

# Gamification, citizen science and civic engagement: in search of the common good

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## Abstract

In this paper we discuss the importance of play and the growing use of playful sensing techniques as a valuable tool for participatory design initiatives which are triggering new forms of creative collaboration and civic engagement. The relevance of gamified citizen science projects as part of an emerging culture of massive collaborative initiatives that make use of crowdsourced skills is highlighted. Among other collaborative initiatives - in which users voluntarily and playfully contribute their time, effort and resources towards scientific research and civic issues - we present a project we are devising for users to enter and retrieve information on commercially available food products which contain ingredients associated with an increased risk of cancer and other diseases. Through gameplay, we expect to crowdsource an open database of potentially unhealthy food products, raising awareness among consumers about the risks of certain ingredients and artificial additives. Always tethered to our mobile gadgets and social networks, we have become a major source for - voluntarily or not - collecting and sharing all kinds of information about our universe, what calls for a more ethical, critical and meaningful use of these new potential capabilities, and greater awareness of our new civic responsibilities.

## Keywords

Gamification, citizen science, collaborative design, civic engagement, crowdsourcing, mobile applications, health, food products, ingredients, artificial food dyes

## Introduction

As foreseen by Mark Weiser over two decades ago, computer devices and systems have become intrinsically and transparently integrated into the fabric of our human existence [1]. Ubiquitous mobile technologies have intertwined our physical and digital realities, creating new hybrid experiences and expanding both our individual and social frontiers. Our information and communication technologies are now “worn on our skin” [2].

Smartphones have become affordable to more people around the globe - by the end of 2016, 4.8 billion users had a mobile in their pockets, according to a study just released by GSMA [3] - and have gained substantial relevance in everyday life, as they become integrated in all social environments. Thanks to the increasing use of positioning systems and sensors, the growth of networks for wireless communication, as well as the increasing

offer of applications and functional items, the amount of personal data and information gathered by these mobile devices is multiplying at an incredible rate. And if in the first decade of the 21st century much of individual social interaction was mediated “by sorting algorithms from recommended movies to selected books, music, and even lovers”[4], with the fast growth of ubiquitous computing - which took place during this second decade - ordinary devices and technologies not only became smart and more attractive to users, but also much more pervasive. Information concerning the habits of individuals - collected in a much greater detail and depth - is now widely available and can be used for different purposes. “Queries on search engines, status updates, friendship connections, preferences generated in social media, geolocation data from smartphones, purchasing history, and more provide businesses, governments, and scientists a wealth of insights and a new way of understanding the world.” [5]. Cross-linking of different data sources provides deep insights into issues such as personality, health, commercial intent and risk. The aim now is to understand and characterize the population, down to the individual level. Although the power of accumulated capital can still play a major role in international economic affairs, a new form of power is emerging in our digital society: data is our new currency [6].

Tethered to our mobile gadgets and connected to our social networks on a full-time basis, we have become a major source for sensing, collecting, retrieving and sharing all kinds of information about the universe, with or without our intervention or awareness. “By far the biggest generator of data is all of us – people: everything that we are, as physical, emotional, thinking beings, is reflected digitally; our behaviors, our habits, our DNA, our passions, our relationships, our dreams.”[7].

This scenario not only raises concerns about privacy, surveillance and ethical issues, but also calls for a more critical and meaningful use of technology, as well as greater awareness of our new civic responsibilities.

## Citizens as sensors

While driving in the streets of our cities, or taking pictures and posting comments using apps and social media, we are constantly sharing our locations and geotagging our lives. Citizens have become “sensors” - unconscious and passive data sources - knowingly or not [8]. This undisclosed extraction of data from people, either for surveillance and control or for commercial

purposes, has raised ethical issues about the responsibility of autonomous computer systems [9],[10] and the impact of objectification and classification of human beings [4]. “Sensing” – defined as the ability to measure what happens around us and to respond dynamically [11] – has become crucial to our data-driven society.

But if, on the one hand, much of the sensing is done involuntarily by citizens who are unaware of both the data they are providing and its end results, on the other hand many citizens are now collaborating by choice, with the aim of achieving specific results. In recent years, the process of sensing has been also performed as a deliberate civic action: citizens themselves are increasingly taking an active role in participatory data sharing. A plethora of mobile applications has been devised over the past few years, allowing people to share their information, opinions, preferences and needs with their communities, with the aim of achieving a desired common result. “Real-time information is sent out from our pockets, into the city, and right back to our fingertips.” [11]. The diffusion of digital networks, mobile technologies and social media, all converging with social innovation, “has enabled the creation of a new generation of services that not only offer unprecedented solutions to difficult social problems but also challenge our ideas of welfare and the relationship between citizen and state.” [12]. Several social innovations today are based on original uses and applications of sensing and collaboration technologies to foster “civic engagement”, which takes place when citizens work together and use their knowledge, skills, values and motivation to make a difference, to promote the quality of life in a community, through both political and non-political processes. In essence, initiatives in the domain of citizen science and collaborative awareness networks - led by collaborations between open government agencies, non-governmental organizations, research institutes, urban labs, maker spaces and grassroots communities – are in search of the “common good”: what is shared and beneficial for all or most members of a given community, and can be achieved by citizenship, collective action, and active participation in the formation of a shared will. These collaborative initiatives are proposing new forms of common cultures and democracy, as well as opening new grounds for participatory design explorations.

### **Citizen Science, Gamification & Civic Engagement**

Citizen scientists are individuals who voluntarily contribute their time, effort, and resources towards scientific research - either in collaboration with professional scientists or alone - but do not necessarily have a formal science background. Innovative civic technology initiatives using citizen sensing techniques are being developed under the label of citizen science. These initiatives are empowering citizens to engage in collective action through grassroots science across our neighborhoods, cities and nations, exploring mobile phones and other kinds of sensor technologies as

personal measurement instruments capable of sensing our physical environment [13].

Examples of citizen science initiatives promoting social innovation with the use of citizen sensing techniques include: Smart Citizen Kit (<http://smartcitizen.me>), a crowdsourcing platform for measuring environmental data with experiments in Amsterdam, Manchester, Glasgow and Barcelona; Safecast (<http://safecast.org>), a volunteer-centered citizen science project launched after Japan, 2011 earthquake and tsunami and the subsequent accidents at the Fukushima Daiichi Nuclear Power Plant, to monitor, collect, and share information on environmental radiation and other pollutants [14]. Another relevant example is Rede InfoAmazonia Mãe D'Agua project (<http://publiclab.org/wiki/mae-d-agua>), a network of low cost sensors distributed to citizens who live alongside rivers in the Amazon region for collecting data on water quality of rivers, wheels, and springs [15].

A core element in many citizen science initiatives is the idea of play, as a means to stimulate the interest and engagement of participants. The act of playing can enable the creation and discovery of new and unique experiences. “Everyone who plays a game puts a little of themselves into the experience, and takes away something that is wholly unique.” [16]. Games are capable of providing immersion, motivation and learning. Game design has also been applied in areas outside the production of games, including science and technology, as a means to stimulate user engagement, learning and fidelity through compelling game-like experiences. Such trend is referred to as “gamification” - which can be defined as “the use of game design elements in non-game contexts” [17], and which typically includes game design elements such as points, scoreboards, and victory conditions, among others. On the other hand, gamification can also mean the transposition of other elements – such as interaction design patterns, visual stimuli, etc. – from games to other media [18]. Gamification has been widely and successfully applied to citizen science [19], education [20] and, to a lesser extent, scientific software [21]. In these contexts, user participation can be facilitated by game design elements [22], narrative [23], socialization [24], fun [25], learning and discovery [26], desire to contribute to bigger causes [22], and personal interest in science [27]. Gamification can reframe tedious, repetitive tasks, transforming them into exciting ones [28]. It has been widely used for engaging voluntary participation in initiatives related to citizenship issues, as well as for the collection of diverse data. Through citizen science, the general public can be informed and, at the same time, contribute with gathered data [29]. Through gamification, citizen science initiatives crowdsource skills - ranging from ordinary human skills to highly specialized ones - to perform tasks and, eventually, outperform computational resources [30]. Moreover, gamified citizen science allows players to learn about specialized domains and, at the same time, empowers them to generate data that will contribute to that same field of knowledge [31]. The success of citizen science projects can be attested from academic contribution

originated from them, and also from the engagement it entices on the general public [32].

Gamification processes have been widely used successfully in the engagement of voluntary participation in initiatives aimed at citizenship and also in the collection of diverse data. Through the use of game design elements, such initiatives are able to stimulate from the reorganization of neighborhoods [33], Civic Media Platforms [34] to the mapping of noise pollution levels [35]. In addition to facilitating and motivating participation, such processes promote loyalty, or a prolonged engagement, seeking to insert users/players in surrounding dynamics, in addition to highlighting the significant character and real impact on society of their contribution.

### Dyet: Do you eat this?

*Dyet (Do you eat this?)* is a gamified citizen science collaborative project which is being devised by Laboratório de Arte Eletrônica (LAE) at PUC-Rio University, in collaboration with Tecgraf Institute of Technical-Scientific Software Development at PUC-Rio, with the financial support of Fundação de Amparo à Pesquisa do Rio de Janeiro (FAPERJ). By means of using the *Dyet* smartphone app, citizens can enter and retrieve information on commercially available food products which contain ingredients associated with an increased risk of cancer and other diseases. Through gameplay, we expect to crowdsource an open database of potentially unhealthy food products, raising awareness among consumers about the risks of certain ingredients and artificial additives.

### Context, goals and methodological aspects

The project originated from our desire to combine the diverse professional expertise and academic Laboratório de Arte Eletrônica (LAE) – an interdisciplinary locus where undergraduate, graduate and faculty students meet to reflect, research, create and produce Art & Design projects with emphasis on the use and development of digital technologies adapted to different contexts, considering their impacts on society and on the natural environment. Since its creation, in 1992, LAE has adopted a work methodology which has rigorously been maintained until today: all the team members participate in all phases of the projects, performing different activities and contributing in different areas, thus having a holistic view of the project.

The list of areas of expertise and interests of the team included game design and gamification, scientific software, education, crowdmapping, citizen science, intelligent citizens, civic technologies, mobile applications, and audio-visual-haptic interface design [Fig. 1], and we discussed possible project proposals that would encompass all those areas.

We were also interested in the use of different forms of digital intelligence (physical sensing, artificial intelligence, data analytics, big data, internet of things), on aspects of community engagement in governance and

decision making processes, civic participation and co-design processes, such as e-democracy, e-participation, e-governance, open innovation and open government.



Figure 1. Laboratório de Arte Eletrônica's team and expertise.

We decided the goal of the project would be to investigate the use of digital media in processes of civic engagement and construction of digital citizenship in the context of intelligent cities, focusing on how gamification and autonomy in data collecting, processing and analysis can empower bottom-up initiatives. But we still needed a specific theme to address, and another converging topic of interest in the group was “healthy eating”. Many team members expressed their concerns on the abusive use of pesticides in agriculture [36],[37], and the inclusion of artificial additives in food products [38], both in Brazil and abroad. We found out that, although the list of ingredients is printed on the package of all commercially available products, such information is neither fully legible (the print is usually far too small), nor intelligible (the use of scientific names of the ingredients makes it impossible for the average citizen to decode the information). Moreover, the average person does not have access to information on the dangers and risks involved in the consumption of certain ingredients, and should be better informed about those facts by the industry and state. Although food labeling is subject to strict standards and legislations from health and sanitary surveillance agencies, most information is still unsighted to the general public. The bar code - which is printed in every product packaging - enables access to a global database with product information. However, that information is not available to consumers. Instead, it mainly serves the purpose of speeding the process of registering the sale of the product and generating its final price at the market's cashier. As our society advances towards more government and corporate transparency, we look forward to more accessible and intelligible food labeling information.

We approached the researchers at Fundação Oswaldo Cruz (Oswaldo Cruz Foundation, known as Fiocruz) - the most prominent science and technology health institution in Latin America, attached to the Brazilian Ministry of Health - and asked for their guidance on what would be necessary information to crowdsource. They have suggested a list of ingredients and additives

which can cause serious health problems, and highlighted the risks of artificial food dyes – which can impair children's behavior and cause serious health diseases [39], but are commonly found in candies, cookies, soft drinks, chewing gums, jellies and other food products marketed to children and teenagers.

## Design and Development

From a design perspective, we have envisioned the application as a location-based game, along the lines of Niantic's *Pokemon Go*, in which players are challenged to actively search for objects by moving around in the real world, if necessary [Fig. 2].



Figure 2. Scanning the barcode

The game dynamics can be summarized as the following: (1) players are presented visually compelling information about a harmful ingredient that must be searched for; (2) players look, in the real world, for products including that ingredient; (3) players scan the barcode of such products; (4) if required, players enter additional information about that product; (5) players send the gathered information to a database of potentially harmful products; (6) players are rewarded for their contribution with points and visually stimulating illustrations based on and inspired by the data they have submitted.

Also included in the game are opportunities for self-expression (players are asked about their view on products they contribute with), socialization (information generated can be shared through social media), and mild competition (player results are compared to the average between all participants).

The design process for elaborating the app's dynamics took approximately three months and involved eight members of LAE. After brainstorming our conceptual goals, discussing possible alternatives and sketching our initial ideas [Fig. 3], we created a narrative (in the form

of a storyboard) and started to layout design alternatives for the app [Fig. 4].



Figure 3. Initial brainstorming and sketches

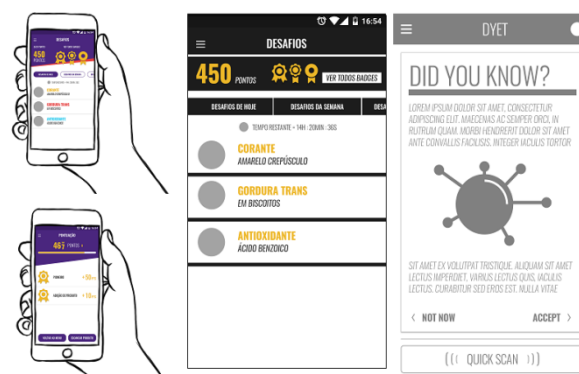


Figure 4. Layouts of design alternatives

Given the plurality of visions and diversity of backgrounds of participants, we resorted to Playgen's *Adding Play* gamification framework to assist with the process. Using that framework's play card system, we have organized goals, motivation, game design elements and mechanics [Fig.5]. Initially worried about having the creative process excessively constrained by the framework, we actually found it a valuable tool for generating ideas and establishing a common ground for discussions.



Figure 5. Game design organized in *Adding Play* framework



From the start of the design process, we had in mind that we wanted to appeal to a wide range of demographics: not only health-conscious consumers and politically engaged individuals, but also casual players looking for a game to spend some time with. We believe we were able to approach different types of player motivations – from extrinsic rewards and scoreboards to an intrinsic sense of purposefulness – that could foster civic engagement in citizen sensing initiatives like the one we are now devising.

Through gameplay, we expect to crowdsource an open database of potentially unhealthy food products, raising awareness among consumers about the risks of certain ingredients and artificial additives.

The app, planned for Android and iOS platforms, is currently being developed with the Unity game engine.

## Concluding Remarks

The concept of “open observatories” [40] - coined by Roger Malina almost a decade ago - shed light on the importance of promoting a broader dissemination of methods and knowledge for micro science, intimate science, people’s science and crowdsourcing. In his view, scientific knowledge is not culturally appropriated, and these observatories could meaningfully alter the way people deal with science, and make a substantial contribution to the development of a more sustainable society. In his *manifesto* “Intimate Science and Hard Humanities” Malina calls attention to the need to expand and disseminate scientific knowledge - which is still confined to “guarded monasteries” - and make science popular, intimate, meaningful and accessible to all [41].

The "common good" will only be brought about by people acting jointly and in common to achieve it [42]. The transformation of our society’s mode of production - from industrial to informational - and the rise of Open Source technologies and Peer to Peer Production has brought new scenarios of technological and social innovation, demanding new creative approaches in terms of collaborative processes, strategies and methods, and opening up new opportunities to the field of Design [15].

In the view of Weiser, “there is more information available at our fingertips during a walk in the woods than in any computer system, yet people find a walk among trees relaxing and computers frustrating.” [1]. Today, however, younger generations find the use of mobile computing technologies easy and friendly, as they allow them to freely explore, connect, share and participate in all domains of life, giving them the choice to be everywhere, with everybody, at any time. Friendly and natural interfaces with voice recognition, high image definition, high speed connection, virtual and augmented realities, when combined with gamification techniques, are turning the use of highly complex, powerful and sophisticated computational technologies into an activity as relaxing as a walk in the woods. With *Dyet*, we hope to bring wider audiences closer to complex subjects such as dietary restrictions and health risks of food additives - in a fun, meaningful, intimate, and informative way.

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Clorisval Pereira Júnior has a Master's degree and a Ph.D. in Design from the Pontifical Catholic University of Rio de Janeiro (DAD/PUC-Rio). He is a researcher at the Electronic Arts Laboratory (LAE/DAD/PUC-Rio) with interest in Interaction Design, Civic Technologies and Digital Social Innovation. He was managing partner at Sarjana, a creative design and branding strategy agency, where he coordinated web design and content management projects and applications for social purpose and business corporations. He was also a project manager at the Information Technology Center of the National Counsel of Technological and Scientific Development (NTI/CNPq) and at the National Research Network (RNP), where he worked with digital inclusion and web accessibility projects for government and public interest organizations.

Francisco Queiroz is a digital media designer from Rio de Janeiro, Brazil. He started his career back in 2000, soon after graduating in Communications/Advertising (PUC-Rio), working with advergames and web games. Francisco has a master's degree in Digital Game Design (University for the Creative Arts, UK). He curated and organized an exhibition held at SBGames 2009, which explored the connections between video games and art. SBGames is the annual symposium of the Special Commission of Games and Digital Entertainment of the Computing Brazilian Society. Francisco works as a digital designer at the Tecgraf/PUC-Rio Institute, where he designs interactive presentations, concept prototypes, and user interfaces for scientific software and visualization. He also works as a lecturer at PUC-Rio, teaching undergraduate design students 3D modeling and technology/CG for games. Additionally, Francisco is a PhD student in design at the same institution, and a member of the Laboratório de Arte Eletrônica (LAE).

Peter Dam is a software developer from Rio de Janeiro, Brazil. In his early teen years, he started experimenting with game development, which led to learning programming. From that moment on he decided that software development was what he wanted to do for a living. In 2006, he started pursuing a Bachelor's Degree in Computer Science at Pontifical Catholic University of Rio de Janeiro (PUC-Rio), followed by a Master's Degree in Computer Graphics at the same institution, title which he holds since 2012. Also in 2006 Peter started working at Tecgraf/PUC-Rio Institute, where he currently is a senior systems analyst and team lead. In parallel to his academic and professional career, Peter keeps his interest in the passion that drove him into programming to begin with, having worked independently on several games, being awarded twice by SEBRAE's national entrepreneurship game development contest.

Marcelo Pedruzzi Ferranti has started his career in Interaction Design back in 2005. Since then, he has had experiences in many different fields, like advertising, games, apps and digital

products. Marcelo has a Bachelor's degree in Graphic Design by Ritter dos Reis University (Brazil), where he was also a scholarship student researching museum curatorship towards education using Augmented Reality techniques. He has also been an honorary professor in the Digital Games Design course at ESPM - RS. Marcelo has two national awards conceived by IDEA/Brasil, in the student category, besides professional awards, like Latin Website Awards, Clube de Criação de São Paulo and Brazil Game Show. Nowadays, Marcelo is a Design Master's degree student at PUC-Rio, and a member and researcher at Laboratório de Arte Eletrônica at PUC-Rio. Besides the academic life, Marcelo is a Senior Design Interaction at globo.com, the digital string of the big media corporation Globo.

Leonardo C. Leite is a Master in Design and a professor for the undergraduate design course at PUC-Rio (Brazil) since 2007. Currently a PhD student with a focus on game design education and tutor for a student-led group interested in developing games. As a freelance designer, has worked with various international clients on projects related to video game art, interactive museum installations, 3d projection mapping and webdesign.

Renan Kogut is a digital media / motion designer from Rio de Janeiro, Brazil. He got his Bachelor's degree in 2014 in Digital Media Design at Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio). In 2013, he studied Art, Media and Technology for one year as an exchange student at Parsons The New School for Design, New York. Renan participates in Laboratório de Arte Eletrônica (LAE), a weekly study group about new technologies and how to develop them to new forms of multimedia communication. He created the app Aleitamento, aimed to help newborn parents with their questionings about one of the most important moments of one's lives: breastfeeding. Renan is currently working as a motion designer at Instituto Nacional de Educação de Surdos (INES), which is the national reference center about deafness. He makes a series of videos that explore the visual sense which facilitates learning.

Wesley Oliveira has a Bachelor's degree in Media Design from Pontifícia Universidade Católica do Rio de Janeiro and is currently enrolled in a Master's Program in Computer Science at Universidade Federal Fluminense. Passionate by design, technology and art. Developed works in educational area for museums, exhibitions and serious games for private companies. His main interests are in the areas of Augmented Reality, Virtual Reality, Game Design and Human Computer Interaction.

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