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Design Guidelines for the User-Centred Collaborative Citizen Science Platforms

POONAM YADAV, IMPERIAL COLLEGE LONDON

JOHN DARLINGTON, IMPERIAL COLLEGE LONDON

ABSTRACT

Online Citizen Science platforms are good examples of socio-technical systems where technology-enabled interactions occur between scientists and the general public (volunteers). Citizen Science platforms usually host multiple Citizen Science projects, and allow volunteers to choose the ones to participate in. Recent work in the area has demonstrated a positive feedback loop between participation and learning and creativity in Citizen Science projects, which is one of the motivating factors both for scientists and the volunteers. This emphasises the importance of creating successful Citizen Science platforms, which support this feedback process, and enable enhanced learning and creativity to occur through knowledge sharing and diverse participation. In this paper, we present guidelines for designing these platforms as user-inspired socio-technical systems. The guidelines are the result of CitizenGrid Platform developers reflecting on their experiences in a focus group and state-of-the-art literature review. We also present the case-studies on popular Citizen Science platforms, including our own CitizenGrid platform, developed as part of the European Union funded Citizen CyberLab project, as well as Zooniverse, World Community Grid, CrowdCrafting and Epi-Collect+ to see how closely these platforms follow our proposed guidelines and how these may be further improved to incorporate the creativity enabled by the collective knowledge sharing.

1. INTRODUCTION

In recent years, Citizen Science (CS) has opened new territories of scientific collaboration by involving the general public. The dictionary definition of term Citizen Science (n) is "scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions" (Oxford, 2014). Internet-based Citizen Science projects attract volunteer participants from diverse communities and benefit both scientists and volunteers. Volunteers can easily participate in an online Citizen Science project and increase their knowledge and understanding of the scientific process whereas scientists receive contributions in their scientific studies from volunteers' with varied skill sets and from various geographical locations (Curtis, 2014; Land-Zandstra et al., 2015; Gommerman and Monroe, 2015; Jennett, 2013).

Due to these potential benefits, new projects are being regularly created. This invokes a need for the online Citizen Science platforms that can host different projects and allow volunteers to choose and participate. Examples of such platforms include CitizenGrid (Yadav and Darlington, 2015; Yadav et al., 2017b) that is developed as part of the European Union funded Citizen CyberLab project (Citizen Cyberlab, 2015), Zooniverse (Zooniverse, 2015) and others. To understand how to design these platforms and the projects to keep both scientists and volunteers engaged in collaboration, we researched what are the other benefits these platforms could bring to both groups from their motivational perspective. Based on our understanding gained from the analysis, we designed the guidelines for a user-centred Socio-technical collaborative Citizen Science platform that we summarise in Section 2. In Section 3, we study the already existing Citizen Science platforms with respect to the proposed guidelines to see how closely the platforms follow the guidelines and discuss how these may be further improved to incorporate the creativity based on collective knowledge sharing. In Section 4, we present other similar online platforms that are used for listing the Citizen Science projects and present the conclusions and a summary in Section 5.

2. THE COLLABORATIVE PLATFORM'S DESIGN GUIDELINES

The goal of Citizen Science platforms is to bring together a number of Citizen Science projects for volunteers participation. The platforms could provide these different functionalities, such as (1) project portal where volunteers can find their favourite project by searching or selecting from dashboard, menus, etc.; (2) host complete project or project clients; (3) launch and run project servers. All Internet-based Citizen Science (Virtual Citizen science) projects are not similar and may fall into different project categories and have different deployment scenarios, for example volunteer computing and human-computation CS projects (Yadav and Darlington, 2017a,b). Moreover, Citizen Science platforms are also designed for either one or more project categories. Therefore, the design guidelines we present here are generic and are based on our experiences gained from building the CitizenGrid Platform and could be applied to any Citizen Science platform regardless the project categories the platform supports.

1. **Cost Effective**: This is an important consideration for a setting up Citizen Science projects, since most are started by an academic or a public institution with a limited initial grants. The use of open source technologies in the platform and project development or free to use services is an important consideration for the platform usability, having a wider scientific community in mind.
2. **Easy to Create Project**: The easy, simple and quick project creation and deployment process allows scientists to deploy and maintain their project themselves (DIY: do-it-yourself feature).
3. **Multi-categories Projects**: If a Citizen Science platform supports multi-categories (types) of projects, it would make it easier for the scientists to advertise, host, and maintain different types of Citizen Science projects at the same place. For example, this would allow flexibility to host and deploy volunteer thinking (VT), volunteer computing (VC), game-based Citizen Science and Data Collection (DC) projects. This feature helps volunteers to discover and participate in different types of projects on one platform. In volunteer cognition and thinking projects, where volunteers only need to use their time, cognitive power and knowledge to analyse data. The volunteer participation in this category is marked as creative, learning oriented and interactive (Jennett, 2013). To involve volunteers in this category, some projects present and structure scientific tasks as games that provide creative and learning-oriented participation, however, all citizen science games are not necessary to be creative. The volunteer computing allows volunteers to contribute

by providing and sharing computing resources through the Internet. In this type of participation, computationally intensive project tasks run on volunteers' computers, generally when they are otherwise idle, and with the permission of the volunteers. This doesn't require volunteers' active participation because they are not continuously interacting with the project. However, some volunteers do invest time into these project through interacting with the community, setting up a better system, etc., which is their combined (active and passive) participation. In order to identify idle periods, the tasks running on a volunteer's computer monitor the system looking for periods of inactivity when volunteers are not interacting with their machine for their own work purposes.

4. **Comparative Project Performance**: This feature provides scientists the comparative summary report of their project, including volunteers engagement and participation report, volunteers learning and creativity report, project overall impact and volunteer contribution report.
5. **Easy Maintenance**: For long-term projects, it is a very important design consideration. The platform should allow easy project file updates - adding new files, deleting, synching new information without causing problems to participating volunteers.
6. **Security and Trust**: The platform should adhere security requirements that are required for the standard web platforms.
7. **Scientists and Volunteers Interaction**: This is important for users engagement and long-term participation. The interaction can be achieved by user forums, online videos for help and tutorials, real-time message exchange systems, etc.
8. **Simple Project Participation**: The volunteers who contribute in the Citizen Science projects advertised on the platforms have varied computing skills levels ranging from novice to expert. The devices they use to access the platforms are also heterogeneous in terms of hardware capabilities and software. Therefore, it is very necessary that platform make the project simple and easily accessible to them.

3. CASE STUDIES

In this section we analyse already existing Citizen Science platforms World Community Grid (World Community Grid, 2015), CitizenGrid (Yadav and Darlington, 2015; CitizenGrid, 2015; Simpson et al., 2014), Zooniverse (Zooniverse, 2015; Tinati et al., 2015), Epicollect+ (Epicollect, 2015; Aanensen et al., 2014), and CrowdCrafting (Crowdcrafting, 2014). All platforms are free to use and allow easy project creation. CitizenGrid, Epicollect and Zooniverse, CrowdCrafting are open source and supports do-it-yourself (DIY) new project creation process. In this section, we analyse all these platforms with respect to the design guidelines and present the summary in Table 1.

CitizenGrid: CitizenGrid allows do-it-yourself hosting of the project and simplify the process of hosting and deployment of the project by supporting Virtual Machine based client distribution. The CitizenGrid allows flexibility to use any of the task management and distribution frameworks from the list: Copilot (Predrag Buncic, 2011), LiveQ (Charalampidis, 2015), or BOINC (BOINC, 2015) and allows project discovery and search mechanism by free text search for volunteers. On CitizenGrid interface volunteers can see their participation history and scientists can see projects' comparative performance, and easily maintain their project by changing the project new files etc.. However, in current version any change in the client part requires volunteers to restart the client again. In current version, CitizenGrid requires scientists to create the Virtual Machines of their Server and client themselves, which is not very easy for scientists. Therefore, in future it is rec-

ommended that CitizenGrid makes a new project creation process easy for scientists if it hosts and supports Virtual Machine templates of various build-in frameworks such as BOINC (BOINC, 2015) and PyPossa (PyBossa, 2016) . CitizenGrid team consists of four members and have hosted 4 real projects, e.g., RedWire (Redwire, 2015) and Cern Virtual Atom Smasher Game (VAS, 2015; Yadav et al., 2017a) and advertised nearly 50 already existing volunteer computing and thinking projects see Figure 1). CitizenGrid doesn't maintain social network account but hold a YouTube channel and a regular meet up event for one-to-one interaction and have nearly 25 registered users.

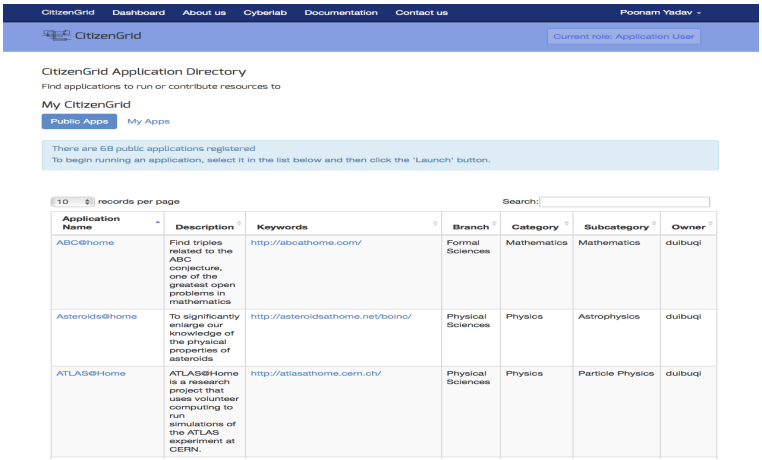

***Figure 1.** CitizenGrid Project directory (screenshot taken on 27th December 2015) (CitizenGrid, 2015) .*

World Community Grid: World Community Grid platform hosts volunteer computing (VC) projects e.g., Uncovering Genome Mysteries (Uncovering Genome Mysteries, 2015) or Mapping Cancer Markers (Princess Margaret Cancer Centre, 2013) and CERN Test4Theory (LHC@home 2.0, 2015). The World Community Grid uses BOINC (Boinc, 2015) middleware framework for the projects task management and distribution. World Community Grid's project support-team provides full support for hosting and maintaining the scientist volunteer computing project, if the platform team approves the project. The platform hosts 5 active projects currently with 26 projects in total. World Community Grid is very popular platform with social networking platforms followers (Facebook: 22196 and Twitter: 7.6 K (on 28th December 2015)).

Zooniverse: Zooniverse platform allows do-it-yourself hosting of volunteer cognition and thinking (VT) projects. In volunteer cognition and thinking projects, where volunteers only need to use their time, cognitive power and knowledge to analyse data. Zooniverse is currently hosting 42 projects (on 28th December 2015) with a very user friendly interface, however, there is no option for searching a project by name or category. The projects comparative performances are not available to the project scientists, however, information is made available through research publications (Tinati et al., 2015). The Zooniverse development and maintenance team consists of nearly 20 members and funded by a number of research grants. Zooniverse is very popular platform with social networking platforms followers (Facebook: 24551 and Twitter: 13.5 K (on 28th December 2015)) and

maintains active blogs – *daily Zooniverse* for a quick daily update and Zooniverse blogs. Addition to this, the platform maintenance team maintains an interactive talk forum as shown in Figure 2 for volunteers' interactions. This is very important feature which motivates volunteers to stay connected with the project. The detail analysis of the interaction has been presented in the research articles (Tinati, 2014). The volunteer participation in volunteer cognition projects is marked as creative, learning oriented and interactive (Jennett and Cox, 2014).

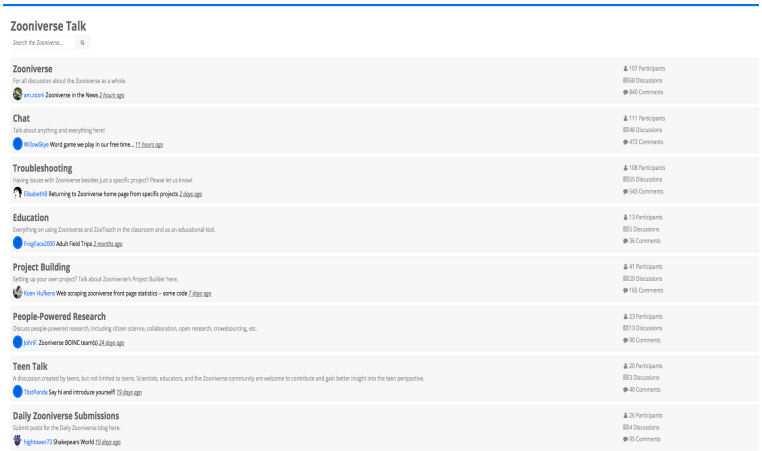

Figure 2. ***Zooniverse Interactive Forum (screenshot taken on 27th December 2015) (Zooniverse, 2015) .***

Epicollect+: The Epicollect+ (Epicollect, 2015; Aanensen et al., 2014) platform allows data collection and aggregation platform. It is supported by the mobile client app, which makes it easy for volunteers to support and participate in the data collection projects. It allows scientists to setup the do-it-yourself data collection projects, for example, photos and text based survey, etc. Epicollect+ have two components: a mobile app and a web server app. The EpiCollect+ mobile app allows scientists to load a single or multiple projects and provides the interface for volunteers to gather the data. All data can be subsequently synched with a central server and, furthermore, data can be retrieved onto the mobile devices from the central server and viewed as tables or maps. The web server app provides facility of hosting the server for project data, by providing server software and instructions for setting up a database and web application for scientists to house and view the data collected by any number of mobile devices.

CrowdCrafting: CrowdCrafting hosts human computation (Volunteer Thinking/Cognition) projects as well as data collection projects such as image classification, transcription, geocoding and uses Epicollect+ for the mobile clients. CrowdCrafting has a very appealing interface with easy project discovery in seven categories: featured, social, art, humanities, biology, economics, and science and allows do-it-yourself (DIY) project creation process. CrowdCrafting requires and uses PyBossa Framework (PyBossa, 2016) to create new projects, which is easy to learn and use. CrowdCrafting is a quite new platform with social networking platforms followers (Facebook: 272 and Twitter: 750 (on 30th December 2016)).

Table 1. Citizen Science Online Platforms

PLATFORMS	GUIDELINES									
	Cost Effective		Easy Project Creation		Multi-Categories	Comparative	Easy	Security &	Interaction	Simple
	Free-to-use	Open-source	General	DIY	Projects	Performance	Maintenance	Trust		Participation
CitizenGrid	✓	✓	✓	✓	VC&VT	–	✓	✓	–	✓
World Community	✓	×	✓	×	VC	–	✓	✓	–	✓
Zooniverse	✓	✓	✓	✓	VT	–	✓	✓	✓	✓
Epicollect	✓	✓	✓	✓	DC	–	✓	✓	–	✓
CrowdCrafting	✓	✓	✓	✓	VT&DC	–	✓	✓	–	✓

– : Partially Supported

4. RELATED WORK

Design guidelines for online platform play central role in human-computer-interface (HCI) research. Apart from the platform discussed in previous section, in recent year, there are a number of Citizen Science Portals such as Scistarter (SciStarter, 2014), Citizen Science Search (University, 2014), and Wikipedia (Wikipedia, 2014) are developed. These portals list a number of Citizen Science projects for easy project discovery. SciStarter is a web-portal for Citizen Science projects that maintains a catalogue of nearly 700 projects and provides different search criteria such as outdoor or indoor projects, featured projects and projects suitable for students and children, etc. SciStarter itself does not host projects, instead, direct volunteers to the individual project websites where potential volunteers can find out more about a project and participate. Citizen Science Search website offers "keyword" based text search and list only a limited number of selected projects. Wikipedia lists and displays many Citizen Science application and projects with their brief description along with project links.

5. CONCLUSIONS

In this paper, we presented the design guidelines for user-inspired Citizen Science collaborative platforms by analysing the participation steps of scientists and volunteers in a Citizen Science project. We discussed how scientists' and volunteers' motivation and participation influence the design of these platforms. We also presented the case-studies on popular Citizen Science platforms such as Zooniverse, CitizenGrid, World Community Grid, EpiCollect and CrowdCrafting to see how closely these platforms matches our proposed guidelines. These case studies are helpful in understanding how closely these platforms follow our proposed guidelines and how these may be further improved to incorporate the creativity based on collective knowledge sharing.

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