How to Gamify learning Systems? An Experience Report using the Design Sprint Method and a Taxonomy for Gamification Elements in Education

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ABSTRACT: One of the main goals of gamification in educational settings is to increase student motivation and engagement. To facilitate the design of gamified educational systems, in recent years, studies have proposed various approaches (e.g., methodologies, frameworks and models). One of the main problems, however, is that most of these approaches are theoretical, and do not provide a *proof-of-concept*. This paper advances the state of the art by providing a practical way to help implement this kind of system. In this study, we present, for the first time, how one can apply gamification elements in a learning system using the *Design Sprint* method, to guide designers and developers on replicating this process. Additionally, as starting point, we use a taxonomy composed of 21 game elements, proposed to be used within learning environments, organised into five game element categories, according to their goal/usage. Our main contribution is to present *how to systematically implement the gamification elements focused on educational ends*, which is of special value to practitioners, designers and developers.

Keywords: Gamification, Design Sprint, Taxonomy, Design, Education

1. Introduction

Gamified systems adoption has increased in the last decade, since the definition was coined (Thiebes, Lins, & Basten, 2014). These systems aim at using game-like elements to provide a gameful experience to their users (Landers, 2019; Thiebes et al., 2014). This caught the attention of education professionals, since the field of education still struggles with motivating and engaging students (Borges, et al., 2014; Lee & Hammer, 2011; Martí-Parreño, Seguí-Mas, & Seguí-Mas, 2016; Paula & Fávero, 2016; Sánchez-Mena & Martí-Parreño, 2016; Toda et al., 2018a). In education, gamification consists of using game-like elements to achieve positive impacts in motivating, engaging, persuading and improving the performance of students (Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011; Kapp, 2012; Seaborn & Fels, 2014). According to recent research, gamified systems impact on psychological characteristics, and effective gamified systems lead to behavioural change (Landers, 2019). However, for a positive impact, gamification needs to follow a *well-thought design process*; otherwise, it may lead to undesired behaviours, or worsen performance, due to disengagement or other declining effects (De-Marcos, Domínguez, Saenz-de-Navarrete, & Pagés, 2014; Dichev & Dicheva, 2017; Toda et al., 2018b; Zichermann & Cunningham, 2011). Therefore, many authors proposed the use of frameworks and methodologies to support the gamification design process (Mora, Riera, González, & Arnedo-Moreno, 2017).

However, these gamification frameworks and methods present some limitations, ranging from their purpose, to the number of definitions of game elements used, which can confuse and drive away designers, developers, teachers, and instructors who wish to gamify their learning activities (Koivisto & Hamari, 2019; Pedreira, García, Brisaboa, & Piattini, 2015). Moreover, some frameworks are too generic and do not encompass learning objectives and other properties derived from the education field, and others are too specific to a given niche (Mora et al., 2017); e.g., the framework proposed by Kotini and Tzelepi (2015), focused on gamifying computational thinking activities. As for the definitions, literature sees it as a considerable limitation on the field of gamification, since there are many gamification frameworks (more than 40, up to date) and all of them use different types of game elements that may not encompass all elements within a game. Additionally, recent studies report the lack of proof-of-concept in gamification studies that may support the theories on which they are based (Kasurinen & Knutas, 2018).

To address this, this work presents and applies a recent taxonomy, created and evaluated to mitigate the issues related to the game elements definitions (Toda et al., 2019a) and the lack of proof-of-concept for gamification frameworks. The taxonomy is composed of 21 game elements to be used within learning environments, which were grouped into five game element categories, according to their goal/usage (Toda et al., 2019b). Next, we present how we can apply that taxonomy using the Design Sprint Method (Sumual, Batmetan, & Kambey, 2019), to guide designers and developers on replicating this process. Hence, we propose the following research question: *How can we gamify learning environments using the Design Sprint method and existing game elements?* Thus, our main contribution is presenting how to systematically implement a recent, expert-validated gamification elements taxonomy, that is focused on educational ends, which is of special value to practitioners (e.g., designers, developers, teachers, and professors), who aim to use this taxonomy to implement gamification in their learning environments.

The rest of the paper is organised as follows: the next section introduces the research background, by reviewing relevant gamification frameworks in education. The research model used in this research is then described, followed by the description of the application of the taxonomy. Finally, the implications of the findings are discussed, and conclusions are drawn.

1.1 Background and related works

Gamification in education is not a novelty, as many studies have focused on applying game elements in learning environments, even before the concept was coined (Darejeh & Salim, 2016; Dichev & Dicheva, 2017; Vargas-Enriquez, Garcia-Mundo, Genero, & Piattini, 2015). The purpose of using gamification in education is to motivate and engage students, to improve their performance and training, and change undesired behaviours (Huotari & Hamari, 2012; Kapp, 2012; Seaborn & Fels, 2014). However, the literature in this field reported mixed results on the application of gamification, wherein most of the negative impacts were related to a poor design (Dichev & Dicheva, 2017; Toda et al., 2018b).

The factors that influence a poor design ranged from users' demographic to behavioural profiles, context and learning activities, and the way the gamified strategies were designed, or recommended (Klock, Gasparini, & Pimenta, 2016; Toda et al., 2019c). Considering the latter, most of the existing frameworks were either conceptual or lacked proper definitions of game elements. Moreover, recent conceptual frameworks lacked empirical evidence on their use, which hindered their adoption by teachers and instructors (Pedreira et al., 2015; Sánchez-Mena & Martí-Parreño, 2016). Furthermore, the lack of proper definitions may confuse designers and other education domain specialists, since most frameworks used not only different names for the same concept, but also the same definition for different concepts; e.g., in Gamify-SN (Toda et al., 2018a) the authors define "acknowledgements" as a type of feedback given to the users when certain actions are performed, while in another framework (Wongso, Rosmansyah, & Bandung, 2014) the authors define the same element as "medals" or "badges."

Furthermore, considering frameworks in the field of education, a recent systematic review (Mora et al., 2017) found 6 frameworks. From this group, one is focused on serious games and five others on gamification.

Simões, Redondo and Vilas (2013) presented a framework for educational platforms divided into three groups. The first group described game elements (N = 12) divided into game mechanics and dynamics. Following, the second group presented guidelines for teachers, focusing on learning tasks, however, without linking these tasks to the game elements. A third group connected focused these guidelines, aligning the objectives with the school identity. These objectives aimed to help students overcome failure, achieve the flow state (Csikszentmihalyi, 1975), experience new roles and enhance their skills. However, the framework did not present empirical evidence concerning its application to learning environments.

Following, Wongso et al. (2014) proposed a framework for educational domains focused on linking gamification and Web 2.0 social features with five steps: Analysis, Design, Development, Implementation and Evaluation. Game elements and social features are defined in the Analysis step. The authors considered game elements as game mechanics (N = 7), further linked to tasks developed in the Design phase. Nonetheless, the authors did not present an empirical validation.

Kotini and Tzelepi (2015) designed a gamification framework focused on gamifying computational thinking courses. The framework divided the game elements (N = 18) into three categories: Behaviour, Progression and Feedback. These groups were tied to computational thinking skills, behaviours and definitions. Nonetheless, the framework did also lack an empirical validation (e.g., any instance or proof-of-concept on its usage) and the elements were heavily tied to the concepts of computational thinking, which may have hindered adoption by other fields.

Concerned with software development, Mora, Zaharias, González, and Arnedo-Moreno (2016) also proposed a framework for education, called FRAGGLE. This framework used an Agile method from software engineering and gamification features, aligned with learning objectives, to gamify learning systems. The framework was focused on aiding developers and designers and consisted of 4 main steps: Declaration, Creation, Execution and Learning. They considered the use of player profiles to select game mechanics. Again, no empirical evidence was provided, nor a description on the game elements that can be used.

Finally, the most recent framework for gamified education was designed by Ana et al. (2016) where they developed a user-centred gamification framework for the educational field. This framework was organised into 7 steps: Who? What? Why? When? How? Where? How Much? The framework was applied and evaluated with 139 students enrolled in an online course, providing empirical evidence on its use and efficiency on motivation, performance and engagement. This is the only framework to have empirical evidence on its use. However, the framework presented little on the use of game elements and it was focused on learning systems, while ours can be used with unplugged gamification (i.e., the use of gamification without a computer or digital tool).

Considering the related works, we can observe that none of them presented any kind of validation to the game elements that were used nor provided usage information of these elements, e.g., how these elements can be applied within the context of the framework. Only one work presented empirical evidence on its use and another provided partial evidence (e.g., presented how the system worked). As for the definitions and number of elements included, most of the frameworks focused only on elements that acted as a kind of feedback (e.g., points, levels and badges) not considering contextualising elements, such as Narrative and Storytelling. To the best of our knowledge, our study is the first study to use a validated set of game elements to gamify learning systems. Table 1 presents a comparison between ours and related works. Some of the studies appear as having provided partial empirical evidences, meaning lack of methods to measure what was intended or focused upon. Also, none of the frameworks presented an explicit way on how to use the game elements.

Table 1. Related works comparison

Work	# of Game Elements	Provides empirical evidence?	Provides validation of the game elements?	Provides a how-to-use the game elements?
Simões et al (2012)	12	Partially, used in a digital learning environment.	No	No, presented the system with the game elements.
Wongso et al (2014)	7	No	No	No
Kotini and Tzelepi (2015)	18	No	No	No
Mora et al (2015)	Not explicit	No	No	No
Klock et al (2019)	17	Yes, used in a learning environment.	No	No, presented the system with the game elements.
Our study	21	Yes	Yes, a validation based on experts' opinion.	Yes

2. Research method

Our study uses the Design Sprint method, developed by GV (Google Ventures). Its focus is to answer critical business questions through design, prototyping and testing ideas (as a proof-of-concept, i.e., the practical model that can prove the theoretical concept established by research). It has been used to design new products, develop new

features, and define marketing strategies, with a good cost-benefit rating. Comparing it with other agile methods, such as Scrum's sprints, the Design Sprint is focused on learning about an idea, without having to build and launch it, as shown in Figure 1. As such, one of the main advantages of this method is the possibility to shortcut debate cycles and compress months of time into a single week (Sumual et al., 2019).

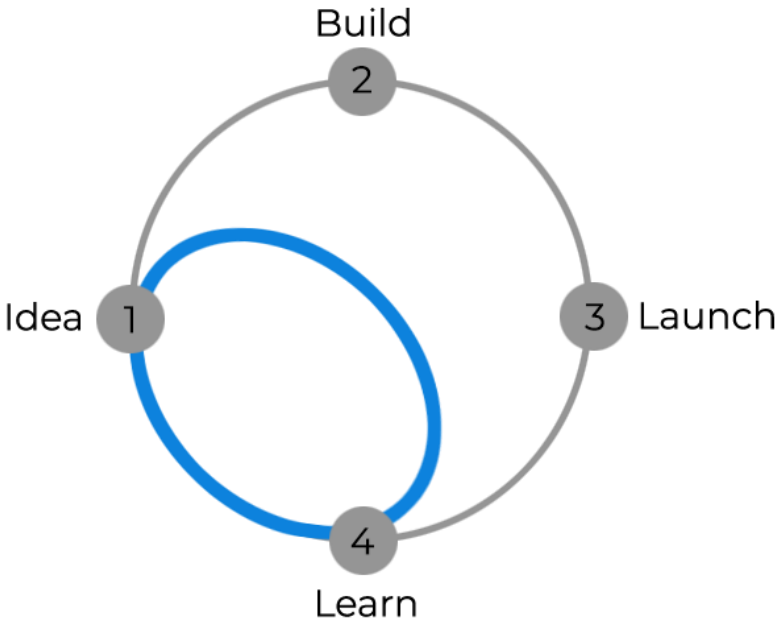

Figure 1. Design Sprint shortcut to learning, without building and launching (Knapp et al. 2019)

In gamification context, as stated in the previous sections of this paper, one of the main problems of its effectiveness is the lack of guidelines and coherent methods to create the strategies and/or applications. Therefore, we chose to work with a systematic and established method for creating and validating new ideas and products, in their conceptual stages, to evaluate the empirical application of the gamification taxonomy for educational purposes and allowing for the proof-of-concept for future building and launching of a digital product based on it. The first step to use the Design Sprint is to set the stage, establishing the right challenge and the right team to deal with it. After that, the sprint is split into five steps (ideally one for each weekday).

1. **Understanding and discussions:** The first day of structured discussions should organise the subsequent steps for the rest of the week. Amongst the tasks included are: establishing a long-term goal and mapping the challenge, picking a target to work (Knapp et al., 2019);
2. **Focus on solutions:** On the second day of the sprint, brainstorming is performed, reviewing existing ideas, in order to remix and improve them. Then, we progress to the sketch phase, emphasising critical thinking (Knapp et al., 2019);
3. **Decision:** here, the team chooses one solution to work, test, and validate, creating a step-by-step plan for the prototype (Knapp et al., 2019);
4. **Prototype:** In the fourth day/step, the team creates the prototype, focusing on testing with customers (end-users). Here, all planning is reviewed and organised for the final step of the sprint (Knapp et al., 2019);
5. **Test and validate:** This includes testing the prototype, interviewing customers and/or learning by watching them reacting to the prototype. As a result, the team knows whether an idea is feasible or not, ending the sprint (Knapp et al., 2019).

For our research, we used the Design Sprint method to validate the use of our taxonomy in the creation, prototyping and testing of an educational gamified application. At this stage of the research, we were not concerned with the application interface and, therefore, the user prototype. Instead, our focus was on the design of gamification strategies (i.e., how can the 21 game elements be used to improve learning experience in a gamified educational system).

The taxonomy used (Toda et al., 2019a) is composed of 21 gamification elements for the education field (Figure 2). These game elements were collected from the literature and focused on creating a syllabus for gamification in education. The authors defined a concept, alongside its synonyms, and a definition for each of the 21 elements. This taxonomy was validated by 19 experts on the field of gamification and education (most of the experts were also lecturers and professors), achieving an overall acceptance of its elements, concepts and definitions. Thus, in summary, we chose this approach as it is an expert-validated, state-of-the-art alternative, specifically developed for educational environments that suits our need.

Figure 2. Taxonomy design (Toda et al., 2019b)

According to Toda et al. (2019b), those elements have been hierarchically linked by classification into five dimensions, related to *performance/measurement*, *environment*, *social/personal interaction* and *student experience*. Importantly, all the 21 elements contain synonyms of alternate names found in the literature (Table 2), for domain specialists to be able to use this taxonomy's recommendations alongside other frameworks. In the next section, we describe how this method was used in our context and the results arising from it.

Table 2. Gamification elements and definitions (Toda et al., 2019a)

Concept	Description	Dimension
Acknowledgement	Type of feedback that praises the players' specific actions. Some examples and synonyms are badges, medals, trophies.	Performance
Chance	Randomness and probability properties that increase or decrease the odds of certain events; examples/synonyms: randomness, luck, fortune.	Ecological
Competition	When two or more players compete against each other towards a common	Social

	goal; examples/synonyms: Player vs Player, scoreboards, conflict.	
Cooperation	When two or more players collaborate to achieve a common goal; examples/synonyms: teamwork, co-op missions.	Social
Economy	Transactions within the game, monetising game values and other elements; examples/synonyms: markets, transaction, exchange.	Ecological
Imposed Choice	Decisions that the player is obliged to make in order to advance the game; examples/synonyms: judgements, forced choices (different from Narrative).	Ecological
Level	Hierarchical game layers, providing a gradual way for players to obtain new advantages upon advancing; examples/synonyms: character levels, skill level.	Performance
Narrative	Order of events happening in a game; i.e., choices influenced by player actions; examples/synonyms: strategies the player uses to go through a level (stealth or action), also the good/bad actions influencing the ending, karma system (different from Imposed Choice).	Fiction
Novelty	New, updated information presented to the player continuously; examples/synonyms: changes, surprises, updates.	Personal
Objectives	Guide the players' actions. Quantifiable or spatial, from short- to long-term; examples/synonyms are missions, quests, milestones.	Personal
Point	Unit used to measure users' performance; examples/synonyms: scores, number of kills, experience points.	Performance
Progression	This allows players to locate themselves (and their progress) within a game; examples/synonyms: progress bars, maps, steps.	Performance
Puzzles	Challenges within the game that should make a player think examples/synonyms: actual puzzles, cognitive tasks, mysteries.	Personal
Rarity	Limited resources and collectables; examples/synonyms: limited items, rarity, collection.	Ecological
Renovation	When players can redo/restart an action; examples/synonyms are extra life, boosts, renewal.	Personal
Reputation	Player titles to accumulate in-game; examples/synonyms: titles, status, classification.	Social
Sensation	Use of players' senses to create new experiences; examples/synonyms: visual stimulation, sound stimulation.	Personal
Social Pressure	Pressure through social interactions with another player (s) (playable and non-playable); examples/synonyms: peer pressure, guilds.	Social
Stats	Visible information for the player, about their in-game outcomes; examples/synonyms: results, health bar, magic bar, HUD, indicators, data from the game presented to the user.	Personal
Storytelling	The way the story of the game is told (as a script) within the game, via text, voice, or sensorial resources; examples/synonyms: stories told through animated scenes, audio queues or in-game text queues.	Fiction
Time Pressure	Pressure through time in-game; examples/synonyms: countdowns, clock, timer.	Ecological

3. Application

In this section, we aim to describe how we used the Design Sprint method to propose the gamification design instantiating the taxonomy proposed by Toda et al., (2019a). Our main idea was to use the Design Sprint method in order to think, propose, prototype and evaluate the gamification design. The team is composed of five experts (each with more than five years of experience) in Education, Computer Science, Gamification Design, and Human-computer Interaction (HCI). This number is also a recommendation by Nielsen and Landauer (1993).

On the **First Day** (understanding and discussions), the team members set the long-term goal, mapped project challenges, and set targets for the project execution. As a result, it was decided to propose a gamification design, capable of being used in the implementation of different gamified systems and implementing the gamification

elements proposed in the taxonomy. In the challenge mapping stage, four challenges were defined to guide the project management:

1. **Definition of a general gamification design architecture (Day 1 and 2)**: At this stage, the main objective was to define a general architecture of a gamified educational system and defining how the elements could be organised (i.e., on which pages each element should appear); this was done through a brainstorming session.
2. **Implementation of the elements according to the taxonomy (Day 3)**: At this state, the main objective was to define how gamification elements should be organised and the internal relationships between elements and activities in the system (e.g., when finishing an activity, which gamification elements should be changed as a reward to the user); to achieve this step, we mapped the activities and events on the system and matched each with the elements based on recommendations presented in previous works (Toda et al., 2018a; Toda et al., 2019c).
3. **Gamification design proposal (Day 3 and 4)**: At this stage, the main objective was to write the documentation of the gamification design, condensing the results from the previous steps. In other words, this meant formalising the gamified strategies (A gamified strategy in the scope of this work is an event that links a task and a given gamification element, e.g., Perform a Login (Task) and receive a badge (Gamification element: Acknowledgement)).
4. **Gamification design instantiation (Day 5)**: In this step, the main objective was to apply the design in a learning system.

On the **Second Day** (focus on solutions), team members reviewed what was defined in the previous day. Through meetings and brainstorming sessions, the team re-analysed what was proposed and made any changes that could impact onto the final system. Then, an outline of the proposal was defined, seeking to relate each gamification element and discussing how the elements could be implemented. These annotations and definitions were made using Trello (see https://www.trello.com), a system design to manage team projects.

On the **Third Day** (decision), team members detailed how each gamification element should be implemented in educational systems, and how these elements relate to each other. At the end of the day, the team finished the gamification design, seeking to define how the elements proposed in the taxonomy could be grouped, organised and implemented within an educational system, through the gamified strategies (Figure 3). An example was to design the Home page. In this page, the students would have visual access to certain elements, as the weekly leaderboard (Competition and Time Pressure), Cooperation (Their groups), their progress within the system (Point, Level, Progression, Acknowledgement and Reputation) as well as the missions that were assigned to them (Objectives). These elements were combined and proposed based on the recommendations of the Taxonomy and other studies that validated those combinations with students (Toda et al., 2019d).

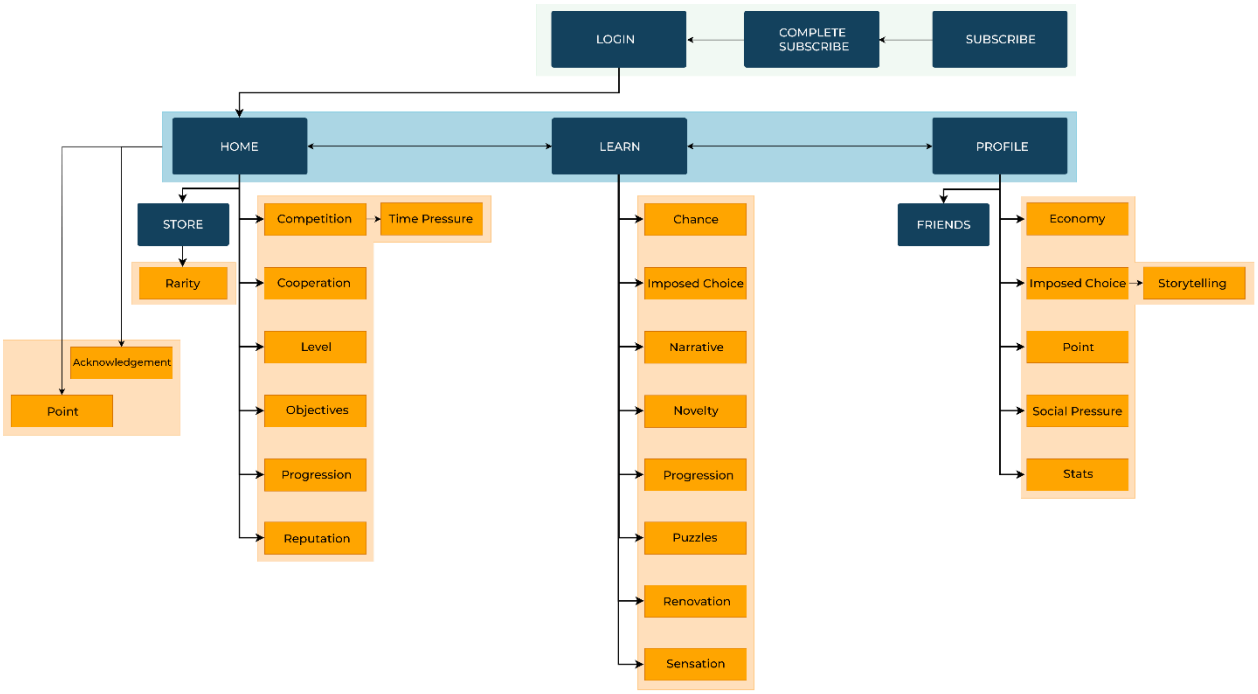

Figure 3. Gamification design flowchart

On the **Fourth Day** (prototype), the gamification design was discussed among all team members and all team members agreed with the proposal. Next, through another brainstorming session, the team defined the functions that would be present in the prototype. On the **Fifth Day** (test and validate), we analysed the prototype and tested the gamification elements interactions through decision tables testing, which is a common software development technique for defining software restrictions and events. It is a systematic method to test input combinations and their output (Jorgensen, 2013). An example of the Decision table testing can be seen in Table 3, where each "Event" row is an action that can be performed in the prototype and the following columns are the gamification elements that are affected by that action.

Table 3. Table testing example

Event	Point	Acknowledgement	Competition	Time Pressure	Social Pressure	Imposed Choice
A1: Student got a question right	Yes	Partially	Yes	No	Partially	No
A2: Student chose their avatar	No	No	No	No	No	Yes
A3: Student achieved a new rank on the leader board	Yes	Yes	Yes	Partially	Yes	No
A4: Student got 5 questions right in a sequence	Yes	Yes	Yes	No	Partially	No

An example on how to understand Table 3 is the first row, where A1 is the event "*Student got a question right*," triggered when the student is answering a question related to a certain content. When students answer correctly, they gain a ***Point***, which can be summed towards an Achievement (***Acknowledgement***), and towards the Leader Board (***Competition***). The update on the Leader Board can influence the ***Social Pressure*** in the system, since the student

can increase their rank or decrease it, affecting other students. Figure 4 demonstrates an interaction diagram of the events A1 and A4, to exemplify the approach.

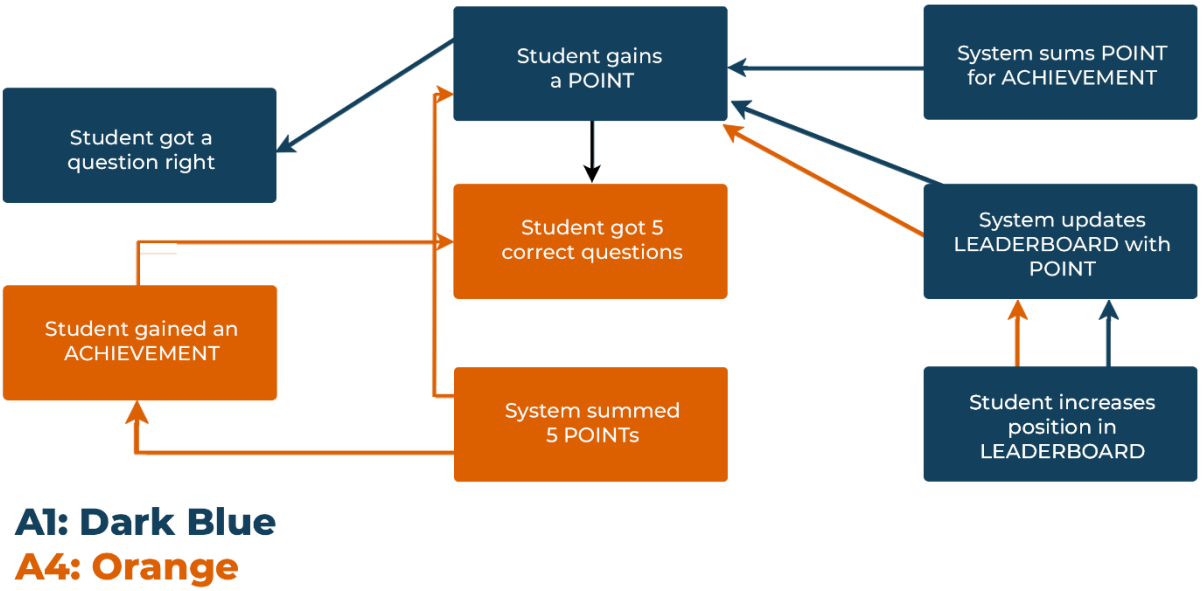

Figure 4. Interaction diagram to exemplify the decision table test

The system consists of three main pages: *Home*, where students can track their progress and evolution in the system; *Learn*, where students will have educational activities; and *Profile*, where students will have access to all their information. The *Home* page has a sub-page called *Store*, where students can buy special items. The *Learn* page has three task settings (missions), where students will have lessons. The *Profile* page has a sub-page called *Friends*, where students can view other members and follow them. These pages were designed using scenarios and evaluated using the persona technique, which is based on creating goal-directed, role-based and fictional users that will interact with the system (De Borba, Gasparini, & Lichtnow, 2017; Nielsen, 2013; Preece, Rogers, & Sharp, 2015). For example, Gareth, the undergraduate student and avid competitor, who tends to get questions wrong, and may not notice functionality of the system due to his impulsivity. Or Cynthia who likes to buy clothes in real-life, and is attracted by the store icon in the system, etc. This technique is used for testing prototypes and can aid designers to visualise the behaviours within the system. This technique has also been used to evaluate other gamified educational systems, as seen in Palomino et al (2019a).

An example for the gamification design is the implementation of the Point element is as follows: "*The Point element will be displayed on all pages (in the fixed header) and will be represented by experience points (XP). The student will earn seven (or a specific number according to the system specificities) points for each activity done and two extra points if the activity is done correctly (hit the answer). Points will be updated each time the student completes an activity group. The total points will also be highlighted on the Profile page*." Table 4 synthesises the proposed gamification design.

Table 4. Proposed gamification design

Concept	**Design description**
Acknowledgement	The Acknowledgment element should be displayed on all pages and will be represented through the achievement feedbacks. Thus, the user will receive immediate notifications of all achievements in the system.
Chance	The Chance element should appear on the Learn page and will consist of a random option offered to the user to increase their prize.

Competition	The Competition Element should be featured on the homepage and represented by weekly leaderboards with up to 10 students.
Cooperation	The Cooperation element should be featured on the Homepage and represented by the formation of random teams of up to 5 students.
Economy	The Economy element should appear on every page and represented by coins that can be used to make in-game purchases.
Imposed Choice	The Imposed Choice element should be displayed on the Profile page. When viewing their profile for the first time, users should be able to choose an avatar to represent them in the system. This avatar will evolve when using the system. In addition, the student should have to make different types of choices during use (e.g., choosing between chests with coins).
Level	The level element should be displayed on the Homepage, represented by phase (bronze, silver, gold, and diamond, respectively).
Narrative	The narrative element should be presented on the Learn page, represented by the user's ability to do extra activities. At times, when the user completes a quest, they may choose to visit other system pages or immediately do a new quest, for earning extra coins.
Novelty	The Novelty element should appear on the Learn page and the Store page. On the Learn page, it should be represented by hints that will be appear when the user misses a sequence of three questions in a row. On the Store page, it should be represented by selling special objects.
Objectives	The Objectives element should be displayed on the Homepage and should be represented by a quest tree. This tree can show the entire sequence of missions the student has in the system.
Point	The Point element should be displayed on all pages (in the fixed header) and should be represented by experience points (XP). The student should earn points for each activity done and extra points if the activity is done correctly (hit the answer).
Progression	The Progression element should be displayed on the Home and Learn pages and should be represented as a progress bar. The Homepage should be represented by a circular progress bar in the activity tree, indicating how much of each activity group has been completed and how much remains to be completed. In the Learn page it should be represented by a progress bar, showing how much has been completed and how much is left to complete each activity group.
Puzzles	The Puzzles element should be presented on the Learn page and should be represented by proposing (non-mandatory) surprise challenges, related to the subject being studied.
Rarity	The Rarity element should appear on the Store page and should be represented as a series of shields. Rare items should be available in the system store with purchase values that can be purchased through coins.
Renovation	The Renovation element should be displayed on the Learn page and should be represented through the possibility for students to perform activities in which they err. There should be no cost for students to redo the activities they have missed.
Reputation	The Reputation element should be displayed on the Homepage and should be represented by the student's title/patent display. Different hierarchical levels can be achieved through special sequences in the system.

Sensation	The Sensation element should be displayed on the Learn page and should be represented by immediate feedback (visual and audible) regarding each action/response from users, indicating whether they have hit or missed each question.
Social Pressure	The Social Pressure element should be displayed on the Profile page and should be represented by an alert message, whenever the user drops in the ranking (is exceeded by a colleague).
Stats	The Stats element should be present on the Profile page and should be represented by all user progress information, which by default will already be displayed on the Profile page.
Storytelling	The Storytelling element should be present on the Profile page, represented by the evolution of the avatar (and its story) of a student (thus associated with the Imposed Choice element).
Time Pressure	The Time Pressure element should be present on the Home page and should be represented by a weekly countdown (thus associated with the Competition element).

4. Discussions and limitations

Before starting the discussions related to our study, it is important to highlight that our study generated some limitations inherent to this type of study. Initially, because it is a critical and creative process, it is not possible to systematise all design decisions (e.g., document all discussions). To mitigate this limitation, we used a process known in the literature and used in similar studies (Design Sprint method). In the last step (***Fifth day***), it was not possible to perform an evaluation with users; however, we used the persona technique, which is a valid HCI technique.

Additionally, there is the limitation of implementing content elements from the Taxonomy by Toda et al., (2019a). By content elements we especially refer to Storytelling and Narrative (Kapp, 2012; Palomino et al., 2019b) that, although already mentioned in the literature, e.g., Marczewski's Periodic Table of Gamification Elements (Tondello et al., 2016) and Klock's gamification conceptual model (Klock et al., 2019), lack systematically validated procedures (e.g., frameworks or processes) guiding designers on how to implement them. For instance, Armstrong and Landers, (2017) investigated the impact of transforming regular texts into scripted texts, thereby making users interact with texts telling a story, which fits in the Storytelling game element (Toda et al., 2019b). Another example is Champagnat, Delmas and Augeraud, (2010) research which dealt directly with the Storytelling concept applied to learning. They presented a variation of Campbell's Hero Journey (Campbell, 2008), specifically, for interactive storytelling, and detailed how this model could be used in an educational context.

In these cases, authors often rely on some specific or self-developed framework/process for implementing those elements. Whereas there exist options for developing stories, which might be used for Storytelling (e.g., that used by Landers et al. (2017)), the literature still lacks a systematic process for adding the Narrative game element to GES, although research towards this direction has recently emerged (e.g., Marczewski, 2015; Palomino et al., 2019c). Thus, future studies maturing the field in terms of how to implement content game elements would benefit designers and, as using these elements along with other common game elements (e.g., Cooperation, Objectives and Puzzles) is of users' interest (Palomino et al., 2019b), their experiences would be benefited as well. Therefore, we call for further research on this topic.

Furthermore, defining which set of elements to use together was another challenging process. This happens due the lack of studies that provide clear guidelines and justifications on the combination of game elements, which has been pointed as an important aspect in the gamification design (Dichev & Dicheva, 2017; Toda et al., 2018b). On one hand, each element from the taxonomy used in this work has a specific goal and, therefore, is likely to be used in different occasions. On the other hand, there are some elements that have similar goals, as can be seen by their grouping shown in Figure 2. However, selecting which game elements to use together, by simply following their grouping, might not be the best option as, for instance, one might be seeking to create a gamification design (game

elements set) that involves showing users' performance (one group) based on their social interactions (another group). To define those sets, there are two high-level approaches that have been explored: theory- and data-driven insights.

While theory-driven approaches explore theories such as the self-determination theory (Deci & Ryan, 1985) to define which game elements to use, data-driven ones rely on, for instance, usage data to select the gamification design (Meder, Plumbaum, & Albayrak, 2017). On the other hand, the data-driven approaches have recently emerged, and scholars have defended their benefits over theory-driven ones, in the context of gamification (Meder et al., 2017) . Given this context, studies on how to define gamification designs based on data have started to appear (Toda et al., 2019c). Nevertheless, as this is a recent field study, it is yet to mature and further research is required to both improve the understanding on how to create those data-driven designs, as well as to identify whether those are more effective than theory-driven designs in affecting users' behaviour – or perhaps combined approaches are required.

Another recent, relevant issue of gamification designs that was not addressed by the design we presented in this study is personalisation. That is, providing gamification design tailored to different user types aiming at improving their experiences (Oliveira & Bittencourt, 2019). As gamified systems are a specific type of information systems, the personalisation dimension is an important aspect to be tackled (Klock, Ogawa, Gasparini, & Pimenta, 2018; Liu & Stacey, 2015). Personalisation emerges as an approach to accommodate different users within the same gamified systems (Seaborn & Fels, 2014), which is a necessary step, as users have different behaviours, interpretations, preferences, and experiences (Lavoué, Monterrat, Desmarais, & George, 2019; Orji, Tondello, & Nacke, 2018), thereby, the same gamification design is unlikely to work for all of them.

Thus, we highlight two closely related research veins that should be tackled. Future studies should further investigate whether the use of personalisation approaches can improve gamification's effectiveness, compared to generic design. The other is that personalisation approaches focusing not only on the users, but also on the task they are performing, should be performed, to provide gamified design aiming to satisfy users' preferences, as well as the task at hand. Consequently, creating guidelines on how to deploy it, which will then support practitioners deciding on how and whether to personalise the gamification designs of their systems.

Regarding the use of the Design Sprint method, it was noted that this method allowed team members to propose a solution rapidly and through a critical-creative approach, where team members were able to share opinions on each step of the solution proposal, and at the same time, criticise colleagues' proposals and self-criticise their propositions. Thus, it is possible to conduct further studies using this method and perform evaluations that can measure the effectiveness of the method in the gamification design process.

5. Conclusions and future work

This work presented a method on how we can use gamification elements to gamify learning environments. We compared our taxonomy with other works concerned with gamifying learning activities that were found through an existing systematic mapping. We also used an agile process alongside the given taxonomy. Through this work, we present a new way on how to gamify learning systems using methods different from other frameworks. We also believe that this taxonomy can be used within most existing frameworks in the education field, since its definitions cover most of the elements that exist in previous frameworks.

For future work, we are focusing on designing an experiment to research if this taxonomy can be used alongside data-driven gamified recommendations based on the elements that compose it. We intend to conduct a deeper analysis on the scenarios provided in Table 3, by using other types of evaluation besides the persona technique (e.g., students' evaluations of the system). We also intend to design a gamified educational system based on the gamification design proposed in this article and to conduct a longitudinal study assessing the students' experience in that system. We are especially interested to investigate the gamification influence in the students' flow experience and learning outcomes.

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