A Design Space For Meaningful Structural Gamification

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Abstract
Gamification design is a complex process. Existing gameful design methods generally focus on high level motivational considerations. In order to provide designers with the tools to create meaningful and motivating game elements, we propose a design space that encapsulates lower-level design decisions, such as visual and operational aspects, during the design process. We also propose a set of design cards and a board that aim to support the design process for collaborative design sessions.

Author Keywords
Gamification; Meaningful Design; User Motivation; Design Space; Design Cards

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous; H.5.2 [User Interfaces]: User-Centered design; K.8.0 [Personal Computing]: Games

Introduction
Over the past few years, gamification (the use of game elements in non game contexts [4]) is used more and more to provide enjoyable and engaging experiences. Specific domains such as education [2], or health [17] rely more especially on structural gamification (defined as the use of game elements that do not alter the content of the activity

Design space

Why?
Behaviour Change
- Autonomy
- Behaviour Encouragement
- Behaviour Discouragement
- Performance

What?
Granularity
- Activity
- Action
- Operation

How? (Content)
Dynamic + Mechanic
- Rewards
  - *Points*
  - *Collectables*
  - *Useful items*
- Goals
  - *Self defined Goals*
  - *Externally defined Goals*
- Time
  - *Timers*
  - *Schedules*
- Self Representation
  - *Skills*
- Social Interaction
  - *Teams*
  - *Trading*
  - *Discussion*
- Progress
  - *Task Progression*
  - *Compared to others*

Table 1: The proposed design space for game elements (first part)

[8]). To be effective, the motivational affordances of such gamified systems (properties that allow users to satisfy their psychological needs[22]) should be designed with a deep understanding of human motivation [3, 22]. Recent studies emphasise the importance of meaningfulness in the design process [14, 3, 16]. Game elements should make sense to users, creating explicit connections to the given activity, and supporting feelings of competence, autonomy and relatedness, identified as essential in Self-Determination Theory [19, 22, 16]. On the contrary, non-meaningful elements may be ignored or worst may demotivate users [16, 3].

Even if gameful design methods have emerged recently [3, 22], affording engaging experiences in non-game interactive systems remains challenging. During design sessions designers, developers and other stakeholders, who may not have the same level of expertise regarding gamification, have to select relevant game elements and decide how to implement them for a concrete situation. They lack guidance on choosing among a huge number of elements considering their impact on motivational affordances. As a result, they are often confined to use only a subset of predefined well-known elements as pointed out by Tondello et al. [23], reducing creativity in the design process.

This work aims to overcome these limitations by guiding stakeholders during collaborative design sessions. We propose to extend the emerging concept of meaningful gamification to operational and visual aspects, bringing together HCI practices and gamification. We present a design space for game elements specification that encapsulates nine design dimensions to consider in the design process. We also present a set of cards designed to facilitate the collaborative exploration of the design space during design workshops and a board used to structure the design process.

Gamification design approaches

Different approaches have emerged from practitioners and researchers, either from HCI or gamification, to support and structure the gamification design process. Readers can review state-of-the-art papers for a presentation of existing gamification design processes [3, 22, 15]. Global design processes generally offer high-level guidelines to consider the context and suggest the following steps: define the main objective, understand the user motivation, identify the game mechanics and analyse the effect of gamification [24, 9]. However, lower-level design decisions (i.e. interface design and visual aspects) are poorly supported although they can also play an important role in improving user experience [14]. Deterding introduced more operational aspects with the concept of design lenses and skill atoms [3]. However, these approaches offer poor guidance regarding customisation and implementation of elements for a given context. To choose among elements, various lists of game mechanics are proposed [23], but the high number of elements in these lists make their usage difficult.

To guide design sessions, Marache-Francisco and Brangier [14] provide designers with a toolbox for gamification that support two design steps: the context analysis and the iterative conception of the gamification experience. Designers can rely on a conception grid and decision-trees consisting of questions which guide element selection. Other works provide design cards, traditionally used in design practice to foster creativity insuring a common vocabulary and shared understanding among participants [12]. These cards often correspond to design steps (such as [5]) or at fairly high abstract level.

Design space for meaningful game elements

Design spaces are traditionally used in HCI for identifying alternatives and structuring decisions in the design phase

Design space (Cont.)

Who?
Actor
- User
- Group
- Community

Range
- User
- Group
- Community

How? (Presentation)
Visibility
- Before
- During
- After
- Always

Style
- Literal form
- Related to the domain

Format
- Relative
- Absolute

Precision
- Precise
- Fuzzy

Table 1: The proposed design space for game elements (second part)

[21]. We present a design space that encapsulates nine dimensions to consider regarding operational and visual aspects of elements for meaningful structural gamification (see table 1 for a summary). These dimensions serve to answer 5 questions that designers have to consider [16]: *Why is the game element used? What is the focus of the game element? How does the game element work (content)? Who is concerned by the game element?* and *How is the game element shown (presentation)?*

Behaviour change (Why?)
Gamified systems aim to engage users in changing their behaviour or achieving their goals. This dimension helps designers reflect upon the design rationale behind the game element. We identified from the related works four behaviour changes according to designers' goal: Autonomy [2], Behaviour Encouragement, Behaviour Discouragement [10], and Performance [24].

Granularity (What?)
According to the Activity Theory [11], an activity is performed by a subject in response to a specific need or motive in order to achieve an objective. By inciting designers to reflect on the granularity level, we lead them to question if the game element should address the main motive of the users (linked to the activity; i.e. running), their sub-goals (linked to actions; i.e. a 5km run) or conditions to realise the actions (linked to operations; i.e. stretching before running or breathing exercises).

Dynamic and Mechanic (How - Content?)
For meaningful gamification, designers have to decide which game dynamic and mechanic the game element should implement. Based on the theoretical frameworks MDA (Mechanics Dynamics Aesthetics) [7] and DMC (Dynamics Mechanics Components) [24] and on well-established game dynamics and mechanics, we list 6 commonly used game dynamics , and classify some mechanics within each dynamic. As we focus only on structural gamification, we exclude elements such as Storytelling or Quests that are directly linked to the content. Furthermore we also do not use the MDA levels as-is, using only on the described elements that can be adapted for gamification.

Actor and Range (Who?)
These two dimensions refer to the actor who uses the element (*actor*) and who can see the game element (*range*): an individual user, a group of users, or a community. These design choices are crucial as they impact the type of regulation intended [6]. Individual users can self-regulate their activity individually or by comparison with others to achieve personal goals. Game elements shared by a group of users can help them co-regulate their own activities according to their own personal goals but also support shared regulation that requires interdependency and the complete cooperation of participants toward a common goal.

Visibility (How - Presentation?)
Schön [20] assumed that reflection can occur both during the activity being performed (reflection-in-action) and after the activity, e.g. when mentally reconsidering it (reflection-on-action). The timing in which the game element is shown to the user can have an impact on the reflection process. We add a third value "before" since we can also incite users to establish goals and plan strategies.

Style (How - Presentation?)
Visual aspects of the gamified system play an important role in the perception of gamification affording an appealing and immersive experience [13]. The Style dimension helps designers decide whether the game element should have a simple literal form (e.g. a basic progress bar) or one

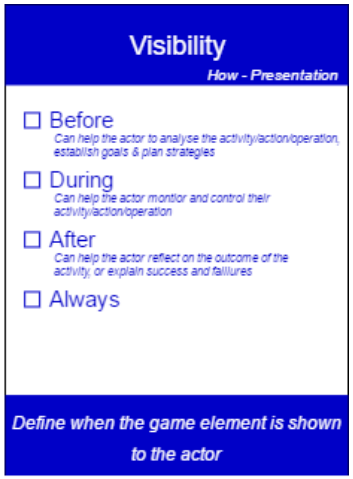

Figure 1: The "visibility" card.

Figure 2: The four secondary school teachers interacting with the design cards and board during the workshop.

more related to the domain (e.g. a heart that fills up when you go to the gym to promote healthy living). Using domain-dependant metaphors can favour explicit connections with the given activity as recommended by Nicholson [16]. However, the choice depends on users' intrinsic motivation for the domain and an independent style can reduce the risk of user' amotivation.

Format (How - Presentation?)
Prensky pointed out [18] that having a clear end state (i.e. a "win point") can increase performance. However, for some users "learning stops when goals are achieved" [2]. Therefore we suggest to consider presenting the game element in a relative (e.g. a score that shows four points out of a possible ten) or absolute format (e.g. a score that only shows four points) depending on the motivational context (users' profile or type of activity).

Precision (How - Presentation?)
Designers have also to consider the precision of information presented in the game element. For some users, giving precise feedback on the activity performance can be motivating [1]. However for less competitive users, showing exact information can be demotivating [17, 23]. Thus we suggest to consider two possible values: precise (e.g. a leaderboard where the actor is shown to be 6th out of 14 users) and fuzzy (e.g. a leaderboard where actor is shown as in the "Top Half" of users).

Tools to explore the design space

The design space presented allows for a systematic consideration of possible choices when designing game elements. This task may remain complex, especially if the different stakeholders involved in collaborative design sessions do not have the same expertise in gamification. To support the design process and to guide designers in the design space exploration, we created a set of design cards.Each card represents a particular dimension and contains the possible values, as well as examples, or explanations of the choices and possible impacts on users' motivation (for instance figure 1 shows the Visibility card).

The cards are designed to be used with a board structuring the different steps to perform during the definition of a game element. In addition to the properties defined by the design space, the board supports high-level decisions such as users and context considerations of the given activity (also identified in [5, 14]), and lower-levels specifications such as visualisation (element mock-ups) and operational rules. We decided to integrate these aspects only on the board since they are closely linked to the domain to gamify and would probably have too many forms or values to be represented by specific cards. These domain-dependant elements are thus instantiated during design sessions for each context and game element.

Testing the design tools

To test the design space and its exploration with cards and board, we conducted a design session in an educational context. We held a workshop with four secondary school teachers, two teaching engineers, and a game design expert working on a project of gamified mathematics exercises (see figure 2). The teachers knew each other and had previously worked together to create maths exercises. The workshop lasted four hours. After a quick introduction of the materials, roughly 50 minutes were dedicated to context specification: determining the users' profiles and reviewing the exercises previously created to define actions and operations within the activity. The rest of the session was dedicated to defining game elements to be used. Participants discussed and agreed on game elements using the cards and following the steps on the board. For each game ele-

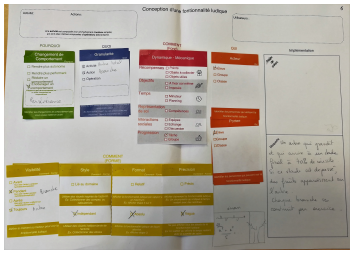

Figure 3: An example of one of the boards produced during the workshop. This game element has been designed to encourage students' perseverance. It implements the task progression mechanic, and is only visible to the user. Instead of a simple progress bar, the participants decided to opt for a more "metaphorical" design. They decided on a tree that grows with each question answered, with a different branch for each exercise.

B.C.	Encourage a behaviour
Granularity	Activity (Tree)
	Action (Branch)
D-M	Task Progression
Actor	User
Range	User
Visibility	During (Branch)
	Always (Tree)
Style	Literal form
Format	Absolute
Precision	Fuzzy

Table 2: The values chosen by the workshop participants for each design dimension

ment, participants used a different board and set of cards. In total seven game elements were designed.

We observed that participants took ownership of the design materials, sharing common ground on the gamification process and favouring communication. As the workshop progressed, participants were able to converge on design agreements faster. Discussions content aimed both at considering the impacts on students' motivation and fulfilling the different stakeholders' interests. Teachers and game designers succeeded in making decisions regarding operational and visual aspects of each game element, so that all of the information required to start the elements development was provided. Regarding creativity, we observed that participants were able to reuse well-known game elements such as points or badges, but also to design unique game elements (see figure 3 for an example).

Generally participants manipulated the cards with ease, however we observed that the participants had difficulties using the "Behaviour Change" dimension as they always selected the same behaviour. Further workshops should certainly be held in order to improve the material, and to think upon the integration within a larger gamification process. For example incorporating questions from Deterding's design lenses [3] or decision trees from [14].

Conclusion

This work aims to extend the concept of meaningful gamification to operational and visual aspects of game elements. To help designers in these complex considerations, we propose a design space that can be used for a vast variety of contexts (education, health, sustainability, etc.). The design space is accompanied by a set of cards and a board to facilitate its collaborative exploration during the design process. We were able to test our tools during a workshop held with different stakeholders where we gathered valuable feedback for their improvement in the future.

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REFERENCES

1. Yigal Attali and Meirav Arieli-Attali. 2015. Gamification in assessment: Do points affect test performance? *Computers & Education* 83 (2015), 57–63.
2. James Banfield and Brad Wilkerson. 2014. Increasing student intrinsic motivation and self-efficacy through gamification pedagogy. *Contemporary Issues in Education Research (Online)* 7, 4 (2014), 291.
3. Sebastian Deterding. 2015. The lens of intrinsic skill atoms: A method for gameful design. *Human–Computer Interaction* 30, 3-4 (2015), 294–335.
4. Sebastian Deterding, Dan Dixon, Rilla Khaled, and Lennart Nacke. 2011. From game design elements to gamefulness: defining gamification. In *MindTrek*. ACM, 9–15.
5. Lauren S. Ferro, Steffen P. Walz, and Stefan Greuter. 2014. Gamicards-an alternative method for paper-prototyping the design of gamified systems. In *International Conference on Entertainment Computing*. Springer, 11–18.
6. Allyson Fiona Hadwin, Sanna Järvelä, and Mariel Miller. 2011. Self-regulated, co-regulated, and socially shared regulation of learning. *Handbook of self-regulation of learning and performance* 30 (2011), 65–84.

7. R. Hunicke, M. LeBlanc, and R. Zubek. 2004. A formal approach to game design and game research. In *Proceedings of AAAI Workshop on Challenges in Game AI*, Vol. 4.
8. Karl M. Kapp. 2013. *The Gamification of Learning and Instruction Fieldbook: Ideas into Practice*. John Wiley & Sons.
9. Janaki Kumar. 2013. Gamification at work: Designing engaging business software. In *International Conference of Design, User Experience, and Usability*. Springer, 528–537.
10. Tuomas Lehto and Harri Oinas-Kukkonen. 2011. Persuasive features in web-based alcohol and smoking interventions: a systematic review of the literature. *Journal of medical Internet research* 13, 3 (2011), e46.
11. Aleksei Nikolaevich Leontiev. 1978. Activity, consciousness, and personality. (1978).
12. Andrés Lucero, Peter Dalsgaard, Kim Halskov, and Jacob Buur. 2016. Designing with Cards. In *Collaboration in Creative Design*. Springer, 75–95.
13. Cathie Marache-Francisco and Eric Brangier. 2013a. Perception of gamification: Between graphical design and persuasive design. In *International Conference of Design, User Experience, and Usability*. Springer, 558–567.
14. Cathie Marache-Francisco and Eric Brangier. 2013b. Process of Gamification. From The Consideration of Gamification To Its Practical Implementation. (Oct. 2013).
15. Alberto Mora, Daniel Riera, Carina González, and Joan Arnedo-Moreno. 2017. Gamification: a systematic review of design frameworks. *Journal of Computing in Higher Education* (2017), 1–33.
16. Scott Nicholson. 2012. A user-centered theoretical framework for meaningful gamification. *Games+ Learning+ Society* 8, 1 (2012), 223–230.
17. Rita Orji, Lennart E. Nacke, and Chrysanne DiMarco. 2017. Towards personality-driven persuasive health games and gamified systems. In *Proceedings of SIGCHI Conference on Human Factors Computing System*.
18. M Prensky. 2005. Computer games and learning: digital game-based learning'in Raessens, J. and Goldstein, J.(Eds.): Handbook of Computer Games Studies. (2005).
19. R. M. Ryan and E. L. Deci. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist* 55, 1 (Jan. 2000), 68–78.
20. Donald A Schön. 1987. *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions.* Jossey-Bass.
21. Mary Shaw. 2012. The role of design spaces. *IEEE software* 29, 1 (2012), 46–50.
22. Gustavo F. Tondello, Dennis L. Kappen, Elisa D. Mekler, Marim Ganaba, and Lennart E. Nacke. 2016. Heuristic Evaluation for Gameful Design. In *CHI PLAY'16 Extended Abstracts*. ACM, 315–323.
23. Gustavo F. Tondello, Alberto Mora, and Lennart E. Nacke. 2017. Elements of Gameful Design Emerging from User Preferences. In *CHI PLAY'17, ACM*.
24. Kevin Werbach and Dan Hunter. 2012. *For the win: How game thinking can revolutionize your business*. Wharton Digital Press.