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Profiles of engagement in online communities of citizen science participation



Maria Aristeidou^{*}, Eileen Scanlon, Mike Sharples

Institute of Educational Technology, The Open University, Walton Hall, Milton Keynes, Buckinghamshire, MK7 6AA, UK

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ABSTRACT

Citizen participation in online communities of scientific investigations has recently become more popular. Enhancing the engagement of citizens within these communities is a focus of attention for researchers and practitioners who want to amplify the impact on learning, science and society. This study investigates the relationship between engagement factors and behaviour patterns in an online community that requires high levels of citizen participation. While other studies explore engagement in communities where citizens contribute data, the current research investigates a community to support citizens in facilitating their own scientific investigations. Data were collected from log files and questionnaires, and multiple measures of engagement were examined: engagement metrics, roles, motivation, attitude, satisfaction and belonging to the community. The results allowed comparison of the engagement levels among different types of citizen participation communities and categorised members in engagement profiles, according to their behaviour patterns. Findings indicate a need for differing design approaches based on the type of citizen participation community and individual engagement profiles.

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1. Introduction

There is increasing interest in involving the public in shared scientific activities and science understanding. In particular, citizen science projects engage volunteers to participate in science research and collaborate with scientists to answer real-world questions.

Stebbins (1982) names this participation in after-work activities *serious leisure*, where volunteers, hobbyists or amateurs are fascinated by activities that provide them with a sense of being part of a shared social world, or offer a challenging routine to those who are not in full-time employment. Furthermore, serious leisure provides lifestyles and identities to people that can be viewed as behavioural expressions of their central life interests. From a different lens, citizen participation in social activities has been examined as a link to citizen power (Arnstein, 1969). The integration of the public in political and economic related activities has been assessed to be the strategy by which they can contribute to social reforming, and share in the benefits of a more prosperous society. In the same way,

the involvement of citizens in authentic scientific inquiry activities requires them to adopt a sense of shared responsibility for issues regarding their communities and become active during the change process, contributing to the well-being of the community and hence their personal lives.

Similarly to Arnstein's ladder of participation which refers to eight rungs of citizen participation, ranging from *non-participation* to *tokenism* and to *citizen power* (Arnstein, 1969), the public participation in scientific research projects has also been categorised in several typologies. Some typologies categorise the projects, according to the level of collaboration between scientists and citizens, into *contributory*, *collaborative* and *co-created* projects (Bonney et al., 2009), while some others focus on the level of participation and engagement, and cluster projects as *crowdsourcing*, *distributed intelligence*, *participatory science* and *extreme citizen science* (Haklay, 2013). Therefore, the inquiry activities that citizens are involved in may range from contributing data (contributory or crowdsourcing) to participating in the entire process and taking part in publications (co-created or extreme citizen science). Results from a review of different types of citizen participation projects demonstrate that the more that individuals are involved with all the aspects of the scientific process, the more likely they will increase science learning outcomes (Bonney et al.,

^{*} Corresponding author.

E-mail address: Maria.Aristeidou@open.ac.uk (M. Aristeidou).

2009). To this end, *citizen inquiry* projects have emerged as a way to open up the scientific process to distributed communities of citizens to create and facilitate their own projects, and report inquiry-led results (Aristeidou, Scanlon, & Sharples, 2013; Sharples et al., 2013).

Despite extensive research into the scientific outcomes of citizen participation communities, little research has been yet undertaken around participants' engagement and community sustainability. Due to the high attrition rate that has been noted in these communities (Nov, Arazy, and Anderson, 2011b, 2011a;; Ponciano & Brasileiro, 2015) and the dabbling behaviour (Eveleigh, Jennett, Blandford, Brohan, & Cox, 2014) more work needs to be carried out in relation to the factors that draw and sustain participants. Current studies recognise user engagement as a necessary ingredient for the success of virtual environments (Verhagen, Swen, Feldberg, & Merikivi, 2015) and emphasize the behaviour of volunteers who invest personal resources such as cognitive power, physical energy and time, in order to provide assistance to others (Lehmann, Lalmas, Yom-Tov, & Dupret, 2012; O'Brien & Toms, 2008).

Human Computer Interaction research can empower citizen participation and considerably increase success in what and how it is done, enhancing learning and amplifying the impact on society, globally and locally (Preece, 2016). Research into the principles of Human Computer Interaction emphasises the importance of the design elements for attracting and engaging users in citizen participation projects (Eveleigh et al., 2014; Kim, Robson, Zimmerman, Pierce, & Haber, 2011; Wald, Longo, & Dobell, 2015) and other online communities (Burke, Marlow, & Lento, 2009; Ren & Kraut, 2013). An in-depth study by Ren and Kraut (2013) on managing online conversations proposes that communities are often less successful than they could be as many design decisions are driven by intuition and trial and error instead of being based on the systematic understanding of users' motivation and contribution. For instance, results of their research regarding motivation suggest that personalised moderation increases members' commitment and contribution, as users can view different messages matched to their personal interests. Therefore, exploring engagement factors facilitates in taking design decisions about the community, as one size does not fit all.

Studies on motivation for participating in citizen science projects focus on the psychological factors of users and explore motivation for joining and staying in the project. This is done through survey data, interviews and forum posts (Aristeidou, Scanlon, & Sharples, 2015b; Curtis, 2015; Raddick et al., 2010, 2013; Reed et al., 2013; Rotman et al., 2012). Findings identify personally-focused reasons (e.g. Aristeidou et al., 2015b; Rotman et al., 2012) or altruistic factors (e.g. Curtis, 2015; Raddick et al., 2013) as main motivations for joining the projects. Some other studies go a step further and assess the influence of motivational orientation on contribution and participation (Borst, 2010; Nov, Arazy, & Anderson, 2011a; Eveleigh et al., 2014). Results suggest that members with intrinsic motives have novel contributions (Borst, 2010), enhanced participation frequency (Nov et al., 2011a), increased (Borst, 2010; Eveleigh et al., 2014) and longer participation (Eveleigh et al., 2014). However, these studies focus on the influence of motivation on participation, without taking into account other engagement factors, such as attitude, satisfaction and belonging to the community.

Another way of investigating user engagement in citizen participation communities is by tracing behaviour patterns. Tracing behaviours and determining user engagement enables project and platform moderators to make decisions, perform actions to avoid dropouts, improve the technologies and adapt the structures or content to users (Cruz-Benito, Therón, García-Peñalvo, & Pizarro

Lucas, 2015). Ponciano and Brasileiro (2015) focus on the behaviours of people engaging with contributory citizen participation projects, clustering users based on log data of the activity, daily devoted time, relative activity duration, and variation in periodicity ratios. The resulting engagement profiles are 'hardworking', 'spasmodic', 'persistent', 'lasting' and 'moderate'.

Nevertheless, research stresses the importance of capturing both behavioural and psychological aspects of engagement. Calder and Malthouse (2015) differentiate actual behaviour from engagement, which is the motivational force to make something happen. Therefore, there is need to explore the actual behaviour as the consequence of the motivational force and not in isolation. Ponciano and Brasileiro's study (2015) provides insight into measuring the level of engagement with the project tasks, but it has not yet captured the psychological factors lying behind those engagement profiles.

Thus far, there has been little research around the motivational force behind the engagement profiles. Most studies either investigate the motivations or the contribution, without further exploring the relationship between them, or taking into account the importance of capturing different facets of psychological engagement (Appleton, Christenson, Kim, & Reschly, 2006; Boyle, Connolly, & Hainey, 2011). Moreover, we are not aware of any previous empirical research studies of behaviour or engagement in participation projects where citizens facilitate their own investigations (e.g. citizen inquiry). A comparison between communities of various levels of citizen participation may indicate differences in the level and type of engagement. To this end, the current research aims to investigate the relationship between engagement factors and the behaviour patterns in citizen inquiry by capturing multiple measures, and relate the observations to results from contributory projects and to possible future design actions and decisions.

We compare the level and type of a citizen inquiry community (Weather-it) to two other citizen science projects (Milky Way project and Galaxy Zoo), finding that the level of activity for Weather-it members was lower than Milky Way Project and similar to Galaxy Zoo, but with longer participation. We employed cluster analysis to derive five types of member profile, according to the type and level of members' activity, and psychological engagement factors. Our analysis has found that two engagement profiles detected in Milky Way project and Galaxy Zoo were also present in Weather-it (hardworking and persistent), and three new engagement profiles emerged to better describe the behaviour of Weather-it members (loyal, lurking and visitors). Surveying the psychological engagement factors behind each profile provided us with answers to why members have a variety of behaviours. Lack of time, website usability, fear, and quality of contributions, as well as reasons for joining, and feelings of belonging to the community are some of the reported factors that determine members' participation behaviour. Design that takes into account these factors may provide a more personalised moderation according to the community behaviour and contribute to scaling up and sustaining the community.

In this study we put forward the following contributions: (a) we extend the framework for assessing engagement profiles proposed by Ponciano and Brasileiro (2015) by adding 'lurking ratio' to the metrics and capturing different facets of psychological engagement (roles, motivation, attitude, satisfaction and belonging) for each profile; (b) we provide a first study that measures engagement of members in a community that requires high levels of citizen participation, and a comparison to communities with other types of citizen participation; and (c) our findings and recommendations may inform design guidelines for recruitment and sustainability of citizen participation communities.

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