Enhance Gamification Design Through End-User Development: a Proposal

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Abstract

Gamification has been increasingly used to foster motivation and engagement in adopting and maintaining a desired behavior. In recent years, the tailoring of gamification, based on the users' necessities, has gained a central role in research. To this end, we propose an End-User Development (EUD) solution that enables users who are not experts in programming to create and customize gamified systems according to their specific needs and preferences. In particular, our EUD solution focuses on providing users with intuitive verbal primitives for creating Trigger-Action rules, which are the basic building blocks of gamified mechanics. To illustrate the potential of our approach, we provide some examples of how users can adopt our system to create customed gamification strategies. These examples demonstrate the flexibility of our EUD system, highlighting how it can be adapted to a wide range of applications.

Keywords

End-User Development, Gamification, Trigger-Action Programming

1. Introduction

Gamification aims to support people's engagement and commitment to complex tasks [1]. Alongside the gamification approach has been increasingly applied to IoT in different domains, such as smart cities, education, health, marketing, and others [2, 3] to improve engagement with this technology. On the other hand, End-User Development (EUD) approach aims to empower naive users - who are not programming experts - to personalize and define complex behaviors of their applications [4]enriching their expressiveness, creativity, and goals strictly related to the applied domain [5]. In this respect, often, EUD has been applied in the context of Internet of Things (IoT) applications since their use is increasingly widespread in multiple contexts [6, 7].

This paper addresses and elaborates on solutions to an emerging challenge that innovatively links EUD and gamification. In particular, we aim to study how to better design, through EUD, solutions to personalize and define gamification rules and systems applicable to IoT technologies. Indeed, facilitating and guiding non-programmer users in customizing gamification dynamics

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could enhance the motivation and engagement of people using IoT and the empowerment of application domain experts to define the operation of their digital artifacts according to their needs, expertise, and goals.

1.1. Gamification

Gamification is commonly described as the introduction of game design elements (i.e., points, badges, missions, avatars) in non-playful activities to create similar emotions to those experienced while playing video games [1]. In particular, gameful systems aim to increase users' intrinsic motivation to support them in learning or maintaining a desired behavior (e.g., doing physical activity, participating in crowdsourcing, adopting sustainable mobility) [8]. Gamification has also been employed in EUD systems [9], improving end-user engagement in end-user programming tasks [10, 11, 12, 13]. In this respect, our approach is different as we aim to allow users to encode gamification by means of EUD. In the early stages of gamification, the so-called *PBL* triad (points, badges, leaderboard) was vastly used in the design of gameful systems [8]. However, interpersonal, demographic, and cultural differences shape users' perception of game elements [14, 15, 16] and should be taken into account in the gamification design [8, 16]. In the last few years, the literature on gamification emphasized the tailoring of gamification design based on the target's needs and characteristics [8, 14, 17]. Finally, Trinidad and colleagues [18] recently underlined the need for tools that easily support gamification designers in the implementation of their solutions. In this sense, our work represents an attempt to facilitate designers in the creation of new gameful systems' design and the following implementation.

2. Combining end-user development and gamification

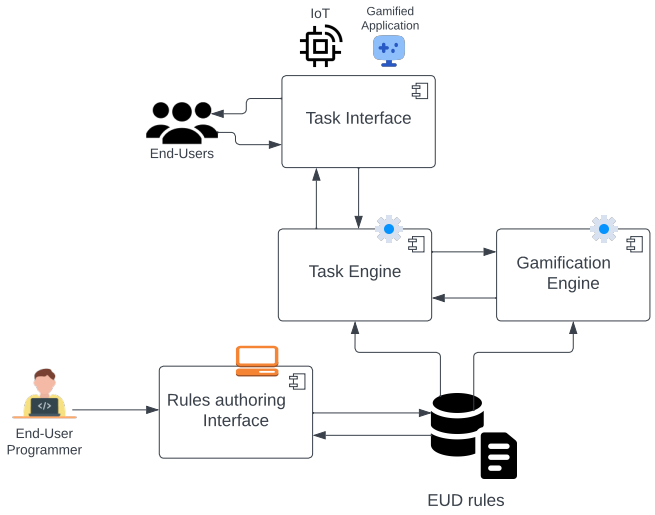
Our goal is to identify ground principles to inspire the design of EUD solutions to empower naive users, who have expertise in the application context but not in programming, to personalize complex gamification and task design according to their specific needs and preferences. We propose an architecture aimed at separating a general-purpose *Gamification Engine* from a generic task-oriented system. The system architecture comprises five key components, including *Task Interface*, *Task Engine*, *Gamification Engine*, *Rules authoring Interface*, and *EUD rules* (see Figure 1). In this architecture, we separate the gamified *Task Interface* used by the end-users (e.g., children using an educational IoT device) and the two engines that control respectively the task (e.g., the IoT device - *Task Engine*) and the gamification mechanics (*Gamification Engine*). Both engines can be customized through the *Rules authoring Interface*, which enables end-user programmers (e.g., teachers) to create customized Trigger-Action rules that define how the task and gamification elements should be executed. The two engines can retrieve the Trigger-Action rules stored in a database (*EUD rules*). Overall, the architecture provides a flexible framework for non-programmer users to create and customize gamification strategies and task logic for IoT devices. This approach allows us to separate the specification of the task from the mechanics of the gamification and, therefore, simplifies the architecture, makings the latter component reusable. In this respect, it is important to specify a set of primitives (namely actions and triggers) that fully define the gamification programming capabilities. It is worth noting that the Trigger-Action rules need to seamlessly integrate task and gamification aspects. As explained

Table 1
Game element-based language primitives for actions, events, and states.

Game Element	[DO] Action	[WHEN] Events	[WHILE] States
Acknowledgment: e.g., badge	"Assign one acknowledgment"	"User gains one acknowledgment"	"User has one acknowledgment"; "User has N acknowledgments"
Level: e.g., profile level	"Level up"	"User reaches the level N"	"User is at level N"; " One is at a level lower[higher] than N"
Points: e.g., experience points	"Assign points"; "Assign a random number of points"	"User gains points"	"User has points"; "User has more[less] than N points"

below, gamification actions are usually attached to rules with task-based triggers while some specific gamification mechanics could require specific rules with gamification-based triggers.

Figure 1: Architecture of the system.

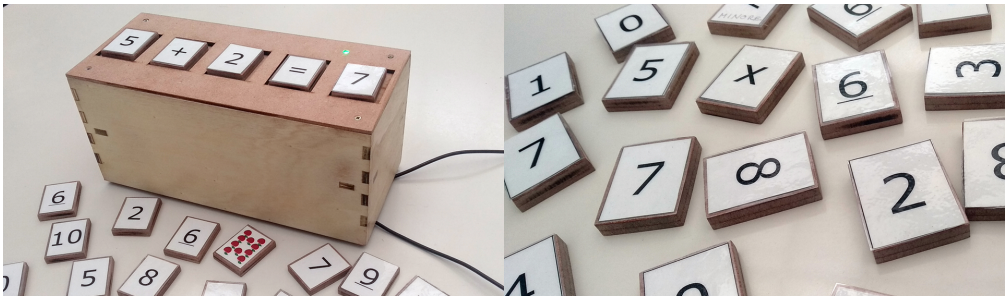


We propose a preliminary attempt to explore the taxonomy of game elements in order to select and implement verbal primitives in the *Rules authoring Interface* based on the notion of Trigger-Action rules. As a first step, we analyzed the domain of game elements referring to Toda and colleagues' taxonomy [19] and selected some examples to be included in an EUD platform. See Table 1 for the game elements and the related language primitives (see [19] for the complete and detailed description of gamification elements). Similarly to the Event-State-Condition-Action rules paradigm (ESCA; [20]), we included primitives for states, events, and actions in order to help users and enrich their expressiveness in rules composition [21, 22, 23].

In the following paragraph, we provide an example of game- and task-related verbal primitives

combination, used to customize an IoT tangible educational device, SMARTER (Task interface, see Figure 2), that engages children (end-users) in math exercises [24, 25]. End-users can perform actions on the tangible tools, such as placing or removing tiles to complete math exercises. The tool can provide end-users with visual and audio feedback (through an RGB led and an audio component), depending on the exercise's logic (interpreted by the *Task Engine* and customized by the end-user programmer). Through the *Rules authoring Interface*, teachers can compose rules to define the task logic using task-related verbal primitive, for states (e.g., "[WHILE] *There are N tiles on the board* [AND] *There is at least a digit tile*"), events (e.g., "[WHEN] *A tile is placed on the board*" or "[WHEN] *The arithmetic expression becomes true*"), and actions ("[DO] *Play audio N*"). So the teacher can create a customized program for arithmetic operation: "[WHILE] *The last tile inserted is a digit* [WHEN] *The arithmetic expression becomes true* [DO] *Turn on LED blue*". Combining these task-related verbal primitives with game-related ones will allow the creation of more complex and expressive programs. Therefore, we can have rules with task-based triggers that include gamification actions and rules with gamification triggers that include domain actions. For example, teachers can assign points based on the task resolution by simply adding game-related actions in the rules "[DO] *Turn on LED green*[AND] *Assign N points*". Moreover, it will be possible to change the logic of the task based on gamified elements, for example: "[WHILE] *User is at level N* [WHEN] *A tile is placed* [DO] *Turn on LED red*". Also, an end-user programmer can define specific game-related rules to define only the gamification aspects: "[WHILE] *User has N points* [WHEN] *User reaches the level N* [DO] *Assign one acknowledgment*".

Figure 2: On the left SMARTER, on the right a set of tiles.



3. Conclusion

In the current paper, we presented an innovative EUD solution that enables naive users to personalize and define complex gamification dynamics and tasks. Developing EUD systems specifically built to support users in creating and modifying gameful elements, besides being helpful for game designers, could be a powerful tool for naive users who daily use gamified solutions in their interaction with IoT. In future work, we aim at investigating and creating a complete set of verbal primitives to populate the *Rules authoring Interface* where users can easily select states, events, and actions in the form: "WHILE state(s), WHEN event, DO action(s)" to create sets of rules to design new gamified tasks.

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