ICT for education and knowledge creation

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1. INSITE objectives

One of the objectives set by the initiators of the INSITE project was to inquire if, and how, innovation cascades currently unfolding across the digital agent-artifact space could contribute to solve some of the problems affecting the innovation society (Lane, Maxfield, van der Leeuw, Sigaloff & Addarii, 2011). In its attempt to substantiate the general and often abused acronym ICT, INSITE WP 7 has promoted a rather functionalist approach to the theme, associating to this term those artifacts capable of storing, processing and communicate information. From this standpoint, not only traditional technological artifacts - such as computers and communication networks - can be considered as ICTs, but also social and emerging structures such as cities, museums and universities, because of their ability to collect, store and elaborate information at different levels.

Within the more orthodox conception of Information and Communication Technologies, WP 4 examined the innovation cascades currently undergoing in the digital and online sectors, framing and coordinating the analysis with the theoretical inquiries on innovation and sustainability performed by the WP2 and the WP5[1]. Throughout a series of workshops and seminars[2], WP4 investigated potential applications of digital, online and mobile games on domains such as education, knowledge creation, climate change and civic engagement. In the next pages of this document, the outcomes of this process are presented, together with some indications about potential future developments.

1.1 - Sustainability and ICT

As the Internet keeps expanding its extension and deepens its penetration among new generations of Europeans, digital technologies widen, change and exapt their functionalities extending their influence beyond the boundaries of traditional areas of application, which currently could be identified with the entertainment and commercial fields. This expansion of functionalities has

[1] On Innovation and Sustainability see Lane, D.A., "Towards an agenda for social innovation". http://www.insiteproject.org/wp-content/uploads/2014/02/Social-Innovation-Manifesto_INSITE.pdf

[2] October 18th - 19th 2012, Venice, "Measuring, Quantifying and Modeling Processes of Scientific Knowledge Creation and Propagation in Online Societies"; October 10th – 11th, Laxenburg, Wien, "Games, Science and Society". Reports of both events are available in the Appendix.

been accompanied, and made possible, by the increasing pervasiveness of digital infrastructures, defined as the complex system made up of agents (developers, entrepreneurs, users, venture capitalists, etc.) and artifacts (communication protocols, patents, mobile devices, etc.) interacting by means of digital communication networks. The growing number and heterogeneity of agents involved, of artifacts available and of attributions amongst them, created the conditions which allowed the emergence of new functionalities, later embedded into new artifacts which in turn led to further new functionalities once introduced into patterns of use[3].

Data about the diffusion of mobile connections and mobile Internet devices sales in Europe prove the ubiquity of these infrastructures, which are expanding far beyond the limits previously imposed by wired connections and whose potential is still largely untapped[4]. From the economic standpoint, the impact of these digital infrastructures is evident and remarkable: the digital economy, despite the false start of the late '90s, created the conditions that allowed the emergence of the biggest, most profitable and most innovative companies of the past two decades[5]. In this respect, the Internet greatly expanded the innovation-possibility space, providing new ground for market-validated innovation.

In the wake of the commercial success of the Internet, governments, along with private companies, have been investing resources, and developing expectations, about the Web as a means to address the crises affecting our societies.

As a result of the converging attributions coming from both the private and the public sector towards ICTs, recent years have seen the development of a new kind of digital artifact. Fueled by the idea of using digital technologies for the construction of *smart societies*, private companies,

[3] Mobile games are in this respect an interesting example. What was at first introduced as a technological device for mobile communication (mobile phones), later became a multimedia platform which today allows users not only to communicate (SMS, instant messaging and social networks), but also to play games and produce/share multimedia contents (photo, videos, texts). But at the beginning, mobile phones were designed to perform only one basic function; phone calls. Even if the first mobile phone with a pre-installed game (the Hagenuk MT-2000) was introduced into the market in 1994, the true popularization of mobile games has to wait until 1997, when Nokia launched the 5110, the first phones to feature the game Snake. The simplicity of the game, and the diffusion rate of mobile devices in mid-90s, attracted a large audience of casual players and non-gamers. Suddenly, people were regularly using their phones for something other than making calls. This functionality-switch led mobile phone brands to produce devices especially designed for games (one of the first attempts was the Nokia N-Gage) and to exploit this new functionality attribution as a marketing elements capable to differentiate devices and attract new segments of customers.

[4] European Commission, Digital Agenda Scoreboard 2013. http://bit.ly/insite_2

[5] On internet and economic growth see (Gordon R.J. 2000)

universities, NGOs, public institutions and civil society at large, created the conditions for the emergence of a new market for socially-inspired digital artifacts. Geographic Information Systems, public debate platforms, serious games for education and vocational training and Mass Online Open Courses are only a few examples of this new kind of digital technology aimed at solving socially-relevant issues. The development of these technologies was either inspired by emerging citizens' needs[6], by functionalities envisioned by entrepreneurs and policy makers[7], and, as explained below, by functionalities exapted from traditional ICTs. The result is a complex cohort of agents (from end users to software development agencies, NGOs and local governments) and artifacts (wireless networks, smartphones, software platforms, etc.), dragged into a spiral of innovation constantly producing new needs and artifacts.

This new wave of digital artifacts has been recently labeled with the name *digital social innovation* and defined as a kind of "social and collaborative innovation in which innovators, users and communities collaborate using digital technologies to co-create knowledge and solutions for a wide range of social needs and at a scale that was unimaginable before the rise of the Internet" (Bria, 2013). The European network for socially-inspired digital companies, Digital Social Innovation[8], affirms that there are more than 400 organizations in Europe currently at work on digital artifacts aimed at confronting youth unemployment, inequality, resources depletion, CO_2 emissions and many other social issues menacing Europe's sustainability and growth.

Besides labels and definitions, the challenge for the INSITE consortium was to understand whether ICTs and web based technologies could evolve into something capable of providing effective answers to the societal crises they are trying to address, or if they represent just another sector of the Innovation Society, to be exploited as long as they can provide grounds for market-validated innovation. And, in this latter case, if and how it could be possible to put in place mechanisms capable to intercept innovation cascades and steer them in order to address relevant social needs.

[6] For instance, protest movements, like the "Occupy Movement", generated new needs of participation that were later embedded into new artifacts (e.g. http://loomio.org)

[7] It is the case, for instance, of the European initiatives Debating Europe (http://www.debatingeurope.eu/)

[8] An EU initiative led by Nesta and the Waag Society. http://digitalsocial.eu/

In this respect, the activities promoted by the INSITE project were aimed at answering these questions by studying the innovation cascades, the agents, the organizations, the artifacts and the functionalities currently carried out by modern ICTs, as well as the processes that have led to their deployment. In line with the overarching vision on innovation and sustainability, the focus of the analysis was not the single innovation, but instead the cascades of innovations made possible by, and responsible for, reconfigurations of the digital agents-artifact space under evaluation (Lane, D., Maxfield, R., Read D. and van der Leeuw, S. 2009). Driven by the idea of comparing theoretical perspectives on innovation with first-hand practical experiences, the project put face-to-face researchers with practitioners coming from the realm of digital technologies. The aims were to understand how modern ICTs are changing the institutions of society, which functionalities could be carried out by means of new ICTs and how mainstream digital technologies can be exapted and used to tackle issues of social relevance.

The analysis was developed in parallel with, and therefore was influenced by, the studies carried out in the field of social innovation performed by the WP 5. As a result, the activities performed throughout the project lifespan extended their range beyond the original objective, which was the study of innovation experiments in multiplayer online games.

1.2 - Exapting digital technologies: Games and gamification

Video games and online games have emerged as one of the most powerful media of the last two decades, generating billions of hours of entertainment worldwide. Unlike traditional media, digital games are interactive, participatory and highly engaging: players can immerse themselves into different roles, face complex problems in a safe environment, understand the consequences of their actions and acquire new knowledge in a stimulating way.

The skepticism that in part still surrounds videogames, often considered as childish activities, is debunked by their popularity[9] and by the proven economic success of this sector. In 2012 the videogame industry generated revenues for US$63.4 Billion worldwide, and the market is expected to reach US$86.9 Billion in 2017. In Europe, the videogame industry is growing at a slower pace if confronted with the global trend; the only European markets to show any signs of

[9] The popularity of videogames is not limited to teenagers and young adults. In Europe, one person out of 4 play videogames and the 49% of whole gamer population is older than 35. Source: Interactive Federation Software of Europe [ISFE], (2012) *Videogames in Europe, 2012 consumer study*.

above-average growth are Czech Republic, Hungary and Poland. Within the digital games market, mobile gaming is the fastest growing business, with revenues expected to hit US$14.4bn in 2017 from the current US$8.8bn (Pricewaterhouse Cooper [PWC], 2013). Within the more traditional boundaries of the console games market, the release of 8th generation video game consoles in 2013[10] and the blossoming of open hardware/Android-based consoles[11] could lead to new, unanticipated, scenarios. One of the most interesting perspectives, especially for European development companies, is the possibility to break the current production chain, composed by developers, publisher, distributors and retailers, by means of new open-hardware consoles and/or by the introduction of new independent online marketplaces for digital contents.

Given the popularity of this kind of ICT, and the high rate of innovation that characterizes this domain, understanding the innovation processes developing throughout this particular area of the digital agents-artifacts space is essential. For this reason, the INSITE project devoted a significant amount of its resources to the study of digital games and to their possible applications in non-entertainment contexts. Hence, the inquiry moved beyond the formal boundaries of the videogame industry to include also agents working on serious games and web platforms that, for motivating and increasing user activity and retention, embed playful elements and game mechanics into their processes. The so-called Gamification, i.e. the use of game elements even outside the field of entertainment, proved to be particularly interesting for the INSITE consortium not just for its potential applications, but also because it represents an example of exaptation. In fact, Gamification is not just a recombination of existing elements coming from different domains because even if the concept originated in the videogame industry, it acquired new functionalities once transposed outside the entertainment field. As a result, around the idea of Gamification, new functionalities, interactions, organizations, artifacts and needs emerged, soon becoming a flourishing business for companies and a popular field of inquiry for researchers. The number of scientific articles about Gamification is growing at a steady pace[12] and the topic has become the

[10] The eighth generation of video game consoles includes Nintendo's Wii U (November 18th, 2012), Sony Computer Entertainment's PlayStation 4 (November 15th, 2013) and Microsoft's Xbox One (November 22nd, 2013).

[11] Among them, Ouya, Gamestick, GamePop, the Mad Catz project Mojo

[12] 878 articles have been published during the first five months of 2014. In 2013, the number of articles published about gamification was 2950. Source: Google Scholar

latest fad in the hands of consulting agencies[13]. Game mechanics are today employed successfully not only in commercial and recreational applications, which led this practice to success around 2008, but also in business (Webb, E N., Cantú. A.) and scientific contexts. Galaxyzoo, Everyaware, GeoWiki and ExCiteS are only a few examples of scientific experiments, analyzed during the INSITE workshops, which embed game dynamics in order to promote users participation and the generation of data to be further analyzed.

In the following pages the results of the exploratory endeavor in the domain of online games, gamification and serious games are described. The analysis was focused on two main areas of inquiry: games for education and games for knowledge creation. But before entering into the details of the results, an analysis of the European context is necessary in order to better frame the INSITE contribution.

3. The European scenario

Videogames, online games and gamification are all fields of enquiry which are already under scrutiny by several European research initiatives. One of the most comprehensive analyses on the subject has been performed, so far, by the Joint Research Centre Institute for Prospective Technological Studies[14]. In the policy report published in 2013, the JRC explored the possibilities offered by new technologies in respect to inclusion and empowerment (Stewart, J. et al., 2013). The report also posed some questions on serious games, an industry still in its infancy and threatened by severe structural problems. One of the most pressing issues outlined by the report is the lack of connection between the serious games industry (a sector still difficult to identify, composed mainly by multimedia firms and small independent development team) and the mainstream leisure games industry. According to the JRC report, this lack of connection between the serious and the leisure game industries is attributable to the different knowledge they employ, and markets they address. The split between the two industries is therefore preventing the free flow of knowledge and technologies from videogame companies towards serious game firms, leading to the current situation characterized by a flourishing leisure game business and a

[13] All the most relevant international consulting agencies such as Pricewaterhouse Cooper (2012), Deloitte (2013) and Accenture (2013) have devoted a great attention to the theme of Gamification in the last years.

[14] http://ipts.jrc.ec.europa.eu/

still under developed serious game sector. In this respect, the INSITE project WP 4 tried to bridge this gap by engaging in its activities both practitioners coming from the leisure game industry as well as researchers and developers involved in the study and implementation of serious games.

Along with INSITE, several are the European research initiatives that are working on knowledge transfer between the two sides of the videogame world, among them, the Games And Learning Alliance (Gala Network)[15], whose goal is to contribute to the scientific debate around games by building a virtual research centre aimed gathering, integrating and coordinating research on Serious Games and disseminating knowledge, best practices and tools. The Gala Network also founded the International Journal of Serious Games[16], which represents one of the first scientific journals devoted to the analysis of games in non-entertainment contexts[17].

Similar in terms of objectives is the SEGAN project[18], an EC Lifelong Learning Programme (Education and Culture DG) which is working on the construction of a consortium to exchange ideas and experiences related to Serious Games and learning. The network hosts webinars and face-to-face events aimed at increase the visibility and awareness of the impacts of Serious Games for learning. Moreover, the SEGAN community produces annual publications on the design, development, delivery and evaluation of serious games and organizes an annual conference along with a summer school.

Finally, also the Emergence by Design[19] project is investigating the role of games in society. The project, which originated within INSITE, is exploring how ICTs can be used to foster mass participation and create collective actions. The idea is to understand if online games, which have

[15] http://www.galanoe.eu/

[16] http://journal.seriousgamessociety.org/

[17] Other scientific journals dealing with game-based learning, serious games, and virtual worlds. are: Games For Health Journal (http://www.liebertpub.com/g4h), Simulation and Gaming (http://sag.sagepub.com/), Journal of Virtual World Research (http://jvwresearch.org/), Virtual Education Journal (http://virtualeducationjournal.com/index.html), The Computer Games Journal (http://www.computergamesjournal.com/).

[18] http://www.seriousgamesnet.eu/

[19] http://emergencebydesign.org

been so successful in helping companies to expand their business, could be used to promote civic engagement at different scales, from the local up to the European level.

4. The INSITE contribution

4.1 - ICT for education

Knowledge creation is a process made possible by the continuous interactions undergoing between all the agents involved in educative institutions, whether they are students, teachers, researchers, practitioners or any other character involved in the process. The traditional university model, which has served for almost a millennium as a place for knowledge creation, supporting interactions amongst agents, provides to young students not only the opportunity to learn and become experts in a discipline, but also offers to them the fundamental chance to discover, and find, their role in life. From this standpoint, the functionality of university it is not just that of educating the future generations of experts, but it is also to assist young people in discovering their real aspirations. In this respect, courses are only but one of the components that made the university such a fundamental step in the life of many.

In recent years, the traditional brick-and-mortar university model has seen the rise of new methods aimed at fostering knowledge creation and exchange. The Open University, the University of the People and the vast array of universities offering online degree programs are all examples of institutions that are trying to promote higher education by refining traditional educational models. Along with these, more radical forms of web-mediated education models have been developed recently; it is the case of Mass Open Online Courses platforms (MOOC), which promise to open quality higher-education to everyone with an Internet access. Coursera, Iversity, Edx are only some of the online platforms currently ruling this new emerging MOOC market.

But can these new approaches to education support, and one day substitute, a millennium-old institution like traditional brick-and-mortar universities? Can Internet foster education and promote access to higher studies, preserving and, why not, re-inventing the social role that the university today has?

Moreover, can these new forms of education go along with demographic and behavioral changes undergoing in population, for example widening the gates of higher education by means of modern digital media? Can online environments support information exchange among agents, and thus foster knowledge creation even in the virtual world? How can they reduce the drop-out rate, which is still very high on online universities (Clow, D., 2013)? Is the same notion of drop-out still necessary in online universities?

All these questions were raised and addressed by the INSITE partners on a series of dedicated workshops, which led the participants to reflect upon the possibility to improve online education by exapting game elements and mechanics coming from the domain of entertainment ICTs. In this new hypothetical online educative environment, where traditional MOOC meet game elements, each student (or better, player) can attend online courses in the form of challenges and games. By exploring a virtual world, players get drawn into quests that require them to learn and memorize a variety of things while they play. During the game, each player can meet others with whom they can communicate, explore, and learn together. This playful learning environment should be built in a modular and scalable way, allowing people to extend it by connecting their individually programmed educational quests to the existing platform. Moreover, by collecting data about students' preferences and behaviors and conducting quali/quantitative analysis on them, it could be possible to understand users' learning methods and transform the game into an adaptive and learning system itself, capable to adapt to needs of its users, thus improving the effectiveness of the system while hopefully reducing the drop-out rate.

But in order to do so, the game should be able to gather information about the individual behavior of students on real time, while they learn. These information, combined with large-scale databases containing data of large collections of students' behavior, will make it possible for the system to build personalized learning paths for each student enrolled. Furthermore, the combination of ICT, students' behavior, interest, and progress rates, with geo-localization tools, could allow students with shared interests and backgrounds to meet physically.

This adaptive system, in combination with existing technologies like video lectures and game dynamics, brings personalized learning within reach of the next decade.

4.2 - ICT and Gamification for knowledge creation

The crises generated by the unanticipated effects of innovation cascades are becoming increasingly difficult to monitor and control. The speed and the spatial scales across which cascades of innovations unfold, measured in terms of number of agents and artifacts involved, are growing at a pace which makes difficult, even for experts and scientists, to keep track and prevent such crises from occur. For this reason new methods for information and knowledge creation are required, which might prove helpful in monitoring and steering innovation trajectories and reduce their negative impact on society, without foregoing the benefits of technical development.

In order to keep up with the increasing speed and magnitude of crises, such methods should rely on mixed networks of experts and non-experts which, collectively, can monitor the agent-artifact space and produce knowledge capable to channel cascades of transformations into socially positive directions. The problem is how to recruit agents and how to incentivize the creation of new knowledge, aimed at detecting untoward social consequences of innovation.

A promising perspective is the one offered by the so-called Citizen Cyber Science (CCS), which consists in the creation of knowledge through the involvement of thousands to millions of experts, and non-experts, by means of playful experiments. Various are the examples of Citizen Cyber Science (CCS) active today, which differ in the degree of individual involvement and the degree of coordination between the Citizen Scientists themselves and between them and the traditional science community. Some of them were analyzed during the INSITE workshops organized by WP 4, in particular:

- **Pardus[20]:** Pardus is a massive multiplayer online game running since 2004, with a worldwide player base of more than 430.000 individuals. It is an open-ended game whose players live in a virtual, futuristic universe and interact with each other in a multitude of ways. The game was created with the aim of analyzing people's behaviors in free-roaming games by collecting data about users' actions and relationships. All data were stored in a database that has been thus used to test theories about innovation and collective behaviors. Stimulating players by changing game's rules and introducing novel elements, researchers have been able to track the emergence of new interaction

[20] http://www.pardus.at/

patterns. What emerged from these perturbations is that players are able to engage themselves in collective actions and to develop new organizational structures, in order to solve problems that unexpectedly arise and that change their perception of the world (Szell, Thurner, 2012a; Thurner, Szell and Sinatra, 2012; Szell et al. 2012, Szell Thurner 2012b). What's more, collective actions have proved to lead to the creation of new tools, or to a different use of the existing ones, thus inventing new functionalities that were not foreseen by developers. Moreover, the game environment is itself evolving and also in 2014, Pardus' developers will implement new features, which will be collectively decided by the user base through functionalities-polls.

- **Geowiki[21]:** GeoWiki is a CCS experiment set up by in 2009 by the International Institute for Applied Systems Analysis (IIASA), the University of Applied Sciences Wiener Neustadt, and the University of Freiburg. The experiment's aim is to improve the quality and the quantity of data about spatial distribution of cropland. Unlike traditional global land cover maps derived from remote sensing, Geo Wiki uses crowdsourced data coming from Google Earth and validated by volunteers who joined the Geo-Wiki game. A first experiment allowed researchers to produce a cropland map of Ethiopia using human-generated data. Compared to traditional global land cover analysis, Geo Wiki was able to produce a cropland with a higher overall accuracy and in a very short period of time (See, L. et al. 2013).

- **Everyaware[22]:** EveryAware is an EU FP7 project aimed at providing new tools for enhancing collective awareness and therefore stimulating positive behavioral changes. The project is currently running two CCS experiments: AirProbe and Widenoise. Airprobe is aimed at assessing the concentration of pollutant gases in cities by means of a low-cost sensors box and a mobile app. The box, which can be installed on vehicles and bicycles, feeds the platform with data coming from its seven sensors while users, through the mobile App installed on their smartphone, can add quantitative data to the measurements. Results are then sent to the EveryAware servers which interpolate the collected data with GPS coordinates and create a map which shows the distribution of

[21] http://www.geo-wiki.org/

[22] http://www.everyaware.eu

pollutant gases, enriched by observations coming from the App users. The second application, Widenoise[23], is aimed at creating soundscapes through a mobile App which, once installed on users' smartphones, record, analyze and map sound pollution. Results, once aggregated and geo-located, are made accessible to the community members through an interactive Google map which shows sound pollution levels from across the world.

- **Galaxy Zoo[24]:** GalaxyZoo is probably one of the most popular CCS experiments along with Fold It. The project was launched in 2007 and asks to users to classify galaxies, whose images are taken from the robotic telescopes, according to their morphology. The dataset so-generated, greatly contributed in understanding how different kinds of galaxies are distributed, allowing scientists to determine whether existing galactic models are correct. The project is currently at its fourth release, in which volunteers are asked to analyze images coming from the Hubble's Candels Survey with the aim of understanding which factors influence galaxies' growth. The success of Galaxy Zoo is remarkable; in the first year 150.000 users contributed to the project, producing 50 million classifications which eventually led to several scientific publications[25].

The results coming from the first CCS experiments are encouraging, even if there's undoubtedly still room for improvement. For instance, results of a preliminary inquiry on CCS presented during an INSITE workshop[26] illustrated how serious is the problem of clique building in online citizen science experiments, and how it can spoil the basic idea of online mass participation. In detail, the research showed how the Fold It! user base was actually composed by a vast group of non-experts, relatively dormant, players, dominated by a small niche of experts. How to balance players' participation and how to stimulate people to engage in CCS experiments are problems that could potentially invalidate this kind of initiative.[27]

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[23] http://cs.everyaware.eu/event/widenoise/map

[24] http://www.galaxyzoo.org/

[25] For the comprehensive list of paper published, see http://www.galaxyzoo.org/#/papers

[26] A research carried out, but not yet published, by Vickie Curtis, PhD Open University

But with the popularization of CCS, it is likely that in the near future vast amounts of data could become available to researchers. Through analysis on those data it will be possible not only to identify flaws and correct them on time, but also to make the process of learning an observable and quantifiable science, allowing researchers to study solving techniques adopted by users in CCS experiments, compare techniques across different domains and constantly improve the effectiveness of Citizen Science initiatives (Preece, Shneiderman 2009).

Bibliography

Accenture Technology Labs (2013), *Changing the Human Resources Game: How Serious Games and "Gamification" are Disrupting Human Resources*, Accenture

Bria, F. (2013), *Digital Social Innovation, interim Report*, Digital Social Innovation

Clow, D. (2013), "MOOCs and the funnel of participation". *Proceedings of the Third International Conference on Learning Analytics and Knowledge - LAK '13*.

Deloitte (2013), "Gamification goes to work". *Tech Trends 2013*.52-59

Gordon, R.J. (2000), Does the "New Economy" Measure up to the Great Inventions of the Past? *The Journal of Economic Perspectives*, Vol. 14, No. 4, pp. 49-74

Interactive Federation Software of Europe [ISFE], (2012), *Videogames in Europe, 2012 consumer study*.

Lane, D. and Maxfield, R. (2005). Ontological uncertainty and innovation. *Journal of Evolutionary Economics*, 15, 3-50.

Lane, D., Maxfield, R., Read D. and van der Leeuw, S. (2009), From population thinking to organization thinking, *CPISC*, 11-42.

Preece, J., Shneiderman, B. (2009). The Reader-to-Leader Framework: Motivating Technology-Mediated Social Participation Theory. *Transactions on Human-Computer Interaction, 1*, 13–32.

Pricewaterhouse Cooper (2012), *Technology forecast*, 2012 issue 3.

Pricewaterhouse Cooper (2013), *Global entertainment and media outlook: 2013-2017*.

See, L., McCallum I., Fritz, S., Perger, C., Kraxner, F., Obersteiners, M., Baruah, U.D., Mili, N., Kalita N.R., (2013), Mapping Cropland in Ethiopia Using Crowdsourcing, *International Journal of Geosciences*, 2013, 4, 6-13

Stewart, J., Bleumers, L., Van Looy, J., Mariln, I., All, A., Schurmans, D., Willaert, K., De Grove, F., Jacobs, A., Misuraca, G., (2013), *The Potential of Digital Games for Empowerment*

and Social Inclusion of Groups at Risk of Social and Economic Exclusion : Evidence and Opportunity for Policy, Publication Office of the European Union.

Szell, M., Thurner, S., (2012a) How women organize social networks different from men: gender-specific behavior in large-scale social networks, *Scientific Reports, 3*, 1214

Szell, M., Thurner, S., (2012b), Social dynamics in a large-scale online game, Advances in Complex Systems, *Advances in Complex Systems 15*, 1250064

Szell, M., Sinatra, R., Petri, G., Thurner, S., Latora, V., (2012), Understanding mobility in a social petri dish, *Scientific Reports, 2*: 457 (2012)

Thurner, S., Szell M., Sinatra, R., (2012) Emergence of Good Conduct, Scaling and Zipf Laws in Human Behavioral Sequences in an Online World, *PLoS ONE 7*: e29796 (2012)

Webb, E N., Cantú. A., "Building Internal Enthusiasm for Gamification in Your Organization". *Human-Computer Interaction. Applications and Services*. Springer Berlin Heidelberg, 2013. 316-322