Badge Architectures as Tools for Sense-Making and Motivation in Engineering Education

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***Abstract*—In this paper we argue that badge architectures are narrative, material and performative repertoires which can be meaningfully employed to provide university students with a coherent understanding of education. Badge architectures function as powerful interpretative tools through which students make sense of their immediate learning world. However, the efficiency of badges in education depends on associated structures of distribution, procurement and display that articulate modes of participation within a local community of practice. By considering our experience in the design, implementation and evaluation of the badge system 'RL Hit List', we claim that more insightful perspectives emerge from considering motivation as a socio-technical accomplishment than as a state of mind. This view might be read as an invitation for designers and researchers to reconsider the intrinsic - extrinsic dichotomy in assessing the value of badges to motivate students.**

***Index Terms*—Badge architectures, achievements, gamification, motivation, reputation, engineering education.**

I. INTRODUCTION

In this paper we critically review and reformulate arguments concerning the use of badges, and we propose orienting concepts for designers of instructional systems. There is a rich thread of literature dedicated to badges and related reward systems in digital games; nonetheless, their use in education, and particularly in engineering education, has been rather understudied. Badges are mainstream components of digital games, and they are increasingly used in non-game contexts and in boundary systems (serious games, gamified applications, games with a purpose). This increasing interest in badge architectures reflects two converging trends: on the one hand, their continuous evolution and growing importance in gaming, and, on the second hand, the expanding relevance of games as models and resources for the design of other systems.

The paper is organized as follows: in the next section we define badge architectures and present their key features and rationales; we then discuss specific issues concerning badges in educational settings, and we present a case study to illustrate some of our key points. We conclude by proposing a set perspectives to guide reflection on the design, implementation and evaluation of badge architectures.

II. BADGE ARCHITECTURES

We use the concept "badge architectures" instead of simply "badges" in order to underline one of our main arguments: badges are valuable as components of a system of rewards, related, in turn, to a system of activities and actions. Awareness of the systemic functioning of badges is a key consideration for the design process.

Seen from a critical distance, badges may seem a simple or even simplistic mechanic. Still, successful badge architectures often balance multiple objectives and combine heterogeneous elements to create smooth user experiences. Their apparent simplicity is, at its best, a sophisticated achievement of design and evolution.

A. Key Features of Badges

We cover by the term "badges" a variety of rewards, including "achievements", "medals", "trophies", "pins" etc. Some of the key features shared by these rewards are: a title, an icon, a description and related points (Galli & Fraternali, 2012). Badges are virtual artefacts that are granted to participants, who thus become their owners. If we extend the description of badges to include their role in the system, we can say that, as a rule, a badge shares the following characteristics:

1) A **graphic sign**: as a rule, badges have a core graphical descriptive component, which may be complemented with additional elements such as text, numbers, and/or other graphical elements (for example, several stars);

2) A reference to a specific **system event** resulting from the user's activity; this may be an accomplishment of a valuable task, a chance finding, a noteworthy failure (for anti-achievements), a memorable experience etc. The event is, as a rule, succinctly described through the badge title and possibly through an accompanying phrase; badges may allow observers to reach (via hyperlinks) a more elaborated description of the underlying activity and performance;

3) After it is unlocked, the badge is attached to the **participant's profile** in the system and, possibly, transferred in other systems as well;

4) Badges rely on a **quality vs. quantity** mode of involvement: they are virtual possessions, and, as such, can be either possessed, or not. Still, badges may be further quantified (by counting them, or by summing achievement points), thus becoming again commensurable on a continuum.

5) Badges often are **secondary rewards** [1] meaning that the game can be played without paying too much attention to them; nevertheless, many players consider the secondary achievements a critical game element [2].

B. Rationales of Developing Badge Architectures

Previous work focus on the role of badge architectures: badge architectures may create user portraits, system maps, and dedicated timelines, supporting new forms of attention within the system and at meta-system levels. By affording new activities in and about the system, badges are considered as means to offer participants resources to internalize their extrinsic motivation.

Badges in digital games are diverse. Montola et al. (2009) identify several types, ranging from rewards for exploring the game (tutorial) and completing game activities (completion, collection) to badges for outstanding achievements (virtuosity, hard mode, veteran, loyalty, paragon), for eccentric events (special play, curiosity, luck) and to meta-gaming (fandom). This diversity makes visible several functions of badge architectures in digital games: they show the way, they render visible certain activities and stimulate participation, and they encourage prolonged engagement with the game. From the point of view of game designers, achievements are especially valuable insofar they retain players longer in the system. Antin and Churchill (2011) point to five other functions of badge systems: 1) instruction about possible activities, 2) goal setting, 3) reputation – including information on players' experiences, skills, interests, and overall dedication to the game, 4) conferring status, and 5) group identification. They go on to highlight two topics for further reflection: badges are not motivational for all participants, and they may even have adverse effects by displacing intrinsic motivation.

The diversity of participants, the diversity of possible badges, and uncertainty concerning motivational effects, pose designers several questions about how to tackle the task of deciding whether a given badge architecture is adequate, and how to implement it.

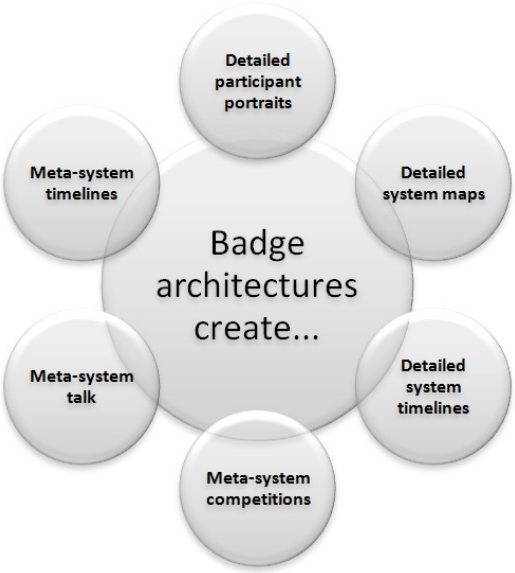

Figure 1. Creative effects of badge architectures

On the one hand, badge architectures function to **map the system** of activities (game or non-game) to which they are attached. Badge architectures also function to **portray** participants, making their experiences, skills, and inferred preferences available to others, in a system of co-veillance [2]. One step further, by specifying valuable activities and outcomes in the system, and by making participants visible to one another, badge architectures allow a "**Gestalt understanding**" [3] of the system and its community.

On the other hand, through this descriptive effects, badges afford novel **activities within** the system and **about** the system (such as various metagaming activities – Sotamaa, 2010), and new sets of **reasons** for engaging with the system. In his ethnographic work on Xbox 360 gaming, Jakobsson distinguishes three main types of users in relation to achievements: achievement casuals (enjoying them now and then for their scaffolding function), hunters (aiming for the largest overall score), and completists (aiming for an integral achievement collection) [2]. We identify, through his analysis, three creative effects of badge architectures that apply to games and possibly to other systems as well. On the one hand, they add a **resistance structure** to the gameworld, by making salient the less visible regions of the game, by structuring gameplay time, and by extending the duration of gameplay beyond the first game end. Secondly, badges create a **new definition of game completeness**: they compose a collectable set that invites a new type of activity: "collecting badges". Thirdly, as Jakobsson notices, badges may create **a different (meta)game** whatsoever out of a series of initial games: he concludes that players of the Xbox 360 console games have become, with variable awareness and willingness, participants in a multi-player online game in which each achievement represents a distinctive "quest".

C. Badges Architectures and Motivation

A focus on the descriptive and creative missions of badge architectures give rise to a heated debate on whether badges foster **intrinsic or extrinsic motivation**. Badges are often denounced as depleting activities of their fun, displacing intrinsic motivation, or making it irrelevant, at minimum. Laschke and Hassenzahl (2011) join a trend of denouncing badges (and other instances of gamification) as meaning-depleting stimuli that enforce a behaviorist theory of human motivation [6]–[8]. Still, their argumentation does not rely on empirical evidence on how badges are actually taken over by participants. They notice that "becoming a "mayor" of a place can be solely driven by the wish to get the according badge (…) there might be a big difference between being there because of an intrinsic interest in the people, the place, the atmosphere or being there because of the badge" [5]. While this difference certainly *might* obtain in some instances, empirical research and testimonies concerning Foursquare users / players point out that many of them have multiple reasons for using the system, beyond collecting badges [9] – even when cheating in the game [10]. Jakobsson replies to the intrinsic vs. extrinsic discussion that badge collecting is in itself an intrinsically motivated pursuit – but this does not directly address the issue of whether the joy of collecting decreases the joy of playing or otherwise engaging with a system. Jakobsson notices that, in practice, there is a deep ambiguity of players concerning achievements. They can be experienced as stimulating, as addictive, as alienating, or as informative and quasi-inert – depending on the game the participants actually play, within the formal system frame (ibid.). The question then becomes not whether badges support or displace intrinsic motivation, but **what kind of novel activities are afforded by badge architectures**, how are they taken over by participants, with what kinds of reasons, and with what consequences? These

questions can only have specific, empirical answers, depending on the social context of the activity.

III. BADGES IN EDUCATION

Badge architectures in educational systems may be **embedded into a gameful system** (see for example [11]), or may be used as **independent game-like mechanics** to animate non-game learning activities, as in the examples of the Khan Academy and the future MITx framework [12], in Mozilla Open Badges [13] or in the RSS Network [14].

Unlike gameplay that is, more often than not, voluntary and driven by enjoyment and other forms of individual fulfilment, students often experience educational activities as dry and tiresome beyond enjoyment. Therefore, the issue of intrinsic motivation displacement is less salient for badges granted in non-game learning systems. The problem becomes, rather, one of attention focus, for instructors and students as well. Badge-fuelled instructional systems may be accused of being lazy: do badge architectures stimulate instructors to create relevant, engaging learning experiences, or do they rather relieve them of this pressure? Do they stimulate learners to seek the hidden logic and relevance of unfamiliar notions, or just to navigate the surface of the subject matter and collect badges?

On the other side, badge architectures appear as promising significant motivational effects for potential recipients – be they students or teachers. Final, outcome-badges are especially valued for their **descriptive** force: unlike diplomas, they are specific about underlying experiences and skills, and they can be displayed immediately after they are 'unlocked', making personal growth visible on a continuous basis [12]. Badges provide a form of fast (if not immediate) feedback, and they offer resources for self-presentation in front of peers and employers. Unlike badges in digital games, which are of interest mainly for other gamers and designers, badges in educational systems can speak to a larger set of publics, including potential employers in various fields, peers, and family members who may belong to different generational and occupational worlds. Educational badges may function, therefore, as **boundary objects** ([15], [16]), translating formulations of skills and experiences to support interaction across domains of expertise.

At finer levels of task granularity, badges that reward intermediate progress or secondary performances make the participant more aware of, and invested into the system. The **self-determination theory of motivation** [17], [18] downplays the intrinsic / extrinsic distinction and brings forward the issue of internal versus external source of motivation. Insofar badges offer pretexts for engaging with an activity, moments of fun that give some impetus for tackling a difficult task, they become antidotes for procrastination. Badges may function as tools for internalizing extrinsic motivation, enhancing participants' self-determination. Learners often appreciate that study tasks are useful and relevant – but they may lack a here-and-now impetus for actually starting the work. Getting the work started, for reasons intrinsic or extrinsic to that activity, is the first step towards developing better appreciation of a competence field, a first and necessary step towards autonomous learning. Badge architectures can therefore be designed not as promoters of intrinsic motivation, but as a **scaffold** for what Ryan and Deci (2000) call **internalized extrinsic motivation**, which we might think of as a quasi-intrinsic motivation.

The third reason for considering badge architectures as motivational tools derives from their creative effects. Badges can consolidate learning by producing structures that extend beyond the here-and-now of instruction:

- Architectures of badges create **maps of learning fields and communities of practice** [19]. Therefore, they may support a better understanding of what is relevant in a specific field, and they can encourage convergence between different stakeholders in formulating the curriculum: human resource experts in the industry, K12 and university professors, and students;

- Unlike the too-official grades, badges "give concrete evidence for bragging rights" [20] through detailed participant portraits, and thus stimulate **conversations** around learning; badges can also support consistent **contributions** on forums, peer-learning and content generation;

- Grades are only for students, but badges are for students and teachers alike, linking them in **horizontal social networks**; this is particularly relevant given the opportunities of social web for education [21]

- Badges afford comparisons between students and teachers from different course years, crossing classroom and generational time borders; they create **extended timelines**;

- Badges create **communities** of members that are attentive to one another's progress and even compete in educational arenas.

IV. CASE STUDY: RL HIT LIST

In order to illustrate some challenges in designing badge architectures, we present the "RL Hit List". We have designed this system for students in the Computer Networks course (abbreviated as CN, in translation as RL) taking place in the 3rd year of study in a Computer Science program of a European technical university. The course enrolls around 100 students. The Hit List is already in use: it currently lists 350 achievements, awarded until January 2015[1]. The objectives of this badge system are:

1) To assemble **communities** of students and teachers:

- To create a visible, public, and course-related merit-based elite of students, including around 25% of each generation;
- To create a trans-generational record of performance, linking instructors and students from different years in a common network;
- To raise interest in computer networks and in the CN course among top performing students, and to recruit future student mentors and TAs;
- To position the CN course as a meaningful, challenging learning experience for students, instructors and employers alike – and in this process to consolidate the identity of the CN instructor team, and the research group in which they belong;

2) To stimulate technical and casual **talk** referring to computer networks and the CN course

- To make student performance throughout the course a public matter and a topic for conversation – that is, to create what Jarvinen aptly called "evidence for brag-

[1] https://systems.cs.pub.ro/teaching/courses/rl/hit-list/

ging rights" (2009) related to the CN course concepts, participants, and memories; this evidence can become a topic in students' talk with their colleagues, and also in interactions with significant others from other professional fields, including family members and friends;

- To stimulate joint reflection in the faculty group – as teaching assistants are the ones who deliberate and vote on the students that receive badges for their laboratory and overall contributions.
- To position performance in the CN course as an 'experience that makes a difference' in students' CVs and when interviewing for jobs in the IT&C industry;

3) Last but not least, to **motivate** students to engage with course, laboratory, and forum activities, to raise their interest for participating in attendance-monitoring systems [22] and for obtaining top grades in midterm and final examinations.

The RL Hit List falls squarely in the set of badge architectures, but it has two distinctive traits:

- It combines digital and material rewards: each prize consists in a digital inscription and a metallic pin badge (Figure 1), which is ceremonially awarded at the beginning of a course;
- Instead of images, it uses numbers as visual signs (Figure 2): each recipient receives an ID number on the Hit List, in increasing chronological order. The initial number was 256, the first value to symbolically evade representation on one byte. ID numbers do not represent scores or levels, but marks in time – which, at the same time, serve to construct a distinctive timeline and a tradition in reference to the CN course. The system displays a minimalist graphic, aimed at a community of professionals, with no explicit reference to gamefulness or playfulness.

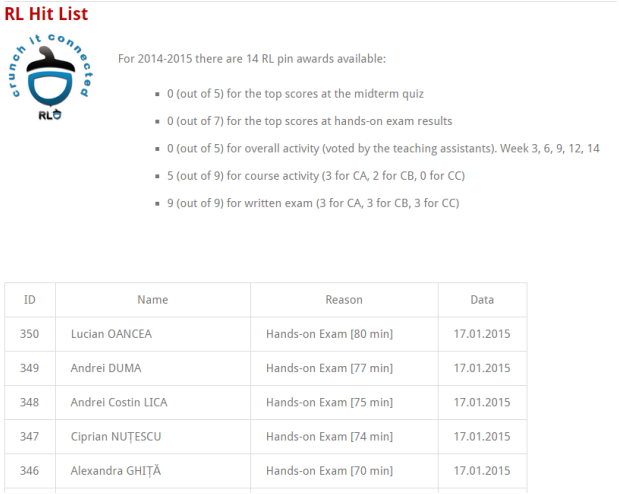

Figure 2. The online RL Hit List at 20.02.2015

The allocation of RL pin badges (Figure 3) is not entirely automated, depending, for some categories, on instructors' deliberation. As a consequence, this award architecture has immediately produced a new kind of **awareness** of possible and alternative criteria for appreciating student contributions to classroom and virtual discussions. In order to be able to make their case, members of the course team have had to pay more attention and to remember more of their students' activity in class, by name. Although it seems that teaching assistants and course professors would anyway remember outstanding students, setting this as an objective visibly refines the granularity of the remarkable contributions. While virtual badges are swiftly allocated by system administrators, metallic pins are awarded festively, in front of around one hundred colleagues. Still, this feeling of ceremony is volatile: we have noticed that, when granting three identical pins (top score in midterm quiz), the first student to be announced has received intense applause, while the third was barely applauded – at a distance of seconds. Therefore, the most challenging aspects that need to be managed concerning the offline pins are not the material issues per se (designing, ordering, depositing etc.) but the symbolic issue of creating and maintaining their **ritual** dimension.

Figure 3. Metallic pin badges for the RL Hit List

We have initially assumed that the purpose and functions of this badge architecture are transparent for all participants, students and teachers alike, in virtue of the simplicity and self-explanatory nature of the system, and a shared gaming culture. Subsequent discussions have indicated that this was not the case: the only objective which featured prominently in members' talk was "to motivate students to be more engaged with the course". This is why we have decided to make the architecture more **verbose** – that is, to publish explicit self-descriptions for some of its rationales. This digital loquacity of the system was organized as a hypertext, with increasing layers of details aimed at different publics.

Last but not least, if there is a shared keyword across most objectives, it is **talk**. Badges are designed for conversation: they are alive if students, professors, employers end up discussing them one way or another. Students can contribute to course discussions, can "brag" about their achievements, can mention them in their online presentations; faculty members can talk about them as a noteworthy feature of their course, and as a personal accomplishment. Still, all this talk is only a possibility, until it really happens. The most difficult task of this achievement architecture is **to kindle its conversational infrastructure**.

V. DISSCUSION AND LESSONS LEARNED

In what follows, we use RL Hit List as a framework to comment upon the powerful role played by badge architectures in education. We illustrate our main points by presenting both the observations we made during the implementation of this specific badge architecture and the results obtained from semi-structured interviews with students, instructors and designers.

A. Narrative repertoires: Badge architectures as stories

Badge architectures are based on scenarios defined in their design and implementation. Moreover, they incorporate forms of **narrative reasoning** articulated through practices of use and communication. Badges are employed to tell a story about the system in which they are integrated. The structure (types of badges, graphics, hierarchy, order to receive badges) and procedurality (rules to be followed in acquiring badges) are relevant in disseminating messages relevant for a learning community. Badge architecture tell something about students themselves, about the associated course, and about the educational process characterizing a wider socio-cultural context. Badge architectures function as a narrative of progression, defining the significance of certain activities while enabling checkpoints to navigate the curriculum.

1) Badge architectures provide a narrative understanding of the self

Badge architectures are **technologies of the self**. According to Steven Brown, a social technology is "that which enables as its primary object the self-modification of some subjective state of affairs of a human subject" [23]. In this sense, badge architectures are technologies which make people establish a rapport with themselves and with the world around.

By functioning as **systems of self-assessment**, badge architectures instruct students how to think about their own person. Badges are resources used by students to define themselves. As grades, feedback from peers, and other similar methods, badges represent modes of acquiring a sense of who you are in a learning environment. Accordingly, badges represent criteria to position students in relation to others, means to make students aware of their role, and alternatives for students to acknowledge future possibilities.

Moreover, badge architectures are a **self-looking glass** in that they provide students with a projection of how others think about them. Functioning as collectively validated standards of performance, badges offer recognizable signs and signals to self-interpreting learning behavior. As part of a system of rewards, receiving a badge is a confirmation of acquiring something relevant. Badges integrate a generic voice of the community telling something about those who received them.

Beside these two features, badge architectures might be designed to incorporate **public identity displays**. Badges architectures provide students with tools to manage how others see them. Not only receiving a badge appears to be relevant for an effective badge architecture, but also showing others that it was received. When badges are allowed to be displayed on personal public profiles or otherwise, they become a resource for the management of impression.

2) Badge architectures provide a narrative understanding of the curriculum

A personalized badge architecture (i.e. that which is designed for a specific course based on its particularities) shows students how the course they enrolled in have to be approached. By rewarding specific educational achievements, both badge architectures (as a whole system) and badges (as part of the system) come to incorporate bits of knowledge relevant for the course. Implicitly, badges architectures develop a view of personal advancement as a process of accumulating information, skills, and resources.

Badge architectures represent a translation of the syllabus in a more attractive language. The course objectives, competences to be acquired, prerequisites of the course, all of them might have correspondents in how badge architectures are organized (what is awarded and how). In other words, badge architectures bring students closer to the formal documentation used in organizing the content of the course. Badges architectures give a playful character to the curriculum: it transform formal documents which are part of the academic bureaucracy into creative substitutes which are operated and understood by students.

Badge architectures are tools for the **management of learning**. Through badges, students become more aware about what instructors expect from them. Badge architectures organize knowledge in conceptual maps and temporal frames. Therefore, badge architecture provide students with a visualization of progress, status in completing the course and future outcomes necessary to pass. Also, badges function as predictors of the final grade. This is why we consider that introducing a badge architecture in education might improve students' skills of self-evaluation. Moreover, badge architecture make visible different levels of complexity characterizing parts of the curriculum, allowing students to effectively distribute their learning effort as to have good final results.

3) Badge architectures provide a narrative understanding of education

Badge architectures might be understood as part of a **student-centered pedagogical culture**. They are employed to create a desirable identity for those students who are actively involved in course activities, thus contributing to the valorization of learning. Badges in education are primarily addressed to students and therefore designed according to students' needs, preferences and worldviews. Therefore, effective badge architectures employed in academia should be both enjoyable and useful, facilitating students' commitment to education.

Based on gamification principles, badge architectures are tools that construct a view of education as an assemblage of fun activities. Badge architectures might be seen are part of the pedagogical methods that are employed to orient students' attention towards significant learning outcomes. Consequently, badges architecture blur the distinction between learning and play, by introducing the opportunity of **playful learning**.

Considering their participatory and collaborative character, badge architectures might be employed to frame education as collective action (instead of individual action). Badge architectures could be employed to create a **sense of togetherness** in learning: they help students and instructors be more aware each of other by promoting an understanding of themselves as members of a shared world.

B. Material repertoires: Badge architectures as objects

Not only badges but also badge architectures are objects since they are part of the material ecology which organize people daily routines. Badge architectures might be approached as independent objects considering some of their particular features which resemble other entities that belong to the generic category of "objects" (as it is commonly understood).

Badge architectures might be approached as independent objects based on their following proprieties:

- Badge architectures are limited and recognizable realities incorporating specific physical forms (maps, hierarchies, lists etc.).
- Badge architectures are associated with a sense of possession. They belong to an agent that exert control over them.
- Badge architectures are products created by considering multiple alternatives. They result from processes of conception in which their functionality, graphics and mechanics are established.
- More than receiving significance through practices of conception, badge architectures receive significance through use. It appears the risk to use badge architecture differently than they were actually projected.
- Badge architectures might be upgraded without substantially altering their already established significance and modes of use.
- Badge architectures may expire and be replaced by other significant systems of rewards. Therefore they should be continuously improved as to manifest interest and answer the needs of a specific public.

1) Badge architectures are mnemotechnic objects

Badge architectures might be designed to build **awareness of a personal past**. They might be employed as records to say something about how those who received them had performed at a certain moment in time. Badges leave traces when theirs acquirement is made visible and with the passing of time they come to tell something about how a person was in the past.

Functioning as mnemotechnic objects, badge architectures could build a common shared past. Therefore, they might become **institutions of local history**. Badge architectures might create links between generations of students from different years but with similar results. Therefore, badge architectures could be employed to make people aware of a local history of the course.

Illustratively, RL Hit List functions as a chronicle of the CN course:

- It references a chronology of achievements as significant events in the course history (mid-term results, final exam-results, project results etc.).
- It is designed on the idea of factuality. An event becomes important not because it happened once in time but because it is mentioned in the RL Hit List.
- The local history mediated by RL Hit List is a history which could not be changed and altered. Each event is assigned a person who receive one number. The event is recorded once and for all.
- The RL Hit List is an ongoing product which is transformed each semester when the CA course is organized. The changes appeared in the organization of the course have correspondents in RL Hit List. Some new events appear, some events disappear depending on the activities on which the final grade is based on.

By paying attention to their memorable character, badge architecture are devices that might be easily employed to create **positive memories** of the course. Badges (e.g. metallic pins) could become souvenirs that might help ex-students remember the course in an enjoyable manner.

Moreover, being awarded to terminal year students, the RL HIT List is designed to be relevant for managing the alumni identity, corresponding to a mode of being together with ex-colleagues on a list after graduation.

2) Badge architectures are boundary objects

As boundary objects [15], badge architectures create links between those communities that establish different rapports with the same system of badges. In this case badges architectures employed in engineering education might facilitate relationships between industry and academia since previously divergent interests are brought together by designing a badge architecture that, for example, could help in selecting best candidates for a job.

Badge architectures are assigned with a plurality of meanings across contexts. They incorporate multiple **layers of intelligibility** depending on persons' mode of approaching them. Different categories of people use the same badge architecture differently. Badges have a different meaning for students than from instructors, or for ex-students than for employers etc. Each of these categories interacts differently with the same badge architectures depending on their interests and roles. For example, for students it counts to acquire a badge, for instructors to distribute them properly, for employers to have badges rewarding relevant competences in selecting the best candidates for a job etc. Even though the significance of badges is different across groups, badge architectures come to be recognizable and meaningfully integrated by each of them into a locally constructed world.

Still, we have to mention that in order for badge architectures to function as designed, some persons should be made responsible to create and disseminate particular narratives, thus presenting badges as useful and of worth according to the specific interests of the groups. A single narrative of how badges are useful wont's work the same way for students, instructors and potential employers.

3) Badge architectures are situated objects

Badge architecture are highly contextually dependent. The same system of rewards won't function the same way when employed in different settings. This is why the efficiency of a badge architecture might be defined only relative to a setting, its integration in other contexts necessitating particular adjustments and refinements.

The significance of badge architectures is **locally constructed**. The meaning of badges is communicated based on shared vocabularies which comprise types of knowledge that are available for some persons but not for others. Badge architectures structure two types of communities: the community of those whom badges are designed for and the community of those who have received badges. The simple fact that a person is entitled to receive particular badges makes her a community member. Outsiders are not allowed to receive badges.

Badges architecture might be employed either to incorporate elements that are already relevant for a community or to define as relevant for a group those elements that are relevant for other groups. In any case, badge architectures assimilate elements that count at least for some persons on local grounds.

4) Badge architectures are symbolic objects

Badges architectures are **concrete representations of abstract ideas.** Badges extend their significance beyond their form and content. They are relevant for their ability to grab ideas and values from the outside world and incorporate them into unitary settings.

Badges might be framed by design as rare objects. This type of mechanic have implications in defining their local value. Badges come to be relevant differentiators between students not only because they are rare, but also because they are **non-transferable**. Generally, objects that could not be transmitted from person to person are socially defined as valuable and special.

The symbolism and the associated superiority derived from the rare and non-transferable nature of badges might be technically accomplished through particular design features.

C. Performative repertoires: Badges architectures as actants

Performativity is most usually defined as the capacity of language to create the reality it refers to [24]. Starting from this understanding, we might talk about the performativity of badge architectures as well. Certain things are made possible by integrating badges within the educational process.

More than simple objects, badge architectures are actants [25]. As actants, badge architectures do something in the world to which they belong. Their quality to act appears clearly when considering that learning practices would have been different in their absence. Badge architectures are not neutral elements but an infrastructure which offer mediated possibilities of participation and involvement, thus coming to shape the world in which they are introduced.

1) Badge architectures create types of students

Badge architectures are complementary systems of **people classification and categorization**. Badges architectures act upon inequalities and differences established between students. Firstly, badges differentiate between students who received them and those who did not. Secondly, badges differentiate between those who received them earlier and those who received them later. Thirdly, badges create types of students who have certain competences, skills and interests, each of them coming to be collectively known and acknowledged. Also, when instructors are allowed to negotiate who receives a badge, as it is the case of RL Hit List, new types of students emerge in instructors' discussions and rationalizations.

Therefore, badge architectures create identities which are further used to organize local interactions. The social categories mediated by badge architectures transcend the boundary of a specific course and are made to count in the wider academic context and beyond it.

2) Badge architectures create types of actions

Different types of actions arise by employing particular systems of rewards in education. Badge architectures restructure what kind of **individual actions, collective actions and coordinated actions** are possible. Badge architecture redefine what people could do by their own and what people could do together with others. Moreover, badge architectures shape new types of coordinated action with effects on the social organization of learning.

For example, badge architectures enables students to perform the acts necessary to receive a badge which otherwise might have been ignored (individual actions). When badges are awarded in a public ceremony, they provide students with the possibility to be acclaimed by peers and instructors for their results (collective actions). By introducing badges as systems of rewards in the educational process, new responsibilities for instructors emerge. Instructors are thus entitled to persuade others about the value of badges, convincing students that it worth acquiring badges (coordinated actions). Also, badge architectures might become topics of everyday conversation, facilitating interactions and assigning students with new modes of participation (individual, collective, and coordinated actions).

3) Badge architectures create types of relations

Particular types of relations between instructors and students are embedded in particular badge architectures employed in education. These relations might be authoritarian, egalitarian, or a combination of both. Badge architectures establish new hierarchies or give legitimacy to those already established.

On the one hand, if badges architectures allow instructors the power of decision in distributing badges, then it facilitates the emergence of **hierarchical relations** as long as instructors are enabled to be more in control of the situation. On the other hand, if badges are designed to be received both by students and instructors, then badge architectures establish an environment when students and instructors could be together irrespective of their roles and power in the academia. RL Hit List is a good example as long as it takes the form of a list which mention instructors and students in chronological order according to their accomplishment. Ex-students might become further instructors, but they are recognized by the number received as students which is another way of structuring the relations between instructors and students.

Not only hierarchical relations, but also **peer relations** are (re)shaped by introducing badge architectures in education. When badge architectures frame badges as limited resources, than students are implicitly invited to compete. This might give rise to ambivalent results in education. The adversarial nature of badge architectures should be continuously monitored and adjusted as to avoid the creation of counter-productive relations between students.

4) Badge architectures create types of values

Values are normative components that make students judge actions in moral terms. Values are referential frames used to evaluate actions as good or bad, as adequate or inadequate, as benefic or harmful. Functioning as systems of rewards, badge architecture embed values in their design. By awarding certain things and not others, badge architecture define the set of values that are relevant in specific learning contexts.

By introducing badge architectures in education, to own a badge becomes a value in itself. It pose questions about which is the correct manner to distribute and receive them. Functioning on their own logic, badges architecture might be used as platforms to blame activities of cheating in education: cheating on receiving a badge might be framed as more blameful than cheating on the final exam. In this sense, badge architectures might be employed to make some norms more legitimate than others.

Accordingly, badge architectures represent an **objectification of community values**. They represent a materialization of things that count for designers, developers and instructors. These values come to be communicated to students as well. Badge architectures might be approached as resources to synchronize the values of instructors with those of students. By exploring what students are rewarded for, one might find what is relevant for that particular community.

Moreover, badge architecture facilitate the emergence of a community. One of the conditions that differentiate a community from a group is that members of a community share the same values, norms, and repertoires of interpreting the world. Badge architecture make members of the community (students, instructors) be more aware of those norms. Badge architectures creates both a space where norms could be found and some possibilities to operate with them in daily circumstances.

5) Badge architectures create types of experiences

Badge architectures modulate the **emotional and cognitive experience** of learning. Introducing badge architectures in education create specific modes of being aware of the environment in which education takes place.

Specifically, badge architectures generate some emotions which would have been impossible to arise in their absence. Badge architecture establish the wish to receive a badge which comes to be associated with particular emotional experiences. These emotions are a result of success and failure which come to be defined and redefined once badge architectures are introduced as systems of rewards. Badges either amplify or diminish certain components of learning and therefore they might be employed as resources instructors could use to calibrate success and failure as it is experienced by students. The types of emotions mediated by badges might be known through intermediary evaluation and discussion with students, and thus they are subject to change. The type of emotional experiences might be changed by acting upon how badge architectures are structured and used. How emotions are to be known is a matter of design: emotions might either be kept private or made publicly available by providing students with opportunities to display and express them.

We refer to the cognitive dimension of badge architectures by considering their power to make students think in specific manners about the learning environment. Badge architectures incorporate various strategies, different forms of reasoning, specific cost-benefit analysis and learning practices which are supposed to be applied when attempting to acquire a badge.

D. Motivation as a socio-technical accomplishment

The most common rationale that lies behind the employment of badge architectures in education is to motivate students to participate in learning in a relevant and enjoyable manner. In this sense, badges are understood as instruments that might work upon students' motivation.

In general terms, motivation is understood as a state of mind that orient people's behavior. It is a determinant for action. Specifically, motivation is the element that give significance to actions. The same acts coupled with different motivations becomes completely different action. For example, the act of participating to a lecture has different significance when considering the associated motivation: being together with colleagues, accumulating knowledge, receiving a badge etc.

When introduced in education badges either make possible different actions or redefine the acts performed even in their absence by assigning them a different motivation. Therefore, the action of studying becomes the action of receiving a badge. This issue was addressed in different papers that discuss the role of badges in education [13], [14], [16], [26], [27].

The main risk of introducing badges in education derives from their possibility to motivate students only towards receiving a badge, thus motivation to study (intrinsic motivation) being replaced by the motivation to receive a badge (extrinsic motivation). This is why the most effective badge architectures were considered those that develop possibilities to create adequate rapports between intrinsic and extrinsic motivation. In this case, it was brought to the fore the necessity of rewarding only achievements that are relevant for educational purposes and self-development. This way it was avoided the risk of making students interested in receiving badges, but not in studying for the course.

As long as motivation is subject to change, it is something which designers and developers can act upon by organizing badge architectures that support particular types of interactions, actions and relationships. In this sense, motivation could be manipulated and badge architectures represent one of the instruments to do this.

Motivation embeds a mode of interpreting a situation shared across different people. It is legitimated through actions in which the significance of badges is communicated (formal and informal interactions, lectures, website etc.). Motivation allows individuals to make sense of their world by structuring their modes of social participation.

To motivate students is to work upon their interests, but before existing in the mind of students, those interests exist in the environment as affordances to act. The interests of students depend on the alternatives that the world in which they are engaged offers to them. This is why we consider that it is of great importance to create a **motivational socio-technical environment** to facilitate particular experiences and modes of thinking about the self and the educational world. Based on our experience with RL Hit List, we consider that students' motivation could be mediated though badge architectures as narrative, material and performative repertoires.

However, in order for badge architectures to be effective, designers and developers should understand the **social dynamics** that characterize the context in which badges are integrated. Sociological studies conducted before, during and after implementation are relevant in understanding how badges make sense for students, therefore contributing further to their enhancement. Sociological methods such surveys, interviews and observations are essential in the continuous assessment of badge architectures.

VI. CONCLUSIONS

Badge architectures are an increasingly relevant component of learning experiences. Engineering education is especially inclined towards using achievement-type rewards, due to widespread engagement with the gaming culture. We argue that the conceptual framework for reflecting and evaluating badge architectures relies on two

common, but problematic, tropes: that badges are **simple** mechanics added to an activity, and that they operate within the **intrinsic / extrinsic** motivation dichotomy. Instead, we propose that badge architectures can be more productively thought of in light of their **descriptive and creative functions** for the system in which they are implemented. In brief, badges are productive elements: they can generate **maps, portraits, timelines**, and they open up a **meta-system level of activity**. As **narrative, material and performative repertoires**, badge architectures may help participants internalize a structure of relevance for study and work, and they may open a communication space centered on the experiences and skills that they reward.

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