Discussion paper on the INSITE Workshop at IIASA, Laxenburg, Austria,
October 10-11, 2013

# Games, Science & Society

## Vision/Challenge

What impact can games and new teaching technologies have on the process of education and learning?

Western society is based on re-inventing itself every couple of decades. If the rate of invention is slowing down, (which practically never happened in the past 300 years) this has drastic consequences for western society and the survival of its values. Science, natural science in pariticular, is at the heart of driving innovation dynamics.

For innovation dynamics to run in a self-sustained way it is key to educate potential innovaters, to educate future users of the innovations, and to engage people to understand the use and broader meaning of innovations. If people do not accept innovations they will not survive, and cannot be used to build upon.

Last year's ‚sister' workshop in Venice, *Measuring, Quantifying and Modeling Processes of Scientific Knowledge Creation and Propagation in Online Societies,* dealt with the changes in the world of learning and the question what learning and teaching will be in 20 years. After debating the notion of „knowledge" and its value, the vision of a large scale digital university arose. The possibilities of assistence of IT components and methods were questioned as well as the accessability of a knowledge-creation component of a university to a wide public. One purpose of this workshop was to continue this discussion. The aim was to do so in a project-based way.

## Objectives of the workshop

This year's workshop focused on how science and new technologies can be used to re-invent learning (re-phrase what learning could be) and how new forms of innovaition in education technology will impact and shape society.

Based on F. Taddei's introductory tallk, we revisited Humboldt's ideal of education and found it unexpectedly timely and largely unrealized for the last 200 years. A central theme of the workshop has been: How can one accelerate and sustain scientific progress? The answer might be in a „science 2.0" which catalyzes (in new ways) simultaneoulsy all three of Humboldt's components of scientific knowledge production:

- Education
- Technology
- Science

The aim of sustaining and maybe even accelerating the scientific process – and thus changing and re-inventig society as a secondary effect - can be achieved by opening these three components to a much larger and wider audience and a much broader participation-base, the so-called ‚crowd'. Much enhanced participation of learners in schools and universities than presently found would be an aim; how to achieve this, was matter of extended discussions.

During the workshop we focused on these themes from different angles:

- What is the value of education? The discussions reached from the Humboldtian enlightenment values to the scientific fact that life-expectancy in nations correlates directly and strongly with education levels.

- What are the best „problem solvers"? A promising direction of answers seems to be in the direction of a man-machine combination, as for example discussed on the famous ‚Kasparov against the world' game in chess.

- How to create sustained interest in eduation and science to realize a broad interest in innovation? The general feeling is that participation plays a decisive role. ‚Citizen cyber science', scientific discovery games (eg. Foldit) might be directions in where future directions must explore, and do experiments.

- What is the value and ‚edge' of participation in education?

- ‚How does technology transform the world into a laboratoy?' A wide set of concrete examples (and ideas for future realization) were discussed. In particular, simple possibilities to transform cellphones into scientific instruments or of how to link them up and combine them with scientific facilities. These devices then can automatically store data on servers that are (possibly) open to all participants or could be even made entirely open.

- What are behavioral changes as a consequence of participation and learning? Can behavioral changes be observed on a scientific basis? We have had stimulating presentations by V. Loreto, and A. Tesnière on the subjects (among many others) of e.g. acoustical assessment of noise in a person's surrounding, air pollution measurements across a city with measurement boxes (scientific devices, see above) that are attached and carried by participants. Other examples were given on new learning technologies in medical education.

- What is the consequence of future learning for medical innovation and medical institutional education? The presentation of A. Tesnière was eye opening in showing the present state of what is already possible in the context of teaching medical content with completely automated methods. These methods engage novel devices that can be combined with each other and with cameras and other electronic devices. Especially interesting was to see how large scale medical data (like CT or MR scan data) can be fed into these learning systems to produce devices which allow to exercise and train medical skills, ranging from reanimation procedures to complex surgical maneuvers.

- How can we attain a quantification of learning? We discussed – stimulated by talks by V. Loreto and C. Tsiapalis - in what ways it can be quantified that people actually do learn and adapt their behavior as a consequence. The specific example of learning to assess and quantify noise levels in everyday environments was presented. Clear ‚learning curves' are obtainable in relatively simple experiments using a cellphone in combination with data servers. C. Tsiapalis presented possibilities to quantify ‚learning paths' of

Wikipedia users. These ideas are based on tracking the klick-paths on Wikipedia as users read various pages.

An intriguing facet is to investigate the reasons for participating and educating oneself. Can one use games to make humans better predictors (of all sorts of questions or problems)? Many games in general lead humans into situations where they have to predict the outcome of future scenarios based on decisions taken right now. In that sense games can form an ideal setup. To become good and better predictors (than they already are or better than others), people feel the need and feel encouraged to educate themselves to become better predictors. At this point good educational games must provide the players with useful information that allows the player to self-educate, maybe without the person even noticing or knowing that she is doing it.

**The concrete projects presented in particular**

The projects presented at the workshop partly provided advancements or solutions to issues that were raised and addressed in last year's sister workshop in Venice

- Ways of future knowledge creation
- Ways of creating continued interest in science
- New technologies for personalized learning
- Interacitve and personalized learning on the basis of Wikipedia

The majority of the presentations included concrete projects run by the participants. Most of the projects are based on a gameful participation of many people. In many realizations the idea is that the participants in these educational projects profit personally: they get a subject-specific ‚education' simply through participating, without even knowing that they are being being taught or that they self-educate themselves. Many have fun while they are pursuing their tasks. In some cases behavioral changes can even be observed as a consequence of their engagement.

These projects generally involve hardware components which are nowadays readily available, data bases, big data analyses tools, and methods to coordinate humans.

- *Air pollution citizen cyber science game.* People are equipped with a device to measure air pollution in real time (data collection). People engaged in the game can bet on the degree of pollution in specified areas, and will be rewarded for good predictions. The gameful character makes them to continue playing the game repeatedly.

- *Platform for human experiments.* This setup uses game theory in combination with psychological tests and results in an open-programming platform (that can be used freely by everybody) to conduct (behavioral) experiments in relatively large groups of potential participants. Recruitment of these participants can happen through other (existing and successful) online platforms that offer slight payment or compensation for participation. We have seen examples that the unit of a person in combination with mathematics and technology can become a sensor for social moods.

- *Wi-key-pezia*. By installing a program on their computer people make available to others, including researchers, the paths they followed when using Wikipedia; the corresponding results reveal their strategy of using this enzyclopedia and allows to assess the usefulness of the pages, either because they are revisited again or beacuse people remain at certain times for longer times.

- *Geowiki and land use*. In this realized game (S. Fritz, IIASA) people are shown pictures of areas all over the world; identifying or non-identifying them as crop land allows them to score up in the game and to contribute to scientific knowledge production. The result is a detailed map of agricultural land use across the globe. The project made clear several strategies to aviod erroneous answers of users and how to score them and correct them.

- *Medical teaching at the man machine interface*. Combining the use of objects (dummies) and virtual learning (tracking decisions, comparing to previous decisions, including multi-tasking, multi-user-teaming, 3D, real time) can make training in health care related issues not only much more effective, but also allows to automatize it in the sense that its teaching does not depend on human instructors anymore and can be scaled to arbitrarily many students. Some examples were shown where students can create and assemble their own personalized learning equipment and tools.

- *Humans as part of optimization codes.* In a presentation by A. Vincent we have seen how humans can be integrated in a genetic algorithm of optimization. Participants become part of genetic algorithms in prediction games. Again, here it was made clear that the man-machine combination might be a superior problem solving ‚device'. In particular, it was argued that in an application to financial trading, the genetic programming part of a typical optimization problem can be made significantly more effective, if carried out by humans. This was reflected in superior trading strategies that were ‚designed' in part by the genetic algorithm and in part by humans. The later chose the particular recombinations during the algorithm.

- *Understanding and quantifying social systems.* We had two presentations, by B. Tadic and A. Chmiel, focusing on how to measure and quantify emotional content in inter-human communication and its consequences for behavior across different types of online communication platforms. Tadic's talk focused on rebuilding societies through agent based models. This serves to understand to what degree microscopic human decision making can effectively explain emergent social behavior. In particular, a society of a linux chatroom participants was mimiked and simulated in terms of the co-evolution of actions of participants with the emotional content of their communication network.

- *Meta-analysis of user behavior of CCS and discovery games.* The quality and success of scientific and participatory computer games that involve large numbers of users and participants, can be assessed by several indicators, including the number of participants, the frequency of their activity, their online time, the duration of their participation, etc. The presentation by V. Curtis made apparent that in participatory games the dynamics of clique building is serious and can spoil the basic idea of establishing a broad userbase entirely. This was made most explicit in the analysis of the userbehavior in the game Foldit.

The presentations were rounded off by theoretical talks. A. Lusoli spoke about how to mobilize society to initiate innovation processes, how to make innovation sustainable, and the value of a dynamic evaluation process. P. Panzarasa presented an approach from social science to show how the analysis of performance in social structures as well as interaction in them might contribute to the understanding of the evolution of networks.

**Discussion session on EU project proposals**

We discussed three provisional calls of the Horizon2020 program. In particular, these calls where: ICT20, ICT21, and ICT10. For potential partners it was suggested that next to the participants at the workshop, the ASOKA network, the FAB-lab the „Gamify your PhD" operator could be of interest, and should be contacted. It was agreed to prepare a project proposal by some of the workshop participants for the call in April 2014.

In terms of content for this call, we discussed the idea to produce a data platform that can be readily plugged with hardware that is used participatory in CSS–projects. Different projects such as the dog collar project (currently exploited in Paris), air pollution data (currently run in Torino), medical data (Paris) could all be fed into this common data base. Data acquisition happens through specific hardware (dog collars, air pollution sensors, movement devices) which are connected to cell phones which send the data to the data base via simple wireless or usb technologies. The database is publicly owned and can be accessed by anyone who wishes to construct or design their own (scientific or other) prediction games. The database can be accessed by any researcher intersted in social dynamics, medical data, etc.

More information on the workshop, including the slides and abstracts of participants, can be found at http://www.complex-systems.meduniwien.ac.at/events/insite13/