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A Taxonomy of Game Elements for Gamification in Educational Contexts: Proposal and Evaluation

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***Abstract*—Gamification has been widely employed in the educational domain over the past eight years when the term became a trend. However, the literature states that gamification still lacks formal definitions to support the design of gamified strategies. This paper aims to create a taxonomy for the game elements, based on gamification experts' opinions. After a brief review from existing work, we extract first the game elements from the current state of the art, and then evaluate them via a survey with 19 gamification and education experts. The resulting taxonomy taxonomy included the description of 21 game elements and their quantitative and qualitative evaluation by the experts. Overall, the proposed taxonomy was in general well accepted by most of the experts. They also suggested expanding it with the inclusion of Narrative and Storytelling game elements. Thus, the main contribution of this paper is proposing a *new, confirmed taxonomy to standardise the terminology used to define the game elements as a mean to design and deploy gamification strategies in the educational domain*.**

***Index Terms*—gamification, taxonomy, survey, experts, education**

I. Introduction

The use of gamification strategies in educational contexts has increased over the past few years, due to the fact that it has been shown to improve the student's motivation and engagement [1], [2]. However, since the success of gamification in those contexts relies on a proper design to avoid undesired effects [1], [3], [4], many input variables must be considered by the gamification researchers, to achieve a satisfactory outcome. Some examples of these variables are the students' characteristics (e.g., demographic, psychological and cognitive data) and the game elements to be used to gamify a task [5], [6].

Game elements are characterised in different ways by the literature. One of the most used approaches is through the MDA framework, originated from digital games, which describes the game elements as belonging to one of these categories: Mechanics, Dynamics and Aesthetics [7]. This framework has been adapted to generic gamification framework [8], which do not take into account specifications from educational domains nor present ways and examples of how those elements can be used in those contexts.

Besides, existing gamification frameworks that focus on the education domain present game elements that are tied to particular contexts [9]. For example, Kotini and Tzelepi [10] developed a conceptual framework focusing on Computational Thinking, and the game elements used were tied to the subject and concepts their students needed to learn. Likewise, the framework of Toda et al. [11] proposes a taxonomy for the game elements and evaluated the framework with gamification experts, without verifying the comprehensibility, coverage or examples of each game element.

To address this problem, our work aims to not only present a taxonomy for game elements in the educational domain, but also to evaluate it (via a survey) with specialists. After extracting 19 game elements from the literature, their comprehensibility, description, examples and coverage were evaluated with 19 experts on gamification and education. Another evaluation was conducted with 11 experts, in order to verify the relevance of the game elements for education. This process results in the final taxonomy, which is our recommendation.

Thus, the main contribution of this work is to provide a taxonomy standardising the game elements employed by both gamification in education and educational games, since those elements were also derived from the game design literature. This taxonomy can support the design of gamified strategies in educational domains (e.g., classrooms or computational systems).

The remainder of this paper is structured as follows. Section II introduces the methods and materials that were produced to conduct the study. Section III describes our results, the proposed taxonomy as well as threats to validity. Finally, section IV presents our conclusions and future works.

II. Materials and Methods

This section describes the methods that were used during the pursuing of this research (Figure 1). We first identified and analysed the game elements commonly employed by gamification frameworks focused on educational contexts. Next, we analyse the game elements explored by a framework focusing on Behavioural Games [12] and took them as baseline.

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Dignan's framework for behavioural games was one of the first frameworks to address gamification concepts (although not defined as gamification at the time).

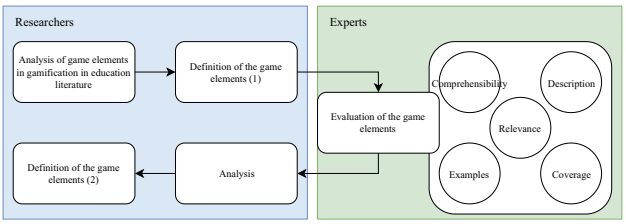

Fig. 1. Steps of the study

To evaluate these game elements, we conducted an online survey with experts[1]. Those experts ranged from game developers, game designers, researchers and teachers. The experts were invited to answer the survey by e-mail and online messages through social networks, in order to make the whole process more convenient for them. The evaluation is composed of five statements, focusing on:

1) **Comprehensibility:** to create a standartised concept for a given group of synonyms of the same element (e.g., *Points* could be allocated as a common denominator, incorporating *Experience Points* as well as *Score*);
2) **Description:** to provide a suitable definition for the game element; this means it has to be both clear, thus specific enough, as well as comprehensive (wide enough to include the semantics of the various synonyms, as above);
3) **Examples:** to provide practical examples of where and how each game element could be used;
4) **Coverage:** to determine if the 19 chosen game elements were sufficient to represent all types of gamification needed in educational environments;
5) **Comments:** to include any additional observation or opinion concerning the given taxonomy, which they felt was needed, in their expert opinion.

Each expert had to answer the above 1 to 4 items through a Likert scale [13] ranged from 1 to 5, where 1 represents *Totally Disagree* while 5 *Totally Agree*. We also asked the experts to make open-ended comments (item 5) on the existing elements; here, they were asked to consider also if they would insert, remove or modify them in any way. Other information collected during the survey included the domain of each expert (e.g., game development or designer, researcher, teacher or instructor, or other) where multiple types of domains could also be selected; and their experience (in years) in that domain.

To analyse the relevance of the game elements to education, we developed another online questionnaire[2] composed of 19 questions – one for each element. It is important to note that not all of the experts answered this questionnaire, since it was optional to participate in this section of the study. This time, the questions consisted of evaluating the relevance of each element.

Each game element is composed of a Concept, a Description defining this Concept, and an Example where this concept is implemented in practice. The Likert scale [13] that was adopted for each game element, ranged from 1 (the element is not relevant) to 5 (the element is highly relevant). An example of a question can be seen in Figure 2. The concept (game element) is displayed in capital letters, followed by its description and examples. Please note that questions were designed to be unbiased (not asking positive or negative questions). Regarding comments, the experts could suggest new game elements and any changes that they thought would be important to the ones that were already presented.

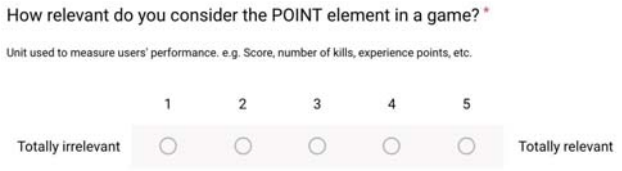

Fig. 2. Example of game element that was analysed by the experts

After the evaluation, we analysed the answers, to propose a taxonomy of game elements used within gamified educational practices. The analysis performed was a semantic analysis [14], where the concepts of each element were re-analysed after the modifications that were suggested by the experts. This analysis also aimed at identifying possible behaviours that those elements could trigger amongst the learners while interacting with those elements.

III. Results and Discussion

A. Results

In total, 19 experts answered our survey. Most of them were researchers (N = 17) and teachers[3] (N = 7), but we also had game developers (N = 3), a designer (N = 1), and an Artificial Intelligence Engineer (N = 1). It is worth to note that the field of expertise was open, so each expert could select more than one field. An overview of the experts' opinions on the game elements can be seen on Table I. We calculated Cronbach's Alpha for each of the aspects; the result suggests a high internal consistency among the 19 experts ($\alpha > 0.8$) [15]. The data used in this study can be found in https://tinyurl.com/y22qrw8g.

TABLE I
Experts' general answers about the game elements

	Likert Scale						
Aspect	**1**	**2**	**3**	**4**	**5**	**Mean**	α
Comprehensibility	7%	10%	0%	21%	62%	4.21	0.84
Description	7%	3%	14%	28%	48%	4.07	0.85
Examples	7%	0%	24%	34%	34%	3.90	0.88
Coverage	7%	14%	7%	31%	41%	3.86	0.90

[1]Available on: urlhttps://forms.gle/DAyMRJfa2gG5HdQF6
[2]Available on: https://goo.gl/forms/LKrc4HF2YKqRZ1xC2
[3]It is important to note that all of the teachers were also researchers.

As we can observe in Table I, the game elements that were analysed had an overall good acceptance in their coverage, which means that the majority of the experts agreed that the 19 game elements could represent well the entire set required for educational applications. Additionally, the game designer suggested to include two new game elements as part of the elements set: *Narrative* and *Storytelling* (which was suggested by 4 out of the 19 experts that answered our survey). There were also some minor changes related to the game elements terminology. These two new game elements were considered important by the authors, because, as concepts, they are intrinsically connected to human behaviour and our necessity of telling stories, as stated by Ricoeur [16]. Thus, both elements were included in the proposed taxonomy.

The *narrative* can be defined as a sequence of events transmitted by a subject. This sequence can be modified in quantitative and qualitative ways (e.g. how this sequence is told, or its storytelling). It also has a calming function and is directly related to motivation and purpose. We can say that the act of narrating stories merge together a purpose of meaning and constant transformation, by establishing a dialogue with a receptor [17].

To fully understand narrative in games, it is important to observe the role of the narrative as it is lived through the game. In this sense, the narrative begins to unfold from the moment the player reads the title of the game or interacts with its mechanics. Everything is an element that contributes directly, and uniquely, to this narrative experience in games [17].

Scartozzoni [18] explains that to understand the term storytelling, one must realise the difference between the English words 'History' and 'Story'. The first is related to real events, such as the fall of the Roman Empire. The second is a narrative structure, usually linked to fiction, but not necessarily. The act of telling this story can be defined as a chain of logical events, within a structure with certain patterns, whose main points are:

- A break in the routine. Stories are mostly about extraordinary events, as we can see in the steps described in Campbell Hero's Journey [19].
- At least one protagonist must exist, which is the character that people should identify with and can be the avatar in a gamified system.
- At least one antagonist must exist in order to create obstacles for the protagonist. In a gamified system, this can be represented by challenges and tests, for example.
- A story needs a conflict, the tension between opposing elements, to grab users' interest (i.e., engagement). In a gamified system, this can be represented by the learning route itself and the tension generated by the process of understanding and frustration in moments of incomprehension.
- The story must have a plot, with beginning, middle and end, passing through some kind of climax. The term 'plot' is the one used in Storytelling, and is considered essential for the story to make sense to people (i.e., build meaning).

Further qualitative evaluation derived from the survey consisted in analysing the written comments provided by the experts. Although most of the experts agreed on most of the aspects that were evaluated, some of them suggested changing the terms, to improve the comprehensibility of the concept, or to change the examples, for similar reasons.

Furthermore, from the 19 experts, only 11 opted to answer the survey analysing the individual game elements relevance to education. The results are detailed in Table II. According to the results, the experts believe that Objectives, Level and Progression are the most important game elements. Besides, according to Table II, no game element was considered irrelevant by the experts who answered this survey.

TABLE II
RELEVANCE OF EACH SUGGESTED GAME ELEMENT

	Likert Scale						
Game element	**1**	**2**	**3**	**4**	**5**	**Mean**	**SD**
Objectives	0%	0%	0%	23%	77%	4.77	0.44
Level	0%	0%	8%	31%	62%	4.54	0.66
Progression	0%	0%	15%	23%	62%	4.46	0.78
Acknowledgement	0%	0%	15%	62%	23%	4.08	0.86
Point	0%	8%	8%	54%	31%	4.08	0.64
Competition	0%	0%	23%	54%	23%	4.00	0.71
Novelty	0%	0%	15%	69%	15%	4.00	0.58
Data	0%	0%	31%	46%	23%	3.92	0.71
Puzzle	0%	8%	23%	38%	31%	3.92	0.95
Classification	0%	8%	8%	77%	8%	3.85	0.76
Scarcity	0%	8%	23%	46%	23%	3.85	0.9
Sensation	0%	15%	15%	38%	31%	3.85	1.07
Cooperation	0%	0%	31%	62%	8%	3.77	0.69
Time pressure	0%	8%	23%	54%	15%	3.77	0.6
Chance	0%	8%	31%	46%	15%	3.69	0.83
Economy	0%	0%	54%	31%	15%	3.62	0.85
Choice	0%	7%	50%	36%	7%	3.43	0.77
Renovation	8%	15%	15%	54%	8%	3.38	1.12
Social pressure	8%	15%	38%	38%	0%	3.08	0.95

Based on the suggestions from the experts, we proposed a taxonomy composed of 21 game elements (Table III). We conducted a semantic analysis, to identify which learner behaviours these elements may affect, based on their descriptions and instances. Furthermore, we analysed the *engagement* and *motivation* behaviour in those elements, since those are strongly connected to gamification definitions [2]. This analysis consists of reading the instances where these elements were implemented, to extract possible affected behaviours, i.e., the Point element was used by Toda et al. [11] to reinforce positive behaviour and repetitive action – to answer a question correctly. In other words, the Point was used to increase engagement. Another example can be observed using Competition. This concept is usually tied to aims such as motivating and engaging the students through a healthy conflict. In the same work, the authors [11] developed a competition among the students, to motivate them in achieving the learning goals, while also engaging them in performing the activities that were proposed by the teacher.

B. Discussion

Based on our results, we can observe that most of the researchers agree that the game elements selected have good

TABLE III
GAME ELEMENTS AND AFFECTED BEHAVIOUR.

Concept	Description	Affected Behaviour
Acknowledgement	All kind of feedback that praises the players' specific actions. Some examples and synonyms are badges, medals, trophies.	Engagement
Chance	Randomness and probability characteristics to increase or decrease the odds of certain actions or outcomes. Some examples and synonyms are randomnesses, luck, fortune.	Engagement
Competition	When two or more players compete against each other towards a common goal. Some examples and synonyms are Player vs Player, scoreboards, conflict.	Engagement Motivation
Cooperation	When two or more players collaborate to achieve a common goal. Some examples and synonyms are teamwork, co-op missions.	Motivation
Economy	Transactions within the game, monetising game values and other elements. Some examples and synonyms are markets, transaction, exchange.	Engagement
Imposed Choice	Decisions that the player is obliged to make in order to advance the game. Some examples and synonyms are judgements, forced choices. *(not to be confused with Narrative).*	Engagement Motivation
Level	Hierarchical layers present in a game, which provide a gradual way for the player to obtain new advantages as they advance. Some examples and synonyms are character levels, skill level.	Engagement
Narrative	Order of events where they happen in a game. These are choices influenced by the players' actions. Some examples and synonyms are the strategies the player uses to go through a level (stealth or action), also the good or bad actions that influence the ending, karma system. *(not to be confused with Imposed Choice).*	Motivation
Novelty	New, updated information presented to the player continuously. Some examples and synonyms are changes, surprises, updates.	Engagement Motivation
Objectives	Guide the players' actions. Quantifiable or spatial, from short to long term. Some examples and synonyms are missions, quests, milestones.	Engagement Motivation
Point	Unit used to measure users' performance. Some examples and synonyms are scores, number of kills, experience points.	Engagement
Progression	This allows players to locate themselves (and their progress) within a game. Some examples and synonyms are progress bars, maps, steps.	Engagement
Puzzles	Challenges within the game that should make a player think. Some examples and synonyms are actual puzzles, cognitive tasks, mysteries.	Engagement
Rarity	Limited resources and collectables. Some examples and synonyms are limited items, rarity, collection.	Engagement
Renovation	When players are allowed to redo/restart an action. Some examples and synonyms are extra life, boosts, renewal.	Engagement
Reputation	Titles that the player accumulates within the game. Some examples and synonyms are titles, status, classification.	Engagement Motivation
Sensation	Use of players' senses to create new experiences. Some examples and synonyms are visual stimulation, sound stimulation.	Engagement
Social Pressure	Pressure through social interactions with another player (s) (playable and non-playable). Some examples and synonyms are peer pressure, guilds.	Engagement Motivation
Stats	Visible information used by the player, related to their outcomes within the game. Some examples and synonyms are results, health bar, magic bar, HUD, indicators, data from the game presented to the user.	Engagement
Storytelling	It is the way the story of the game is told (as a script). It is told within the game, through text, voice, or sensorial resources. Some examples and synonyms are stories told through animated scenes, audio queues or text queues during the game.	Engagement
Time Pressure	Pressure through time within the game. Some examples and synonyms are countdowns, clock, timer.	Engagement Motivation

comprehensibility, description and coverage. Some of them argued about some examples that could be addressed differently, removed or changed. [4]

According to our findings, most of the researchers considered Objective, Level and Progression as the crucial elements. It is interesting as, in educational domains, it has been shown that the lack of objectives and sense of progression decreases students' motivation and engagement [20]. This means that focusing on the design and development of gamification strategies that address those elements may be a band-aid for this motivation problem (but not for the root of it, since there are other aspects concerning motivation that can't be tackled by the educational environment alone, i.e., classrooms or virtual learning systems).

Our findings suggest that most frameworks do not consider Narrative and Storytelling as essential game elements. From the gamification frameworks focusing on education domains that were analysed by Mora et al. [9], we can observe that only one framework addressed the concept of Narrative [21]. In this paper, we have addressed the concept of Narrative and Storytelling, as they are described in [22].

To discuss our limitations, we use the constructs proposed by Wohlin et al. [23]: Internal, External, Construct and Conclusion. Concerning internal threats, we believe that the experts could be affected by the period the survey was answered, but we believe to have mitigated this by allowing them to answer the questionnaire on their computer at a time that was most convenient to them. Another internal validation issue can relate to the number of questions that were required to be answered, as well as the number of elements to analyse. To mitigate these possible issues, we divided the survey into two, and the second survey (concerning the game elements relevance) was not mandatory to answer, which reduced the number of questions drastically.

[4]The final version of our survey can be found in the following link: https://goo.gl/forms/05utLTSmxZBX7uQA2

Concerning external validity, most of the surveyees are from the same country (Brazil). Due to this fact, we believe that we cannot generalise this evaluation to all contexts, for all countries. Besides, as only 19 experts have answered our survey, this could be considered a low number of responses. Nevertheless, as they were all experts, the numbers are less relevant, and, in fact, this is a relatively high number for expert consultations. As for the construct threat, we thought that the questions could be misunderstood, and, consequently, the answers collected might not support us to validate the taxonomy. To minimise this issue, before applying the survey with the experts, we conducted a syntactic and semantic analysis with three experts in Human-Computer Interaction, Gamification and Digital Games. Finally, for the conclusion validity, we did not evaluate the affected behaviours with all 19 experts. Instead, these behaviours were analysed by the same three experts that analysed the survey applied to the experts.

IV. Final remarks

This work has addressed the definition and evaluation of game elements that can be used in educational contexts. Our main contribution is the taxonomy of elements presented in Table III, where we defined the concept, description and examples for each game element, as well as how they may affect user behaviour. We differ from other works on this topic by: (a) providing an evaluation of the elements by experts, with an overall good acceptance; and (b) mapping possible affected behaviours. We believe that this taxonomy may contribute especially to Human-Computer Interaction, Software Engineer and Gamification applied to education domains.

For future works, we aim at consulting more experts to answer the survey. We are currently exploring the extension of the Narrative concept in Gamification. We are also applying the validated survey to collect the opinions about the game elements above. We believe that this information, along with the use of data mining techniques, may allow us to find patterns that relate the users' characteristics and the game elements these users consider most important. This information may also allow us to provide recommendations on how to apply gamification in specific domains (in this case, education).

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