Thinking Inside the Box: How to Tailor Gamified Educational Systems Based on Learning Activities Types

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Abstract. *Selecting gamification elements suitable for specific players (personalization) has been sought to improve the impacts of Gamified Educational Systems (GES). However, the lack of context might be a factor on the inconsistent results of those approaches. To address this lack, we introduce a method for personalizing GES based on learning activities types. The assumption is that selecting gamification elements for specific types of learning activities has the potential to improve GES impact on users by considering the context of each activity and, thus, contributing to their learning process. We describe how to apply our approach, how it differs from user-based methods, as well as discuss three cases of application and challenges yet to be tackled.*

1. Introduction

Gamification, the use of game elements in non-gaming contexts [Deterding *et al*. 2011], has been widely applied on educational systems [Borges *et al*. 2014]. Whereas many different studies have demonstrated positive results towards learners' motivation and engagement [Klock *et al*. 2018], others have shown a negative impact on learners [Toda *et al*. 2018]. Aiming to achieve the desired outcomes as well as to mitigate its negative effects, researchers have advocated towards personalizing Gamified Educational Systems (GES) (*e.g.,* [Borges *et al*. 2017; Santos *et al*. 2018a; Santos *et al*. 2018b; Lopez and Tucker 2018]). Personalization is a persuasive strategy that provides users with personalized content, commonly based on their personal characteristics [Oinas-Kukkonen and Harjumaa 2008]. Hence, personalizing a GES is often accomplished through selecting which gamification elements (*e.g.* points, leaderboard or badges) will be provided to the users based on their specific characteristics.

As users' demographic data might impact their opinions [Rodrigues and Brancher 2019a], many personalized GES are developed thinking in collecting users' demographic profile and giving them a reasonable group of game elements [Santos *et al*. 2018a; Lavoue *et al*. 2018; Monterrat *et al.* 2017]. Although, recent studies on personalization demonstrate that these tailored game elements might not impact positively on aspects related to the students' learning process [Santos et al. 2018a; Monterrat *et al.* 2017]. This allow us to assume that thinking from outside the box may not be the most suitable way to personalize those GES. Based on this premise, we propose a novel approach to use gamification by thinking from inside the box. In this approach, we aim at using the learning activities types (LAT; see, *e.g.* [Toetenel and Rienties 2016; Krathwohl 2002]) present on the educational system as the basis for generating the game

DOI: 10.5753/cbie.sbie.2019.823

elements that will be presented to the students. For instance, our approach would provide elements in line with each type of learning activity (*e.g.,* attending to information [Toetenel and Rienties 2016] or understanding a subject [Krathwohl 2002]) instead of elements users with specific characteristics (*e.g.*, males or females) prefer in a general picture. A specific case would be to add time pressure (gamification element) on an activity that intents to make learners effectively summarize (activity type) an essay, rather than inserting a set of gamification elements that, for example, female users (characteristic) prefer.

Thereby, to shed light on how to do so, this paper expands towards addressing the following research question: *how to tailor GES design based on LATs?*. The rationale is that different gamification elements having different functions/impacts [Toda *et al.* 2019; Sailer *et al.* 2017] as well as different types of learning activities also do [Toetenel and Rienties 2016; Chang 2016; Krathwohl 2002]. Thus, selecting the most appropriate gamification elements for each of these activity types based on its specific aims can be a valuable approach. However, the literature lacks evidence of how each gamification element alone, given a specific context, impacts users. To aid in this context, besides introducing our personalization approach, we provide a discussion concerning the reasons of using one element or another in three types of learning activities, based on their educational goals.

Following, this paper presents and discusses studies related to our presented approach in Section 2. Next, the approach presented in this paper is introduced (Section 3). Then, Section 4 describes this paper's case study settings and Section 5 discusses these. Thereafter, Section 6 steps to be tackled as well as challenges from our approach. Lastly, Section 7 provides our final remarks.

2. Related Works

Although personalizing GES aims to improve systems' impact on users [Oinas-Kukkonen and Harjumaa 2008], how those personalized systems affect users, compared to non-personalized systems, is yet uncertain [Santos *et al.* 2018a]. Roosta *et al.* (2016) and Lavoue *et al*. (2018) used adaptation to personalize GES. While the former found no significant impact, the latter found a positive effect on time spent on the system, despite users of the non-personalized version experienced higher motivation levels compared to those of the personalized version. Similarly, whilst the study of Monterrat *et al.* (2017) showed that interacting with the personalized version led to improvements on motivation and performance of learners, compared to those which interacted with a non-personalized version, Santos et al. (2018a) demonstrated that both personalized and non-personalized versions of a GES led to statistically insignificant differences in terms of users' flow state. Therefore, studies concerning the personalization's impact on users presented mixed results, showcasing the need for further research.

How each gamification element impacts users might be related to those findings. Different elements have distinct effects on users and, depending on the context in which those are applied, as well as on the gamification design (set of elements), distinct outcomes are likely to be found [Toda *et al.* 2019; Mekler *et al.* 2017; Sailer *et al.* 2017]. For instance, points alone might not affect users academic performance in terms of solving math problems [Attali and Arielli-Attali 2015], whereas along to badges and leaderboards, those might affect users psychological needs [Sailer *et al.* 2017]. Therefore,

despite users of specific characteristics preferring different gamification elements [Santos et al. 2018a], those leading to different outcomes, according to both context and others elements applied together [Toda *et al.* 2019; Mekler *et al.* 2017; Sailer *et al.* 2017; Attali and Arielli-Attali 2015], might be related to the mixed findings of personalization studies.

In summary, literature presents gaps in terms of the effects of personalizing GES [Santos et al. 2018a; Lavoue *et al*. 2018; Monterrat *et al.* 2017] and in the sense that further studies are required to ground how different gamification designs, as well as gamification elements alone, impact learners [Mekler *et al.* 2017; Sailer *et al.* 2017; Attali and Arielli-Attali 2015]. Consequently, these gaps difficulties the selection of which element (or set of these) is the most suitable to use on each LAT.

3. Inside-out Personalization

This section aims at demonstrating the rationale behind our proposal, starting with the development process. Thereafter, the section highlights how it differs from the interventions that have been explored by the scientific community and, last, it provides a thoughtful explanation of what is necessary and how the "inside-out" approach can be employed in practice.

Figure 1 illustrates the development process of our approach. Firstly, a literature review was conducted in order to find studies concerning the use of personalization strategies on GES. Second, we sought to identify what attributes were used to drive the personalization strategy. Third, as highlighted in Section 2, we identified that users data were the most used through the analysis of the related works. Based on this context, along with results indicating that distinct gamification elements might lead to different outcomes, as previously mentioned, our fourth step was to develop our proposal. We defined it to personalize, specifically, each type of learning activity, with the goals of *i)* considering that each activity type has different aims and, therefore, will benefit from a specific gamification design, *ii)* exploring the outcomes that each gamification element can lead to, and *iii)* not relying on users data.

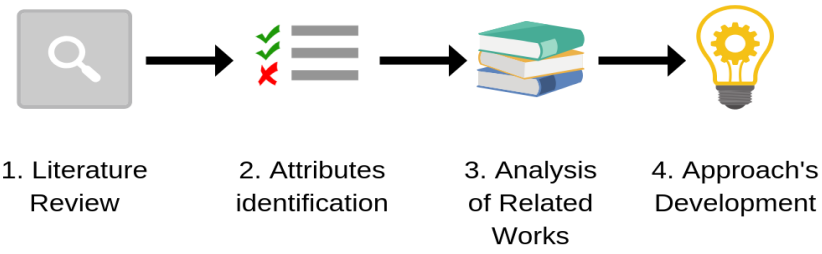

Figure 1. "Inside-out" approach development process.

To showcase the key difference from our LAT-based approach compared to the user-based approach that has been explored in the literature [Santos et al. 2018a; Lavoue *et al*. 2018; Monterrat *et al.* 2017; Roosta *et al.* 2016], Figure 2 illustrates the personalization processes of those two. It shows the entities that we consider to be inside (*i.e.,* educational system and personalization strategy) and outside (*i.e.*, users) the system's context. Also, the figure demonstrates that the key difference in these processes is the kind of data the personalization strategy receives as input. Thereby, while the "outside-in" relies on user data (*e.g.*, players' demographics and gamer types), which

came from outside the system's context according to the figure, the "inside-out" considers LAT data that, on the other hand, came from the system itself, thus from inside its context.

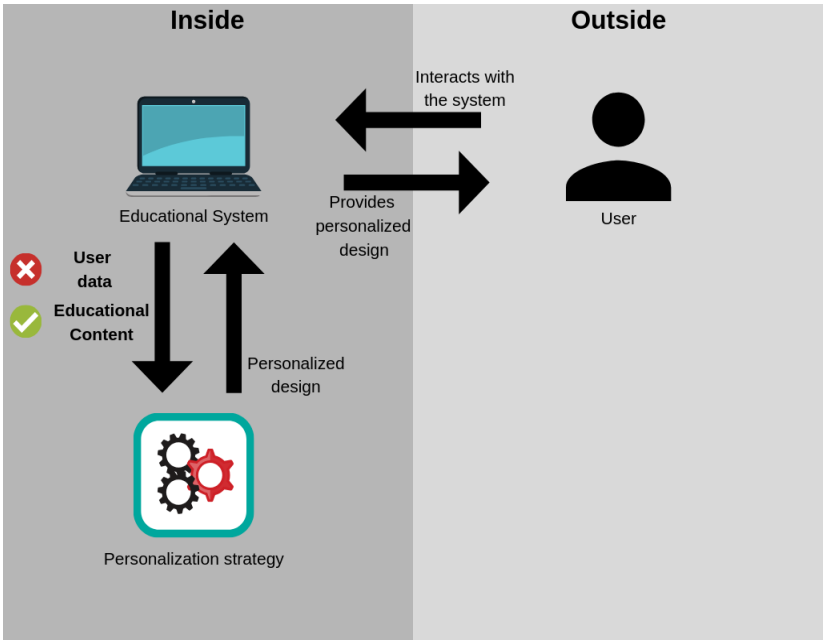

Figure 2. Personalization processes according to both our proposed approach (right) and those of the literature (left).

Given the definition of the "inside-out" approach, how to perform it is highly inspired on studies that employed the user-based methods. However, instead of seeking to collect, for instance, players' gamer type in order to stipulate the best design for each of them, tailoring a GES through the "inside-out" perspective depends on each specific part of the system. Thus, one should note that those personalization approaches differ in terms of *how* to personalize, not in terms of the process itself. We consider that different parts of the educational system will provide the user with different LATs. Hence, to accomplish this we must map the best gamification elements to feature the design of each of those types a GES features because, depending on the LAT, it is better to use one gamification element or another (or a specific set of them) considering that each element might lead the user to a different necessity/emotion/behavior [Toda *et al.* 2019; Sailer *et al.* 2017], as well as each learning activity has its specific requirements and goals [Toetenel and Rienties 2016; Chang 2016].

To compare those different forms of personalization in a practical example, suppose that one must personalize the gamification design of *watching a video lesson* in an educational system, which might be seen as an *attending to information* activity type [Toetenel and Rienties 2016]. Additionally, suppose that the aforementioned mapping indicates that the best design for this activity is to use *points, badges, and leaderboards*. Thereby, through the "inside-out" approach, those three elements would feature the system's design with the goal of improving this activity's execution. On the other hand, in the case of the GES used in both Lavoue *et al*. (2018) and Santos et al. (2018a), the gamification elements available would be defined considering users' preference, based on their gamer types or, in the case of Monterrat *et al.* (2017), according to users preferred mechanics. However, in neither of those, the gamification design is based on LATs. Therefore, it might be the case that the best design for a player type, in general, or the

most preferred mechanic, is not the most suitable design for this activity, as the findings of the studies that adopted those approaches suggest.

Hence, when using the "inside-out" tailoring method, every LAT in a GES will contain a gamification design that is personalized specifically to it, based on these activities types, aiming to tailor the system as a whole through tailoring each of its parts. Consequently, this is expected to improve how the system impacts its users. We believe that adopting this approach might aid to guide players towards *(i)* being more focused on the educational tasks they have to perform, *(ii)* feeling more motivated to achieve better results, and *(iii)* being more engaged with the system itself and, thus spending more time in a learning context. We believe so because the gamification elements available will be in line with the context of each educational activity and, consequently, it is expected to efficiently influence the learners. In sum, by means of successfully accomplishing these aims, our proposed approach has the potential to contribute to users' learning, besides contributing to designers by providing insights into how to create gamification designs to different LATs.

4. Case Study Settings

To address our research question, this paper presents examples of how to tailor three LATs through our "inside-out" method with the goal of showcasing how it can be employed on different occasions. The types of the activities addressed in the examples are: *(i)* attending to information (*e.g.* reading, watching or listening about a specific subject in a web browser), *(ii)* applying learning in a simulated setting (*e.g.* exploring, experimenting or simulating a problem), and *(iii)* assessment (*e.g.* writing, presenting, reporting, demonstrating or criticizing a subject with peers) [Toetenel and Rienties 2016].

When discussing how to tailor each of those, we rely on commonly used gamification elements to inspire and facilitate for teachers/researchers to apply our proposal. We adopted elements described in the taxonomy of Toda et al. (2019), which is focused on gamification applied on education and was validated by 19 experts. The authors described as well as indicated how 21 game elements that can be used to gamify educational systems impact users behavior (*i.e.*, engagement or motivation). Those are: Acknowledgement, chance, competition, cooperation, economy, imposed choice, level, narrative, novelty, objectives, point, progression, puzzles, rarity, renovation, reputation, sensation, social pressure, stats, storytelling, and time pressure. For a description of those we refer the reader to Toda et al. (2019).

5. Inside-out Tailoring of GES

First, consider students have to watch a video lesson in an educational system, which aims at providing the learners with explanations regarding a specific subject (*e.g.* balanced search trees) [Chang 2016]. Hence, an activity type in which learners have to **attend to**/**understand** information [Toetenel and Rienties 2016; Krathwohl 2002]. If the system featured the user-based approach, the following would be necessary. At first, users have to provide some demographic data (*e.g.*, genre and age) or to complete a questionnaire that would, *e.g.* allow the identification of their gamer type to the system (*e.g.*, *Daredevil*). Thereafter, the personalization strategy would update the system according to each user and, then, present the video player with the personalized gamification design. For instance, a user classified as *Daredevil* would be provided with Levels, Acknowledgement, and Competition [Santos et al. 2018a]. Similarly, when users of other

gamer types accessed the system, other gamification elements would be available accordingly. If the system featured the "inside-out" personalization approach, users would not be required to complete a questionnaire neither to provide any demographic information because this strategy relies on data from inside the box (system), thus preventing the dependence of users' data. Hence, when the user access the video player screen, the system recognizes the type of the activity (*attending to information*) and the personalization strategy would select the gamification elements (*e.g.*, Progression) to be available in the screen accordingly. Figure 3 illustrates both personalization processes described here, showcasing their differences within this instance.

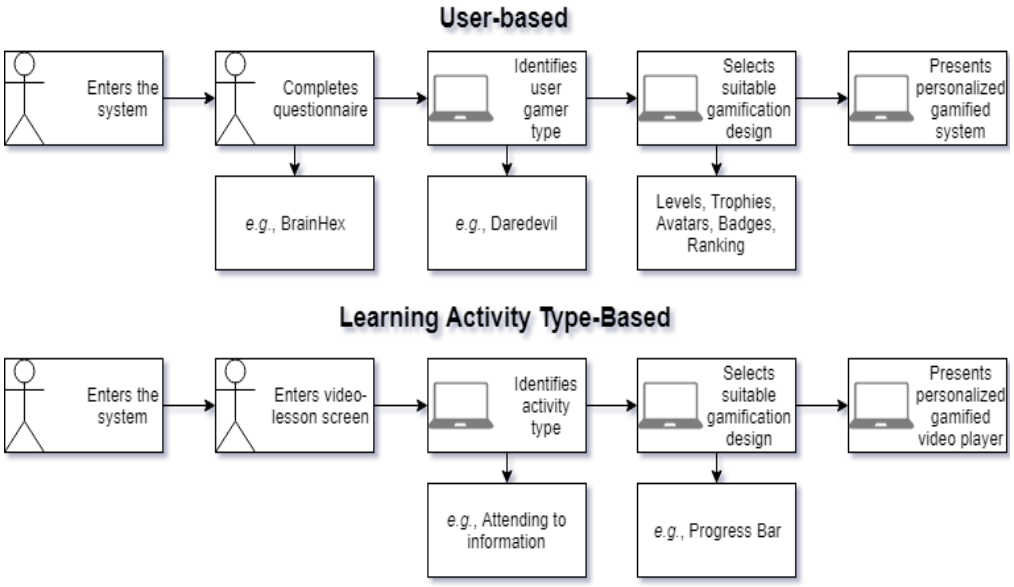

Figure 3. Tailoring the gamification design through user- (top) and LAT-based approaches (bottom) for the attending to information activity type instantiated as a watching video lesson.

As seen in Figure 3, whereas the "inside-out" personalization approach specifically selects the gamification design based on the type of the learning activity, the user-based one only considers the user gamer type. Following this example, while the gamification elements *Daredevil* users prefer might work for some types of activities, those might not for other types. Hence, focusing on users preferences might fail to help them when performing one learning activity or another. Differently, the "inside-out" approach aims to present gamification designs that match the most the goal of the learning activity based on its type. For instance, we argue that a gamification design featuring a Progression (*e.g.,* Progress-bar) would be interesting in this example. As the users have to attend to information through watching the whole video lesson, the Progress-bar would reflect the proportion of the video already watched, and it would be completely fulfilled only when the video was completely watched. Thereby, requiring the user to attend to all information presented in the video (activity's objective) in order to complete the Progress-bar and, consequently, achieving a milestone (*i.e.* Objective).

Second, assume students have to work on a scrum-development-simulation wherein each one of them plays a specific role (*e.g.* scrum master or developers). This activity aims to foster interpersonal skills and human endeavor [Chang 2016]. Hence, this is an activity in which users have to **apply** learning in a simulated setting [Toetenel and

Rienties 2016; Krathwohl 2002]. The personalization process for both approaches (user- and LAT-based) is fundamentally the same as the first example. In fact, the user-based method will yield the same design for *Daredevil* users, as well as those will be the same for users of other gamer types in both examples. Contrary, despite the "inside-out" personalization method will follow the same process as in the previous example, it will yield a design personalized to this type of learning activity. For instance, a design featuring a Narrative, which will emerge the learners into the simulation.

Third, consider students need to criticize colleagues' essays in a grammar class. This activity aids in providing and receiving critics and using these to improve their own works [Chang 2016]. Thereby, this is a type of **evaluation**/**assessment** learning activity [Toetenel and Rienties 2016; Krathwohl 2002]. In the same vein, the user-based approach would provide the same design for users of a specific gamer type, whilst the LAT-based method will present a design focused on this LAT. Therefore, in summary, the introduced method will systematically seek to present gamification designs that improve the execution of the learning activity, based on its type, whereas the user-based one employs the same design regardless of the LAT in order to meet users' preferences.

We highlight that, in the user-based method, different users will be provided with gamification designs based on different sets of gamification elements, based on their personal characteristics; however, regardless of the learning activity they are performing, those designs will still be based on the same set of gamification elements. Contrary, in the "inside-out" approach, different users will be provided with gamification designs also based on the same set of gamification elements, however, these will be selected based on the LATs. That is, users of different characteristics will receive the same designs, however, different LATs will offer different sets of gamification elements. Table 1 summarizes these differences.

Table 1. Design differences between the user-based and the "inside-out" methods.

Approach/Occasion	**Different users**	**Different LATs**
User-based	Different designs	Same design
"Inside-out"	Same design	Different designs

Moreover, from one side, the user-based approach relies on a number of theoretical studies that suggests different users have different preferences (c.f. [Santos et al. 2018a; Monterrat *et al. 2017*]). The problem is that gamification leads to different outcomes, according to both the context it is applied as well as how it is designed [Mekler *et al.* 2017; Sailer *et al.* 2017; Attali and Arielli-Attali 2015]. From the other side, we are introducing an approach that relies on the fact that different gamification elements will lead to different outcomes. Hence, based on literature's findings, assuming that when the right element is applied in the right context (*i.e.* LAT), the potential for positive results is enhanced. In spite of that, the little evidence of how each gamification element influences users [Mekler *et al.* 2017] limit our ability to claim our assumption is correct. Thus, the next section discusses what is necessary to address and validate our hypothesis.

6. Discussion

Based on this context, there are three next steps we believe to be of utmost importance to advance the understanding of how to personalize GES through the "inside-out" approach. We believe that it is necessary to develop a mapping between gamification elements and educational contents. To advance on how the design of a specific educational content should be, we must know which is the best set of gamification elements to feature it. As proposed here, the "inside-out" approach is a generic method and, in order to make it suitable for any GES, we recommend this mapping to be system-independent. Thereby, developers and designers will be able to rely on the mapping to tailor the educational contents of any system. Moreover, this mapping could be used to guide the development of a mechanism able to automatically create the designs of GES, reducing human efforts by facilitating the development of those.

Empirically/experimental validating the "inside-out" personalization approach is the second step that we recommend to be tackled. By doing so, it will be possible to identify whether using this approach is relevant to users' learning, experience, concentration, and other aspects of relevance to educational systems. Supported by the empirical evidence of the most appropriate way to design GES based on their learning activities, researchers can conduct experiments to validate whether those generic evidence actually leads to a positive effect on users, compared to, *e.g.* generic designs or user-based personalization approaches, through different case studies. These experiments' results will provide insights to practitioners concerning whether it is interesting for them to use the presented approach on their systems and classes, for example.

Furthermore, there are some limitations and further challenges which are likely to be faced on applications of our proposed approach. One might note that the "inside-out" approach might represent a threat to some users. In the same way some users prefer specific gamification elements, there are a set of these they dislike [Santos et al. 2018a], which is motivated by the fact that different users behave differently [Rodrigues and Brancher 2019b] and correspond better to different designs [Denden et al. 2018]. Thereby, despite using a gamification element suitable to the LAT is valuable from the perspective of education, it might exert a negative influence on users that dislike elements of that design. Nevertheless, although the gamification design proposed for the aforementioned examples featured a single element, there exist other options that might be adopted for the same type of learning activity as well as users of a specific gamer type prefer multiple gamification elements.

Hence, the set of gamification elements featuring a specific activity type could seek to avoid those that specific users dislike, besides selecting the elements based on the LAT. Thus, yielding a personalization approach based on both users and LATs. However, seeking to mitigate this based on user data (*e.g.,* users' gamer types or demographics), is uncertain, considering the literature's evidence [Santos et al. 2018a; Lavoue et al. 2018]. In spite of that, more advanced and user-specific data-driven techniques (*e.g.*, data mining/machine learning) could be explored to tackle that limitation as the potential of those have been suggested in literature [Meder *et al.* 2017].

7. Final Remarks

This paper introduced a GES personalization approach, presenting examples of how to apply it, discussing steps to both implement and validate it, and challenges and suggestions to mitigate these. This paper's main contribution is the introduction of the approach, which personalizes each system's learning activity specifically and does not consider users data, besides being generic (*i.e.* might be employed on any GES). After the initial mapping provided in this paper, we are in the process of designing the experiment to both refine it and validate its impacts on learners.

Acknowledgment

We would like to thank the funding provided by CNPq, FAPESP (Projects 2018/15917-0; 2016/02765-2; 2018/11180-3; 2018/07688-1), and CAPES.

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