The Role of Gamification in End-User Development

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Abstract. This paper discusses the application of a gamification framework in an end-user development context, in order to investigate a possible solution to the problem of participation and collaboration overload often affecting end-user development activities. Indeed, it has been observed in the literature that when users are required to develop or adapt a system for the sake of other people (belonging or not belonging to the same community) and not just for personal use, motivation mechanisms should be implemented. With the help of an example in the field of ambient intelligence, we propose the integration of end-user development environments with gamification elements.

Keywords: end-user development, cultures of participation, gamification

1 Introduction

Nowadays there is a high demand on users to become producers of information, co-designers of systems, active contributors in system maintenance over time. These activities are encouraged not only in participatory design and end-user development (EUD) projects, but also and more simply in social networks, wikis and advanced web services. This trend opens up novel opportunities for users, who may acquire more control on the software artifacts they contributed to create and make their voice heard within a community. However, alongside these opportunities, users often find the drawbacks and disadvantages of being engaged in activities that are secondary with respect to their main work or daily tasks and that require additional resources not only for participation but also for training.

Therefore, it is urgent reflecting upon this situation and proposing solutions for mitigating the drawbacks of such a request of participation and collaboration.

Gamification is recently considered a useful technique for one's own business or organization [16]. The introduction of gamification elements such as points, badges and leaderboards - the so-called PBLs elements in [15] - has proven to be a successful solution to support collaborative work, increase sells in e-commerce web sites, and foster participation in social networks. Gamification is neither making an application a game nor creating 3D simulations or serious games; therefore, it is substantially a different approach with respect to that proposed in the field of EUD in [13][14].

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The research question we would like to investigate with this position paper is whether the recent studies on gamification techniques could inspire new solutions for supporting the long-term sustainability of EUD activities.

2 Motivating End Users to Become End-User Developers

In EUD, end users are called on to participate in software design and development, by carrying out activities that range from requirement specification through domain-specific modeling to more advanced activities, such as system customization and modification, or even creation of new software artifacts. Differently from participatory design, EUD research advocates end-user participation mainly during system usage; in this way, as underlined in [2], EUD overlaps with end-user programming (EUP). EUP originally referred to end-user creation of formulas within spreadsheets and is currently intended as "programming to achieve the result of a program primarily for personal, rather public use" [12].

To clarify the differences between EUP and EUD, Cabitza et al. [4] have proposed an original taxonomy for classifying EUD activities. In this taxonomy, there is a first-level classification of EUD into *individual EUD* and *public EUD*. Individual EUD encompasses all those activities that lead to the creation, modification or extension of a software artifact for personal use only. Therefore, individual EUD is actually what is usually called EUP. Public EUD, on the other hand, denotes all those situations where end users either program or configure software artifacts that are used by (or also by) *other* people. These people may belong to the same community, e.g. colleagues and co-workers, and thus public EUD refines into *inward EUD*; however, it may also happen that people work in different departments or belong to different communities, and thus public EUD can be regarded as *outward EUD*. In both cases, the outcome of the EUD activity is aimed at being shared and publicly available to others than the end user involved in the programming activity.

The above taxonomy is useful to analyze the possible drawbacks that EUD may bring about. Indeed, whilst individual EUD is usually pushed forward by user's intrinsic motivation, namely by the goal of a user to improve his/her own work or daily life, public EUD often needs external motivation to take place and be sustained over time. In the first case, a typical situation is that of a geoscientist that decides to spend a few months in acquiring programming knowledge, in order to be able to develop a software application to analyze the data he collected [8]. The second case has been addressed in our experiences about the design of EUD environments [7][9, 10], where we observed that playing an active role in system evolution or new artifact creation is often regarded by end users as a further burden and not as an opportunity for improving oneself or one's own community; this occurs especially when end users should work for the sake of other people and not only for their own direct goals.

Therefore, social and technical mechanisms for motivating users involved in public EUD must be studied and integrated in EUD tools. We suggest that gamification is a possible answer.

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3 Introducing Gamification in a EUD context

In this section, we introduce an example case study related to the ambient intelligence domain, where the adoption of public EUD mechanisms could represent a suitable approach to address some of the emerging issues. Then, we illustrate a literature gamification framework and some ideas for introducing gamification in the above mentioned domain.

3.1 An Example Case Study

The domain we take into consideration is that of ambient intelligence (AmI), with specific reference to the smart home. A smart home could be roughly characterized by its components, namely sensors, actuators, and ambient inhabitants, and by its behaviors, which are determined by the interactions occurring among the components and by some configuration rules [3]. Such rules could be predefined in the system at design time or, more interestingly, could be continuously created and modified by the family members inhabiting the smart home. Proper mechanisms for easy rule creation should therefore be made available to users without programming knowledge, in order to support them in rule definition and ambient configuration. Some works that propose user interfaces based on the Event-Condition-Action (ECA) paradigm are being developed in the AmI areas (e.g., [1][11][17]).

An ECA rule could be for example:

```
IF (01:00 A.M.) and (nobody in the living room)
THEN turns off the lights
```

where `01.00 A.M.` is an *event* related to the clock, `nobody in the living room` is a *condition* that may be checked by presence sensors, `turns off the lights` is the *action* to be carried out.

Actually, ECA rules appear as an effective and suitable paradigm for end users [6]. However, even though we may assume the existence of a usable interface that allows end users adapting rules to their needs or creating new ones, a fundamental challenge remains to be considered, which is related to various questions, like the following:

1. Why users (inhabitants) should be willing to adapt or create rules?
2. Which mechanisms could be implemented to motivate users adapting or creating rules?
3. How one may sustain system evolution over time?
4. How one may avoid that users are overloaded by participation requests?

The above questions, such as (3) and (4), could be also in trade-off: indeed, an intelligent environment should evolve over time, but this may require user participation in rule creation and modification.

The literature framework for gamification, illustrated in the following, will help us respond to the above questions and solve possible trade-offs.

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3.2 A Gamification Framework

In [15], a general gamification framework is proposed encompassing three types of elements, namely dynamics, mechanics and components. *Dynamics* are the highest-level elements that provide motivations for participation; *mechanics* are the elements that drive player involvement and allow implementing the dynamics; and finally *components* are the low-level tools that allow implementing the mechanics. Dynamics include, in turn, *constraints, emotions, narrative, progression*, and *relationships*. Indeed, since games are always a matter of choices and tradeoffs, constraints are fundamental for defining a game and providing a sense of tension and accomplishment. Fostering engagement requires activating different emotions, such as curiosity, competitiveness, happiness, etc. An explicit or implicit narrative can make users live an experience that connects up to a larger story line. Progression in the user experience is fundamental to avoid that the user abandons the system. Finally, designing for relationships is important because users are social and social interaction is a powerful human drive.

We suggest taking into consideration all these elements in the smart home example, because they are the milestones to foster user participation and collaboration.

Mechanics encompass *challenges, chance, competition, cooperation, feedback, resource acquisition, rewards, transactions, turns* and *win states* [16]. Supporting cooperation within a family or enabling competition among different families could be valuable mechanics for the smart home case. Equally, providing feedbacks and rewards to the inhabitants who participate in rule creation and modification could be another important tool. Challenges and resource acquisition could stimulate user-system co-evolution over time [5], whilst turns and win states probably could be ignored in our case since they do not exactly match with the problem at hand.

Components can be considered as "the tactics to achieve the goals of the higher-level elements" [16]; therefore, they include a variety of elements that may be concretely implemented and that sometimes appear also on the user interface of a gamified system, such as *avatars*, *badges*, *leaderboards*, *levels*, *points*, *gifting*, *quests*, and many others [16]. In the following, we illustrate the role that these elements could play in the smart home configuration and management through a rule-based approach.

3.3 Gamification in the Smart Home Example

Figure 1 shows a mock-up of a system for rule creation and adaptation in the smart home case study. The system allows managing different set of rules, each one associated to a registered user (in the example "Dad", "Mum" and "David"). Let us focus on the rules that apply to everyone ("All users" in the mock-up). In the system, these have the highest priority, while the rules specific to, for example David, can be activated only when David is in the room and have a lower priority.

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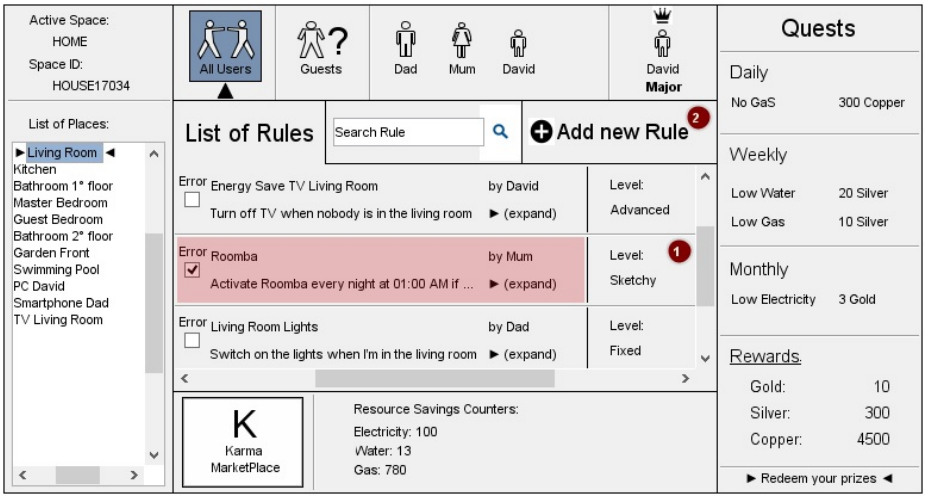

Fig. 1. Mock-up of a gamified system for rule management.

To simplify the view, rules are grouped according to the places (for example, the different rooms) where they apply. Note that this filter may also help users manage the participation overload in rule checking and creation. Therefore, when "Living Room" is selected in the left list, only the rules that involve the living room are shown in the central part of the interface. In this part, one can go through the list of rules, search for a specific rule, or create a new rule. The number "2" in the red circle over "Add new Rule" means that two requests for creating new rules have been made by some users. Requests for new rule creation are an example of social interaction related with rule management. Another example is the request for a modification/improvement of an already existing rule (see the number "1" in the red circle over the "Roomba" rule). Prizes are offered to motivate the satisfaction of the above requests. The prize mechanism is managed through a Karma Marketplace where karma points, gained when someone satisfies a request, can be converted into prizes defined by those who made the requests. For example, Mum will give 20 euros to the user who pays 300 karma points in the marketplace. Every rule modification by some user that is not the rule creator is made effective only after a poll is made and the majority of the voters accept the modification.

In the right-hand side of the user list on the top of the interface, a "Major" user is displayed. A major is specific to every single place selected on the left list of places. The major of a place is the registered user who spent most time in that place. He/she has some advantages: for example, his/her vote in a rule modification poll has a higher weight than the vote of other users.

A rule gains experience every time it is activated, and eventually gains a level. It starts from level "Sketchy" and ends at level "Advanced". If a user reports that a rule is not doing what he/she expected, that user will tick the "Error" box close to the rule. When this happens, that rule is colored red and every time it is activated it loses experience. If experience goes under zero, the rule level becomes "Defective", and the rule cannot be activated anymore. Rule levels allow solving conflicts among rules.

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At the bottom of the interface three savings counters (Energy, Water and Gas) are displayed: every time an active rule turns off a device (or reduces its operation), the corresponding savings counter increases by one. For example, if a light bulb is turned off, the "Electricity" counter will increase. This is a rough approximation of the resources saved, since a perfect reckoning of the savings is obviously impossible. Furthermore, a savings counter is not reliable, because a user could artificially increase it by making repeatedly a rule goes off (indeed, cheating is possible). For this reason, the savings counters are not associated to any sort of rewarding system.

Rewards are instead associated to quests (see the right-hand side of the interface). Quests can be for example: "Consume less than X kilowatts in a week period". Indeed, information about actual consumption over a period of time can be reliably collected. Quests are a way to keep the users going back to modify the rules, even after they have completed the configuration of the smart home. This happens because quests provide the users with difficult goals to achieve, which may require an unusual set of rules and an increased living effort by all the family. Quests must be tailored to the specific family in order not to be too difficult or too easy. They could possibly be generated automatically or set by an administrator (for example of a condominium). Completed quests give virtual rewards (gold/silver/copper coins) that can be redeemed in the form of discounts on real stuff. This could be a way for energy supply companies to compensate the gain loss due to energy savings in the houses.

4 Conclusion and Future Work

The aim of this position paper is introducing the gamification theme in the EUD research area, with particular reference to the case of AmI environment configuration. As an example, the paper discusses rule creation for the smart home, but other kinds of AmI environments could be considered, where more actors should be necessarily involved, such as schools, hospital wards, workplaces, and so on. In these cases, participation, collaboration and information overload could represent a much more important problem; however, we claim that proper gamification mechanisms, which help users filter out uninteresting requests and solve emerging conflicts, could contribute to cope with this problem.

In the future, we plan to experiment gamification in the context of rule creation in smart home settings; then, we would like to apply and generalize this idea to other AmI domains and EUD contexts, in order to study the role that gamification could play in motivating users to participate and collaborate in EUD activities.

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