Long; Vincent Aleven | repeating exercises, reward | lack of effect | Controlled Experiment | math | 2014 | USA |
| Gamified training for vehicular user interfaces - Effects on drivers' behavior (Diewald et al, 2014) | Stefan Diewald; Patrick Lindemann; Andreas Moller; Tobias Stockinger; Marion Koelle; Matthias Kranz | competition, scoreboard, tutorial | priority became winning instead of driving safely (competition, scoreboard); tutorial being skipped to keep the game going; | Controlled Experiment & Survey | driving | 2014 | Germany |
| Gamifying a Simulation: Do a Game Goal, Choice, Points, and Praise Enhance Learning? (Brom, 2018) | Cyril Brom; Tereza Stárkova; Edita Bromová; Filip Děchtěrenko | game goals, increased freedom of choice, points, virtual currency, and praise | Lack of effect | Controlled Experiment & Survey | how to make beer | 2019 | Czech Republic |
| Gamifying learning experiences: Practical implications and outcomes (Dominguez, 2013) | Adrián Domínguez; Joseba Saenz-de-Navarrete; Luis de-Marcos; Luis Fernández-Sanz; Carmen Pagés; José-Javier Martínez-Herráiz | competition, leaderboards, gamification plugin, achievements | loss of performance, participated less on class activities, discouraged by a leaderboard, lack of understanding of how the gamification plugin worked, technical problems, cheating, | Controlled Experiment & Survey | students of the course "Qualification for users of ICT" | 2012 | Espanha |

Table A.6: Overview Of The Mapped Publications, part 6

| Document Title | Authors | Game design elements... | ...that were related to negative effects | Types of empirical studies | In which fields the game design elements are used | Year of publi-cation | Country of authors' institution |
|---|---|---|---|---|---|---|---|
| Grading by experience points: An example from computer ethics (Gehringer, 2013) | Edward Gehringer; Barry Peddycord III | XP, peer review for point giving | demotivation, "The idea that grading was based just on points meant that we could not really require students to complete any course activity. According to the syllabus, all students were compelled to participate in two debates. However, there was no way to enforce this requirement, since students could instead earn points for writing or reviewing extra ethical analyses. | Controlled Experiment & Survey | Ethics in Computing course | 2013 | USA |
| Guilds, die rolls, and leaderboards: Gamification of two undergraduate multimedia and social media courses (Bajko, 2015) | Robert Bajko; Jaigris Hodson; Katie Seaborn; Pamela Livingstone; Deborah Fels | challenge, XP, guilds | Challenges of Structure and Department Rules, non-gamers found confusing, problems of adapting the LMS | Case Study & Survey | multimedia and social media students | 2015 | Canada |
| How can educators with limited resources gamify their classes? A design-based approach | Björn Lefers; Marcus Birkenkrahe | content elements (class content elements, to be more precise) | dislike of certain content elements, too many and too few of those were positive | Controlled Experiment & Survey | students of finance and investment | 2016 | Germany |
| Is it worth using gamification on software testing education? An experience report | Gabriela Martins de Jesus; Fabiano Cutigi Ferrari; Leo Natan Paschoal; Simone R. S. Souza | Achievement, avatar, badge, duel, leaderboard, level, points, quest, team, virtual goods | reduced amount of learning | Controlled Experiment & Survey | Software Testing | 2019 | Brazil |
| Implementation and assessment of three gamification strategies across multiple higher education disciplines (Babichenko, 2019) | Dmitriy Babichenko; Lorin Grieve; Elizabeth Bilodeau; Daryna Koval | competition, tracking, simulation | lack of improvement, bugs found | Controlled Experiment & Survey | dental medicine | 2019 | USA |
| Improved Student Independence Through Competitive Tinkering (Martin, 2017) | Richard Martin; Andrew Klein | competition, open-ended activities | not enough live lecture time, not enough example problems were covered, bugs equipment cost, | Controlled Experiment & Survey | military students, Introduction to Signal Processing; Signal Detection & Estimation Courses | 2017 | USA |
| Increasing student engagement within the core nutritional sciences curriculum: a gameful learning approach (Bridges, 2018) | Dave Bridges; Rina Hisamatsu; Olivia S. Anderson | points, optional activities | perception of extra workload and being overwhelmed | Controlled Experiment & Survey | Nutritional Sciences: Principles of Nutrition | 2019 | USA |

Table A.7: Overview Of The Mapped Publications, part 7

| Document Title | Authors | Game design elements... | ...that were related to negative effects | Types of empirical studies | In which fields the game design elements are used | Year of publication | Country of authors' institution |
|---|---|---|---|---|---|---|---|
| Influence of Gamification elements on emotion, interest and online participation | Can Meşe; Özcan Özgür Dursun | leaderboard, competition | disconfort, negative effects on friendships | Controlled Experiment | 63 freshman students of Information Technologies in Education | 2018 | Turkey |
| Investigating the potential of gamification to improve seniors' experience and use of technology | Michael Minge; Dietlind Helene Cymek | speed reward, customizable personal profile, feedback, rewards | dislike of gamification | Controlled Experiment & Survey | how to use a computer | 2020 | Germany |
| Learning and engagement in a gamified course: Investigating the effects of student characteristics (DavisK, 2018) | K. Davis; H. Sridharan; L. Koepke; S. Singh; R. Boiko | XP, leaderboards, level ups, and badges | lack of motivation, dislike of competition | Case Study & Survey | 139 social networking technology students | 2018 | USA |
| Microcredentialing of English Learner Teaching Skills: An Exploratory Study of Digital Badges as an Assessment Tool | Kerry Purmensky; Ying Xiong; Joyce Nutta; Florin Mihai; Leslie Mendez | badges, quiz, practice sessions, coaching. lack of motivation | lack of value understanding, lack of time to participate | Case Study & Survey | Teaching | 2020 | USA |
| Practicing CPR: A Qualitative Analysis of Resident Motivation | Ilana Harwayne-Gidansky; Dorene F. Balmer; Cara B. Doughty; Lori L. Scarlatos; Todd Chang; Joo Lee Song | simulation | lack of time to participate; lack of resources to participate | Survey | 10 pediatric residents | 2020 | USA |
| So fun it hurts - Gamifying an engineering course (Barata, 2013) | Gabriel Barata; Sandra Gama; Joaquim Jorge; Daniel Gonçalves | XP, badges, levels, leaderboards, challenges, skill tree | perception of high workload, comparison pains regarding a public leaderboard, lack of quality-of-work distinction of rewards, Lack of understanding, resentment of competition. | Controlled Experiment & Survey | Multimedia Content Production master-in-progress students | 2013 | Portugal |
| Spendency: Students' Propensity to Use System Currency | Erica L. Snow; Laura K. Allen; G. Tanner Jackson; Danielle S. McNamara | virtual currency | distractions using the customizable parts of gamification bought with currency | Case Study & Survey | high school students | 2015 | USA |

Table A.8: Overview Of The Mapped Publications, part 8

| Document Title | Authors | Game design elements... | ...that were related to negative effects | Types of empirical studies | In which fields the game design elements are used | Year of publi-cation | Country of authors' institution |
|---|---|---|---|---|---|---|---|
| Student experience of gamified learning: A qualitative approach | Andrew James Clements; Sajeel Ahmed; Bernadette Henderson | competition | lack of perception of competition | Survey | business, nursing and paramedic students | 2017 | United Kingdom |
| Supporting virtual learning for digital literacy: First experiences with a mobile app and gamification elements | Elisabeth Katzlinger; Ursula Niederländer | online ranking, messaging | lack of understanding | Case Study & Survey | Computer science | 2018 | Austria |
| Teaching presence in online gamified education for sustainability learning (Mahmud, 2020) | Siti Nur Diyana Mahmud; Hazrati Husnin; Tuan Mastura Tuan Soh | leaderboards, achievements, points, badges, enjoyment, competition, progression | time pressure, boredom caused by lack of social interaction, and boredom caused by activity repetition and activity's inappropriate level of difficulty | Controlled Experiment & Survey | Environmental Education and Sustainability students | 2020 | Malásia |
| The adoption of students' hedonic motivation system model to gamified learning environment (Oluwajana, 2019) | Dokun Oluwajana; Adeleye Idowu; Muesser Nat; Vanye Vanduhe; Samson Fadiya | quiz challenges, points, rewards, ranking, leaderboard, | focused immersion did not bring curiosity | Case Study & Survey | undefined | 2018 | Turkey |
| The challenges of gamifying CSR communication | Kateryna Maltseva; Christian Fieseler; Hannah Trittin-Ulbrich | flashcards, quizzes, questionaires, Feedback | less interess in the subject taught, instead Of a conventional framing; clash between The mechanics of the game and the objective; | Case Study & Survey | corporate social responsibility | 2018 | Norway. Germany |
| The effects of students' motivation, cognitive load and learning anxiety in gamification software engineering Education: a structural equation modeling study | Chung-Ho Su | storyline, playfulness, enjoyment, challenge, Competition, goal, Learner autonomy, multimedia representations | reduced ability to deal with a cognitive load | Case Study & Survey | software engineering | 2015 | Taiwan |

Table A.9: Overview Of The Mapped Publications, part 9

| Document Title | Authors | Game design elements... | ...that were related to negative effects | Types of empirical studies | In which fields the game design elements are used | Year of publi-cation | Country of authors' institution |
|---|---|---|---|---|---|---|---|
| The effect of gamification on psychological and behavioral Outcomes: Implications for cruise tourism destinations (Kredo, 2009) | Byeong Cheol Lee | rewards, missions and quizzes | lack of motivation, lack of enjoyment, Lack of flow experience | Controlled Experiment & Survey | tourism | 2019 | South Korea |
| The Effect of Informing Agency in Self-Directed Online Learning Environments | Benjamin Xie; Greg L. Nelson; Harshitha Akkaraju; William Kwok; Amy J. Ko | world view, recommendations, skill bars | lack of improved learning, thanks to Decision-making burden | Controlled Experiment & Survey | computer science | 2020 | USA |
| The impact of a forfeit-or-prize gamified teaching On e-learners' learning performance | Zi-Gang Ge | quiz | high anxiety | Controlled Experiment & Survey | english | 2018 | China |
| Understanding the Effect of Gamification on Learners with Different Personalities (Ghaban, 2019) | Wad Ghaban; Robert Hendley | points, badges, leaderboard, chat, quiz, | lack of improvement. | Controlled Experiment & Survey | computer science | 2019 | United Kingdom |
| UniCraft: Exploring the impact of asynchronous Multiplayer game elements in gamification (Featherstone, 2018) | Mark Featherstone; Jacob Habgood | competition, user self-certification | cheating | Case Study & Survey | programming | 2018 | United Kingdom |
| Unravelling the ambivalent motivational power of gamification: A basic psychological needs perspective (Roy, 2019b) | Rob van Roy; Bieke Zaman | challenges, badges, competition, Moderation | diminished feelings of competence (when someone's team was low in the rankings) and autonomy (as the success of the Google+ Community not only Depended on one student, but also on teammates), Abscence of contributions, lack of understanding Time constrains because of master research, Fear of failing and doing mistakes Because of perception of moderators Around | Case Study & Survey | master course | 2018 | Bélgica |
| What Do Higher Education Students Have to Say About Gamification? | Fernando Albuquerque Costa; Joana Viana; Mónica Raleiras | XP, challenges | more time demanding | Survey | multimedia content and production | 2020 | Portugal |

Table A.10: Overview Of The Mapped Publications, part 10

| Document Title | Authors | Game design elements... | ...that were related to negative effects | Types of empirical studies | In which fields the game design elements are used | Year of publication | Country of authors' institution |
|---|---|---|---|---|---|---|---|
| How (not) to introduce badges To online exercises (Haaranen, 2014) | Lassi Haaranen; Petri Ihantola; Lasse Hakulinen; Ari Korhonen | Badges | demotivation; Bugs found; Irrelevance; Lack of effect; | case study & survey | Data Structures and Algorithms (Computer Science) | 2014 | Finland |
| Gamification in educational Software development | Achilleas L. D. Buisman; Marko C. J. D. van Eekelen | points, Leaderboard | lack of motivation | case study & survey | Computer Science | 2014 | Holland |
| It was a bit of a race: Gamification of version control (Singer, 2012) | Leif Singer | milestone, Leaderboard | lack of understanding; distracting; Lack of usefulness; Bugs found Gaming the system; Leaderboard | case study & survey | Computer Science | 2012 | Germany |
| Improving participation and learning with gamification (Barata, 2013b) | Gabriel Barata; Sandra Gama; Joaquim Armando Pires Jorge; Daniel Gonçalves | XP, progression, leaderboard, challenges, and badges | lack of improvement; Sabotage of cooperation; Gaming the system; Resentment; | case study & survey | Computer Science | 2013 | Portugal |
| Gamification of a Software Engineering course and a detailed analysis of the factors That lead to it's failure | Kay Berkling; Christoph Thomas | status, achievements, Competition, Altruism, Points, Levels, paths and Progress, Challenges, Immediate feedback, Leaderboards, XP | dislike of gamification; Gamification seen as A hindrance; worsened performance | case study & survey | Software Engineering (Computer Science) | 2013 | Germany |
| Adaptive and Gamified Learning Environment (AGLE) (Naik, 2012) | Vandana Naik; Venkatesh Kamat | XP, level, Badges, leaderboard | Loss of performance; | controlled Experiment | Computer Science | 2015 | India |
| Gamifying activities in A higher education course (Campos, 2015) | André Campos; Edwyn Batista; Alberto Signoretti; Renato Gardiman; Charles Madeira | instant feedback, Points, Badges and Leaderboards, Collaboration, Competition, challenges, Items | bugs, rigorous correction?, Unclear score system, learning with the system caused loss of score, sabotaging Students, demotivation | case study & survey | Computer Science | 2015 | Brazil |
| Gamification for enforcing Coding conventions (Prause, 2015) | Christian Prause; Matthias Jarke; | Score, leaderboards, Rewards, | Gaming the system, Lack of understanding, Loss of teamwork | controlled Experiment & Survey | Computer Science | 2015 | Germany |
| The design and implementation Of a gamified assessment (Kocadere, 2015) | Selay Arkün Kocadere; Şeyma Çağlar Özhan | Badges, Achievements, Avatars, Content Unlocking, Leaderboard, Teams, Virtual Goods, Levels, Points, Challenge, Cooperation, Competition | Bugs, Unclear score system, demotivation, locked questions for assessment sabotaged students | case study & survey | Educational Game Design | 2015 | Turkey |
| How revealing rankings affects student attitude and performance in a peer review learning Environment (Papadopoulos, 2015) | Pantelis M. Papadopoulos; Thomas Lagkas; Stavros N. Demetriadis | ranking | lack of effect, gaming the System | controlled Experiment & Survey | Computer Science; Telecommunications Engineering | 2016 | Denmark; Greece |
| Using badges for shaping Interactions in online learning environments | Rudy Mcdaniel; Robb Lindgren; Jon Friskics | achievements, badges | frustration, hidden badges linked to grade sabotaged users, Lack of interess | case study | Visual Arts and Design | 2012 | USA |

# B
# Glossary Of Game Terms

Table B.1: Glossary of Game Terms, part 1

| Term | Meaning |
|---|---|
| Achievement | Meta-goal defined outside a game's parameters, with its management usually taking place outside the confines of the game environment and architecture. Meeting the fulfillment conditions, and receiving recognition of fulfillment by the game, is referred to as unlocking the achievement. (Wikipedia, 2021) |
| Avatar | The model, character or picture used to represent each player in the game. (Cybersmile, 2020) |
| Badge | "A distinguishing emblem or mark worn to signify (...) achievement." (TheFreeDictionary, 2014) What is an achievement in games may vary, from basic tasks to almost impossible undertakings. |
| Challenge | A test of one's abilities or resources in a demanding but stimulating undertaking. (TheFreeDictionary, 2016) Games focused on challenge have to offer higher and higher tiers of challenge to keep up with the player's intrinsic technique, numeric power and growing amount of abilities. |
| Feedback | Reaction to something that the player made. Usually feedback in games is immediate, not delayed; Frequent, not intermittent; Focused on outcomes, not people's identities; A mix of positive and negative; Useful for showing progress towards goals (think progress bars). Rarely does it focus on process, instead of results. (Madigan, 2019) |

Table B.2: Glossary of Game Terms, part 2

| **Term** | **Meaning** |
|---|---|
| GDE | Game design element. |
| Leaderboard | A board that displays the leaders in a competition. (TheFreeDictionary, 2020) |
| Quest | A quest is (...) a special mission that the player engages in, that requires a specific set of action to be performed, that has a definite ending point with some sort of reward. (Karlsen, 2008) |
| Quick time event | To give the appearance of interaction, games will occasionally require a certain series of button presses to make a cool or important onscreen thing happen (e.g. make a character avoid falling boulders or stop them from tumbling down a cliff). (Chiang, 2017) |
| Quiz | Form of game or mind sport in which players attempt to answer questions correctly about a subject or variety of subjects. (Wikipedia, 2021c) |
| Scoreboard | A large board on which the score of a game is shown. (Cambridge, 2021) |
| Simulation | Genre of games that emulate a slice of life, real or fictional. (Matthews, 2018) Usually such games focus on operating businesses, building cities or creating people with their own lives. (MasterClass, 2020) |

Table B.3: Glossary of Game Terms, part 3

| **Term** | **Meaning** |
|---|---|
| Skill tree | A hierarchical visual representation of customizations a player can make to their character. Skill trees can either branch out or eventually fold back to a single point depending on the game (Wikitionary, 2020) and the player advance through it picking customizations one at a time, that usually unlock further customizations through the tree. |
| Tutorial | Any tool that teaches players the rules and controls of the game. Some tutorials are integrated into the game, while others are completely separate and optional. (Wikipedia, 2020c) |
| XP | Experience Points. The more points you have, the closer you are to reaching your next level - another quantitative measure of power of a player's character inside a game. (Chiang, 2017) |