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Chapter 1

Introducing citizen inquiry

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The term 'citizen inquiry' was coined to describe ways that members of the public can learn by initiating or joining shared inquiry-led scientific investigations (Sharples et al., 2013). It merges learning through scientific investigation with mass collaborative participation exemplified in citizen science activities, altering the relationship most people have with research from being passive recipients to becoming actively engaged, and the relationship between scholarship and public understanding from dissemination towards cooperation. Through the presentation of empirical studies, this edited volume introduces concepts and practices of citizen inquiry.

In citizen science activities, members of the public (volunteers, non-expert individuals, amateurs) take part in research activities initiated by scientists, such as identification of invasive species, classification of natural history periodicals, or identification of galaxies. The notion of public volunteering in the practices of science is central to citizen science. This is becoming a widespread method for conducting large-scale scientific research (Toerpe, 2013). The main reasons for the growth of citizen science include the availability of technical tools to analyse the large amounts of data collected and the realisation of the power behind this paradigm: involving the public can offer a freely-available source of labour and skills that can overcome some financial and logistical constraints of doing large-scale science (Silvertown, 2009; Catlin-Groves, 2012). The Christmas Bird Count is a longstanding citizen science project, launched in 1900 and sustained by the observations of amateur birdwatchers (Havens & Henderson, 2013). Citizen science activities offer benefits to scientists and the participating public. Scientists generate large and long-term data series that would be labour-intensive and expensive to collect through traditional experiments. Members of the public have opportunities to educate themselves in scientific thinking and how science works, appreciate nature and contribute to science initiatives (Freitag & Pfeffer, 2013).

The degree of public engagement with citizen science varies. Most current initiatives engage the public in projects that are generated and guided by scientists. The role of the public is to contribute to data collection and analysis, such as making observations and measurements. Yet, in collaborative citizen science projects, members of the public take part in refining the design of the project,

analysing data, and disseminating findings. Co-created projects are designed in collaboration with the public, so citizens are engaged in all the aspects of a research project from defining the research questions to collecting, analysing and reporting data. In collegial projects, members of the public initiate and conduct their own research activities independently from scientists (Shrink et al., 2012). The greater the involvement of the public in research activities, the more challenges emerge, including the collection of valid data sets, identification of suitable participants to join the research, and devising a sound process of data analysis and interpretation. Yet, extending continuing participation in citizen science projects could address some of these challenges. There is evidence that systematic involvement in citizen science projects produces learning outcomes in terms of increasing accuracy and degree of self-correction of observations (Bonney et al., 2009).

In this book, the notion of 'citizen inquiry' emphasises the active engagement of the public in scientific activities that are not restricted to processes of data collection and analysis, and includes examples of citizen science projects initiated and implemented by volunteers. In citizen inquiry, the focus shifts from scientists to members of the general public as active agents who define their own research agenda underpinned by models of scientific inquiry, producing identifiable learning benefits. Trained scientists may be recruited as advisors, co-investigators, or assessors. Inquiry-based learning is a learning process by which participants pose questions about the natural and material world, collect and analyse data to address these questions, make and test hypotheses (de Jong, 2006). It is intended to develop thinking competences similar to those of scientists (Edelson, Gordin, & Pea, 1999). A recent approach to inquiry learning stresses the importance of devising personally meaningful scientific investigations by having learners setting their own research agendas that match their preferences and interests (Anastopoulou et al., 2012; Scanlon et al.., 2011; Sharples et al., 2015).

Inquiry learning is a problem-based approach to learning that requires guidance, in the form of cognitive 'scaffolding', to make tasks manageable, support learners' understanding, and encourage self-expression and reflection (Quintana et al., 2004). This guidance can be distributed across teaching material including educational software, teachers and mentors, and learners themselves (Puntambekar & Kolodner, 2005). Structured scaffolding facilitates cognitive apprenticeship whereby learners develop skills by working alongside more expert practitioners. It can enhance learners' problem solving skills (Quintana et al., 2004) and decrease cognitive load by drawing learners' attention to aspects of the task that are relevant to the learning goals (Hmelo-Silver, 2006). In this respect, citizen inquiry points to extensive use of online social networks and mobile technologies, with professional scientists joining not to instruct but to facilitate and support massive participation of the public of any age in collective, inquiry-based activities.

In addition, citizen inquiry is a new approach to inquiry science learning which can be applicable across disciplines. While citizen science was originally used to refer to public participation to

scientific activities in natural sciences such as physics, biology, chemistry, and earth science, recent initiatives make reference to citizen science activities in disciplines such as the humanities. For example, citizen humanities aim to identify how public participation in research can enrich humanities and cultural heritage research. In this respect, citizen inquiry perceives science and scientific activities broadly, to encompass both natural and physical sciences, and social and applied sciences such as education, psychology, sociology, and medicine. One example of how the public could engage with scientific activities in the field of education is the provision of personalised feedback to learners. Teachers could propose and gather together alternative methods to solve problems and help learners in choosing a method that matches their understanding and ability, thus tailoring learning to individual needs (Heffernan et al., 2016).

As an innovative approach to knowledge development, citizen inquiry is situated alongside participatory typologies of learning. Sfard (1998) makes an ontological distinction as to what learning is drawing from two metaphors: the acquisition metaphor and the participation metaphor. In the former, knowledge acquisition is the unit of analysis; knowledge is 'out there' for the individual learner to acquire. The participation metaphor shifts the attention from concept and knowledge to activity, action, participation and a state of 'belonging and doing' rather than 'knowing'. In Sfard's term, the participation metaphor points to no clear end-point to the process of learning. It embraces participation in communities and a constant move from periphery to the centre. Learning through citizen inquiry is participatory in nature; the level of engagement with scientific activities varies - from data collection to initiation and implementation of personally meaningful projects. Yet, participation denotes a shared interest in the proposed scientific endeavour and communication with others to share and negotiate ideas. Systematic participation can lead to the development of scientific skills and expertise and a shared practice evidenced in shared experiences, stories, and tools. Pointing to a third metaphor of learning – 'change as a person' (Marton, Dall'Alba, Beaty, 1993) – learning through public participation in scientific activities may result in changes to individuals and how they identify themselves.

The selection of chapters included in this edited volume present empirical evidence about the processes and outcomes of learning as they have been studied in a range of citizen inquiry projects, to illustrate how melding citizen science and inquiry learning holds certain pedagogical advantages, including massive participation by the public in initiating and implementing personally-meaningful investigations, the strengths of collaborative learning and collective intelligence for identifying scientifically-sound solutions to real-life phenomena, and the long-term engagement of members of the public of any age with online lifelong learning endeavours. Each chapter has been designed to ensure a steady shift of emphasis from theory to application in order for readers to thoroughly understand the current state of research in the field and its applications to practice. The key aims are to describe a number of case studies of citizen inquiry and their pedagogical implications, specify the

nature of citizen inquiry by drawing from concrete applications, identify learning contexts where citizen inquiry can most effectively be promoted, and devise practical recommendations on how successful citizen inquiry applications can be developed.

In this edited volume, eleven citizen inquiry studies are described. These studies were conducted in both formal and informal learning contexts and the majority of them concerned examinations in the domains of natural and physical sciences.

Three chapters explore the concept of citizen inquiry in educational settings. In Chapter 8, He et al. present the motivations of university students to participate in citizen inquiry and how these relate to level of task difficulty. In Chapter 9, Perelló et al. describe the introduction of five citizen inquiry projects in secondary schools and their impact on scientific competences and student motivation. In Chapter 10, Charitonos details a small-scale implementation of citizen inquiry in language learning in community schools and introduces the concept of 'cultural citizen inquiry'.

Three chapters examine the concept of citizen inquiry in the domains of social and applied sciences, specifically education and humanities. These are chapters 10 (see above), 3 and 7. In Chapter 3, Dunn and Hedges explore the kinds of knowledge created in citizen science projects with the aim to help the design of citizen humanities projects. In Chapter 7, Clough describes how a community of Geocachers integrated inquiry learning into their practices, extending the concept of citizen inquiry beyond science to domains such as history, archaeology and cryptography.

Six studies draw evidence about citizen inquiry from the domain of natural and physical sciences. In Chapter 2, Curtis et al. investigate Foldit, Folding@home and Planet Hunters, discussing motivations to participate in these projects and how they relate to opportunities for informal learning. In Chapter 4, Kloetzer et al. report findings from the Science in the City Air Quality Monitoring project, in particular how active engagement of community members led to rich and diverse learning outcomes. In Chapter 5, Peterman et al. integrated embedded assessment in three citizen science projects as a means to systematically capture volunteers' scientific inquiry skills. In Chapter 6, Ansine et al. describe how iSpotnature, an active online citizen science community, supports processes of learning through a five-step process. In Chapter 11, Edwards et al. drawing evidence from two citizen science projects in ornithology, discuss how project design in citizen science may have an impact on learning while they raise the need for a sustained dialogue between citizen science and inquiry learning. In Chapter 12, Aristeidou et al. conclude this edited volume with a set of design elements that can engage the public with citizen inquiry projects and contribute to the development of sustainable citizen inquiry communities.

In this book we propose a new perspective on scientific practice through crowd-sourced science that involves citizens and scientists in shared explorations. There are insights here of interest to an

international audience including: educational policy makers interested in public engagement and lifelong learning and aiming to improve the provision of education through the use of online technologies; researchers in academic and non-academic organizations investigating the potential of online technologies for learning and engagement; and practitioners in the field of learning and education including undergraduate and postgraduate students in education and educational technology, pre-service and in-service teachers, and educational software developers and advisors. This book will be a significant asset to these audiences as it introduces and explains the new approach of citizen inquiry, provides examples of practical applications of this approach to diverse fields, and discusses the integration of citizen inquiry in formal and informal teaching practices.

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