# Researching citizen science by adopting ideas from end-user development: On user roles, expertise, and scaffolding

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## Introduction

Participatory culture and culture of participation are two recently coined terms (Jenkins, 2009; Fischer 2010), which mean the opposite of a consumer culture. The terms refer to a culture in the making, constantly created and updated by lay (non expert, amateur) users, who contribute on their own initiative with a special interest or a skill that is sought after in a common endeavor for making and sharing shared user-generated content. This has to a large extent been possible at a grand scale as a result of Web 2.0 (O'Reilly, 2005). Web 2.0 implies an interactive, decentralized web as opposed to unidirectional, centralized predecessor web (Web 1.0). When the web is enabled by direct access to easy to use web content editing tools that ordinary people can use in order to act as producers and not only readers or viewers of content created by others, we have a culture of participation (Fischer, 2002). Examples are: YouTube, popular blogs, Wikipedia and many Wiki-enabled systems, tools in commercial software such as game engines that encourage users to create hacks and modifications (mods) to those systems, and web application platforms like Google Maps Engine that allow end-user developers to create customized map applications.

A major objective of cultures of participation is to attract a large numbers of contributors (Fischer, 2010) and to organize the contributors into productive constellations (Andersen & Mørch, 2009). Cultures of participation emphasize the potential of 'the unfinished', and take into account that design problems have no stopping rule, need to remain open and fluid to accommodate changes in the user environment, and can be characterized as being in a state of 'perpetual beta,' an always open, continually evolving system (Fischer, 2010).

Whereas cultures of participation is a relatively new term, citizen science dates back much longer. Over the past centuries, with the aid of new technologies, science has invited non-scientists to take part in both the production of knowledge and in managing data, until universities and governments gradually took financial stewardship of research in the mid 20th century and the sciences became increasingly professionalized (Star & Griesemer, 1989, p. 416). In the late 1990s, with the development of the personal computer and the Internet, a new way for non-scientists to participate in scientific projects emerged. Projects began to include new types of more active volunteer participation, using digital tools to support reconfigured communication patterns, expertise and skills among researchers, computer programmers and volunteer contributors. Such projects can be defined as examples of citizen science. Citizen science is variably defined but here we define it as "partnerships between scientists and non-scientists in which authentic data are collected, shared, and analyzed" (Jordan, Ballard, & Phillips, 2012, p. 307). Citizen science can help volunteers develop ways of thinking that are consistent with those of scientists, and are crucial for decision making in modern society (Jordan *et al.*, 2011).

Apparently, many of the tools and techniques enabled by web 2.0 and participatory cultures have not yet been adopted in several citizen science projects. That includes supporting the transition from individual contributor to collaborator to a co-designer (combining creative and collaboration skills) in the domain of concern. The current tools and techniques seem still to be in an embryonic stage (exemplary prototypes exists), which we will explore in this project.

In the domain of end-user development (EUD), researchers have demonstrated tools and techniques for user involvement and changing the roles of the active user toward becoming a (co)designer. The implications of this shift are significant for citizen science as well. If citizens need to be more than contributors, they need take a more active role, have tools at their disposal, and they need to learn how to become a co-designer, and to take advantage of an array of different expertise when collaborating with each other.

**Research questions**

On the basis of the above brief introduction, we will address the following research questions:

- What does it mean to be a co-designer in a citizen science community?
- What lessons can we learn from end-user development (EUD) in this regard? E.g. what does it mean to be a co-designer in EUD, and how will this apply to citizen science?
- What are useful theoretical and analytical frameworks to inform the design and analysis of citizen science communities?

**Perspectives**

We describe the theoretical perspectives from which we wish to draw in our studies, in order to address the research questions.

*User roles*

The ordinary end user is typically not interested in thinking about design and modification issues and prefers to be a consumer. However, the stereotypical user-developer dichotomy has been challenged and intermediate roles have been investigated. A term to describe the role of a person who is neither just customer nor just developer is *prosumer* (it is a portmanteau of the two words producer and consumer). It was originally defined by Alvin Toffler to describe a situation where the production of products and services is closely connected to the customers (Toffler, 1980). Tapscott & Williams (2008) popularized the term to describe a new model of 21st century social interaction where customers become prosumers by co-creating goods and services with product development companies rather than simply consuming the end product (Tapscott & Williams, 2008).

The source of the idea of customers being co-creators of goods and services with product developers is often referred to as user driven innovation, and von Hippel coined the term "lead user" to characterize the type of end user or customer who is in a position to make innovations to existing products. According to von Hippel (1986) a lead user has the following two characteristics: 1) Lead users face needs that will be general in a marketplace, but face them months or years before the bulk of that marketplace encounters them, and 2) lead users are positioned to benefit significantly by obtaining a solution to their needs. In a process of product development, it is the lead users who are in a unique position to propose novel product ideas and suggest adaptive changes to existing products. Because lead users innovate, they are considered to be one example or type of the creative consumers phenomenon, that is, those "customers who adapt, modify, or transform a proprietary offering" (Burton et al. 2007).

Åsand & Mørch (2006) followed the activities of "super users" during the adoption of a new business application by an accounting company. Their findings indicated a need for closer interaction between super users and software developers, because certain instances of local end-user development done by the supers users led to technical improvements that were found to be useful to all of the company's applications.

*Expertise*

All of us possess ubiquitous tacit knowledge either in the form of a) "beer-mat knowledge" (without a deeper insight into why things work), b) popular understanding, and/or c) primary source knowledge. Concerning specialist tacit knowledge, Collins and Evans (2007) distinguish between contributory expertise and interactional expertise, i.e. expertise, which is required to manage a field of knowledge through interaction but which in itself does not contribute to the field. With this as the point of departure, they attempt to develop a periodic table for expertise. Along one dimension, the table is constructed around specialist expertise and what they call meta-expertise. Along the other dimension is a scale from basic knowledge (which we all have) to highly specialized knowledge (which only a few possess). This table contributes to a clarification of expertise as a social phenomenon.

Table 1 illustrates how the three key models of expert/public interaction relate to aims and ideological contexts, and how public participation is formatted and what expertise the different publics may acquire or master.

**Table 1:** Analytical Framework of Science Communication Models

| **Communication model** | **Aims** | **Ideological contexts** | **Formatting public participation** | **Expertise** |
|---|---|---|---|---|
| Dissemination ("deficit") | Transferring knowledge | Scientism<br>Technocracy<br>Rhetoric of the knowledge economy | "general public": possibility for authoring, and to certain degree positionality and improvisation | "popular understanding" and "primary source knowledge" |
| Dialogue | Discussing implications of research | Social responsibility<br>Culture | "pure public": authoring, positionality and improvisation within predefined frames | "interactional expertise", with elements of "contributory expertise" |
| Participation | Setting the aims, | Civic science | "affected public" | "contributory |

| | | | | |
|---|---|---|---|---|
| | shaping the agenda of research and participation in research | Democracy | and "partisan public": broad possibilities to play out authoring, positionality and improvisation | expertise" |

*Scaffolding the activity*

Jenkins (2006) lists "some type of informal mentorship whereby what is known by the most experienced is passed along to novices," as one of five critical features for characterizing participatory culture This is an area of relevance to educational research applicable to for citizen science as well as to EUD. From a citizen science perspective, it implies new scaffolding tools to help volunteers develop specific scientific skills, and applications could also be developed to foster mentor-apprentice relationship (Kuznetsov, 2013).

There are different types citizen science initiatives and platforms, which gather together contributions from different people. An example of a project, which provides an opportunity for participants to contribute to a collective task, is Galaxy Zoo (http://www.galaxyzoo.org/), an online astronomy project that invites members of the public to help in classifying over a million galaxies. Galaxy Zoo started in 2007 because astronomers had 1,000,000 galaxies that needed to be sorted, classified, and examined. In 2014, Galaxy Zoo has just registered its 1,000,000th volunteer, and has collected millions of observations (Simmons, 2014). Another successful project is Foldit, an online game developed by scientists at the University of Washington, in which participants try to solve one of the hardest computational problems in biology: protein folding. Most of the players in Foldit are not biologists of training. In the game, while folding proteins using graphical operations on a 3D protein structure model (Figure 1), players compete, collaborate, and develop strategies to accumulate game points and move to different playing levels (Hand, 2010). Professional researchers will analyze the highest scoring solutions to determine whether or not their structural configurations can be applied to solve real worlds problems in disease eradication biology, thus save considerable time in the scientists' lab.

Environmental research is another important arena for public participation mobilizing large groups of participants (Hetland 2011). CAISE researchers (Center for Advancement of Informal Science Education) distinguish between three models for participation that focus on the degree to which participants are included in various elements of the scientific process (Bonney et al. 2009). "Most projects that are considered to be citizen science by their creators fall under what CAISE researchers call the contributory model, for which participants primarily collect and submit data under the gentle supervision of a sponsoring organization. This model contrast with the "collaborative" and "co-created" models, in which participants are more deeply involved with analyzing data or even helping to develop the project protocols" (Dickinson & Bonney, 2012).

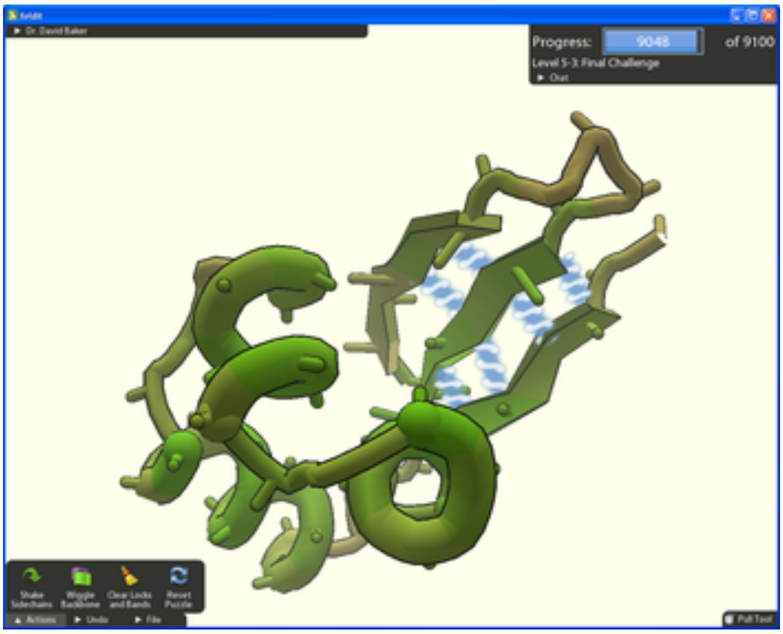


**Figure 1:** Screen image of the Foldit application, showing a game in progress (multiple users collaborate to fold a protein structure as good as possible, using various tools provided in the game). Adopted from: http://en.wikipedia.org/wiki/File:Foldit.png

## References


1. Andersen, R., and Mørch, A. I. (2009). Mutual Development: A Case Study in Customer-Initiated Software Product Development. In V. Pipek, M.B. Rosson, B de Ruyter and V. Wulf (Eds.). *Proceedings 2nd Int'l Symposium on End User Development (IS-EUD 2009).* LNCS 5435. Berlin Heidelberg: Springer, pp. 31-49.
2. Berthon, P.R.; Pitt, L.F.; McCarthy, S.M.; Kates (2007). When Customers Get Clever: Managerial Approaches to Dealing with Creative Consumers, *Business Horizons*, 50(1): 39–47
3. Bonney, R., H. Ballard, R. Jordan, E. McCallie, T. Phillips, J. Shirk, and C. Wilderman. (2009). Public participation in scientific research: Defining the field and assessing its potential for informal science education. *A CAISE inquiry group report.* Washington, DC: Center for Advancement of Informal Science Education (CAISE).
4. Collins, H., and Evans, R. (2007). *Rethinking expertise*. Chicago: The University of Chicago Press.
5. Dickinson, J.L., and Bonney, R. (2012). *Citizen Science: Public Participation in Environmental Research*. Ithaca: Comstock Publishing Associates.
6. Fischer, Gerhard. (20012). Beyond "Couch Potatoes:" From Consumers to Designers and Active Contributors. *First Monday***,** Peer-reviewed Journal on the Internet. URL: http://firstmonday.org/ojs/index.php/fm/article/view/1010/931. Date accessed: 16 Mar. 2014. doi:10.5210/fm.v7i12.1010.
7. Fischer, G. (2010). Extending boundaries with meta-design and cultures of participation. In *Proceedings NordiCHI'10*. ACM, New York, NY, USA, 168-177.
8. Hand, E. (2010). Citizen science: People power, *Nature,* 466, 685-687, doi:10.1038/466685a
9. Hetland, P. (2011). Science 2.0: Bridging Science and the Public. *Nordic Journal of Digital Literacy*, Vol. 6, 2011, Special Issue, 326-330

10. Hetland, P. (2013). *Models in Science Communication Policy: Formatting Public Engagement and Expertis*e. Paper presented at the Annual Meeting of the Society for Social Studies of Science, San Diego.
11. Jenkins, H., Puroshotma, R., Clinton, K., Weigel, M., & Robison, A.J. (2005). *Confronting the Challenges of Participatory Culture: Media Education for the 21st Century*, available at http://www.newmedialiteracies.org/wp-content/uploads/pdfs/NMLWhitePaper.pdf.
12. Jordan, R.C., Ballard, H. L., and Phillips, T. B. (2012). Key issues and new approaches for evaluating citizen-science learning outcomes. *Frontiers in Ecology and the Environment*, *10***,** 307–309. doi: http://dx.doi.org/10.1890/110280
13. Jordan, R.C., Gray, S. A., Howe, D.V., et al. (2011). Knowledge gain and behavioral change in citizen-science programs. *Conservation Biology, 25*, 1148–1154.
14. Kuznetsov, S. (2013). Expanding our visions of citizen science. *Interactions*, *20*(4), 26-31.
15. O'Reilly, Tim. (2005-09-30). *What Is Web 2.0?* O'Reilly Network, http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html. Retrieved on 20014-03-10.
16. Simmons, B. (2014). One million for Zooniverse – and one for Galaxy Zoo! *Galaxy Zoo: A Zooniverse Project Blog* [web log]. Retrieved March 10, 2014, at http://blog.galaxyzoo.org/2014/02/24/one-million-for-zooniverse-and-one-for-galaxy-zoo/
17. Star, S. L. & Griesemer, J. R. (1989). Institutional ecology, translations and boundary objects. *Social Studies of Science*, *19*(3), 387-420.
18. Von Hippel, E. (1986). Lead users: A source of novel product concepts, *Management Science*, 32(7): 791–806.