EDUCATION POLICY | RESEARCH ARTICLE

Using a Citizen Science approach in early childhood education: A call for strengthening evidence

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Abstract: A Citizen Science approach to building the evidence base is well established in many science disciplines, but is far from mainstream in the social sciences. Prompted by the inquiry from the Australian Government's Productivity Commission into the National Education Evidence Base and taking Early Childhood Education (ECE) as an example, this paper aims to provoke discussions about the possible contributions of a Citizen Science approach to broadening the methodological repertoire in ECE research and to positioning ECE research more powerfully in the politics of evidence. It argues that ECE stakeholders' involvement in building the evidence base through a Citizen Science approach could have the potential to make significant contributions to knowledge construction in ECE.

Subjects: Childhood; Early Childhood; Education Policy & Politics

Keywords: Citizen Science; social science; Early Childhood Education (ECE); evidence-base

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PUBLIC INTEREST STATEMENT

“Citizen Science” approach is generally used in scientific research studies. The initial idea of using this approach is to call for the public and civic involvement in scientific research as volunteers. However, today, the term “Citizen Science” has been discussed and explored in social science discipline. It has been used to describe “a range of ideas, from a philosophy of public engagement in scientific discourse to the work of scientists driven by a social conscience” (Cornell Lab of Ornithology, 2016). Although the use of this idea has expanded into the social sciences, only a limited number of studies using a Citizen's Science approach appear to have been conducted in the field of education, particularly in Early Childhood Education (ECE). In this paper, we explore the possibilities and also outline some limitation of using this approach in the ECE field.
1. Introduction

In recent years, we have witnessed significant changes in scientific development. There is a powerful relationship between society and science and scientific benefits from scientific advances have seeped into human life. In the meantime, more non-professional scientific citizens are becoming interested in attending community-based scientific activities. In recent years this has particularly occurred through Citizen Science projects, with people in communities becoming more actively engaged in science and social development. The long-term emphasis on the scientific role has gradually been shifted to a greater recognition of the Social Science and Humanities in broadening the boundaries of “knowledge relations” (Felt, 2014, p. 12). However, most Citizen Science projects try to deal with questions in the scientific domain. Few researchers have shed light on using Citizen Science projects to develop Social Sciences. One reason might be the different research paradigms, and another could be a knowledge gap between Science and Social Science. The philosophical ideas of scientific research lie in positivism but in social science they focus more on social development, persons’ cultural experience and individual perceptions.

The skills and experiences of what we have had could be constructed through human interactions and learning process. The journal Science states “Citizen Science needs to look more like society” (Mervis, 2018). The recent Report of National Academy of Sciences says that the key of Citizen Science projects are to support “both science learning and research goals; inequities in education, opportunities, and resources must be addressed to meet participants’ learning demands” (2017, p. 1). In this regard, the focus of research studies moves from an introduction of scientific knowledge to the improvement of civic understandings and to transferring knowledge about the production process to the public domain (Gibbons et al., 1994). This approach enables more people to be involved in the research process and consequently better their understandings of how science correlates with human social movement.

In The New Production of Knowledge, Gibbons et al. (1994) explored changes in the mode of knowledge production in contemporary society. They are concerned with the social sciences and the humanities as well as with science and technology. This process has been explained in ‘Mode 2’ for the nature of knowledge production. (Gibbons et al., 1994). Compared with ‘Mode 1’, ‘Mode 2’ emphasizes the application of knowledge to solve practical problems and these practices are different from those governing in Mode 1. Also, Gibbons et al. (1994) claims that both scientific and non-scientific actors could be engaged in the trans-disciplinary collaborations.

Hurni and Wiesmann. (2014), similarly claim that trans-disciplinary collaboration might not only require researchers to engage with researchers from other disciplines but also to strengthen ties between researchers and non-researchers to solve practical problems. In modern societies, researchers believe that transdisciplinary collaboration becomes more important as “significant problems of tomorrow will be systemic problems, which cannot be addressed by any one specialty” (Domik & Fischer, 2011, p. 129). To solve these problems, trans-disciplinary collaborations are needed that emphasizes experts working in a broad community and in organizations that encompass multiple ways of collaborating. Schneidewind proposed the concept of “Research in Real-World Labs” and explains that “Real-world labs are built on a trans-disciplinary process understanding of the involved scientific and non-scientific actors, methods facilitating collaboration and knowledge integration as well as suitable project designs” (Schneidewind et al., 2016, p. 10). To achieve this aim, research projects extend boundaries, that is, they might be undertaken in any places other than restricted research labs. In this context, various kinds of actors could be involved in the innovative research process rather than scientific researchers involved only in a knowledge production process.

Based on these studies, this conceptual paper will explore if Citizen Science, as an innovative research method, could be used in the ECE field. To achieve this aim, we firstly provide an overview of a Citizen’s Science approach, followed by an overview of the current diverse nature of evidence-based research in the ECE field. We then consider how, with project examples, it could be aligned with Citizen Science education in practice. After this, issues of whether a Citizen’s Science approach
might assist in strengthening the ECE evidence base will be explored and finally opportunities and challenges of using a Citizen Science approach to strengthen the evidence base in the ECE field will be discussed in depth.

2. Citizen Science: an innovative research method

The term “Citizen Science” is defined in different ways. Some researchers use “Citizen Science” to describe a situation where people with common interest use scientific techniques to investigate a phenomenon without institutional cooperation (Finke, 2015). According to the Citizen Science Association, it refers to “projects in which volunteers partner with scientists to answer real-world questions” (2016, p. 1). In some research, the definition is similar to crowd science, civic science, participatory science, volunteer monitoring or networked science (Vasileiadou, 2015). Though the term might be different, we believe that civic participation and the contributions are important in projects. In other words, we cannot simply judge if the research is a Citizen Science project by non-professionals’ involvement.

After reviewing many research studies related to Citizen Science, Golumbic and her colleagues (2017) identified Citizen Science as having three main components by nature: 1) inclusion of citizens in the scientific process; 2) contributions to both science and the public, and 3) reciprocity, i.e. a two-way communication between scientists and the public (p. 2). In these components, to what extent of civic contributions and involvement might be depended on the initial design of the project. However, the levels of civil participation are also varied in the design of citizen science projects. Haklay’s work (Haklay, 2018) highlights that no matter what the levels of participations are, the different knowledge and engagement have value in different cases. Also, he believes that both the literate and illiterate could participate in citizen science projects (micro and macro-engagement). In this paper, we believe that Citizen Science could be viewed as collaborative projects undertaken by a broader interdisciplinary community, which could involve both amateurs and experts, low and high levels of participation, and is partially transferable between Science and Social Science.

Few researchers shed light on discussing Citizen Science in Social Science that might be due to the different rationale between science and social sciences. Based on a historical perspective, scientific research, in general, had been predominantly conducted outside of the institutional context until its professionalization in the late 19th century. In the natural sciences, volunteers continued to collect data on natural phenomena even after the process of institutionalization (Rushing et al., 2012); This is commonly found in data collection process in scientific research projects as they follow a positivist path instead of being involved in sharing individual experiences and attitudes. However, social science “evolved from philosophy and had a strong normative focus” (Heiss & Matthes, 2017, p. 23). Under the epistemological rationale, Citizen Science is reconceptualised to look into who are eligible to possess knowledge, and qualified to collect data that are legitimate (Bourdieu, 1991). In this view, the way social scientists traditionally perceive experts’ and non-experts’ contributions would not help in large citizen science projects. Also, Bourdieu (2004) believes that theory and practice cannot be separated as the research needs to be contextualised.

Giddens’s (1984, 2013) theory of explains that there is a two-way relationship between what is interpreted by scientific professionals and laypeople. For example, whilst social science might interpret our daily life, that life has already been construed and understood by laypeople living their life, thus creating a two-way relationship. Therefore, the previous assumptions of “lay” may be mis-institutioned. In our life, as Giddens argues, “there is a constant slippage from one to the other involved in the practice of social sciences” (1984, p. 374). In this regard, an ontology is needed for stating Citizen Science in which “lays” are not illiterate, incompetent, and uneducated. The importance of Citizen Science could assist us reassessing that participants in the ECE field, such as young children, who have been regarded as not fully involved in projects due to necessary consent from their parents. For example, children at preschools and kindergartens could participate in research projects only by being consented by their parents or guardians. In this case, their limited degrees of participation would hinder the progress of broader community involvement in data collection process, as well as the interpretation of data in ECE Citizen Science projects.
Though few researchers shed light on the focused area, notable exceptions were found in Vasileiadou’s research. He claimed that there is an increasing number of literature discussing Citizen Science because its advantages are “not only for scientists and the science that is produced, but also for the participating citizens” (2015, p. 1514). Meanwhile, Vasileiadou argued that scientists could not use the same recipe for all interdisciplinary studies. For example, “Sociology of science has shown that there are systematic differences among different scientific fields” (2015, p. 1516). Besides the nature of research projects being different, researchers argue that Citizen Science projects should be transformative and have social impact (Bonney et al., 2014; Nature, 2015; Zeegers et al., 2012). For example, Bonney et al. (2014) claimed that though citizen science projects have an orientation of scientific objectives, social outcomes should also be realized in a significant way. Technologies have been employed in their projects as a popular method to gather data in broader cultural and historical community contexts. In this view, Citizen Science research might not only need to shift the focus from the pure-professional scientist-based research to a broader non-professional and community-based approach, but also from tackling limited scientific driven research questions to a wider community benefit and participatory research contribution.

With this purpose in mind, we will explore if a “Citizen Science” approach could be used as an innovative research method to construct partnerships between experts and stakeholders so as to provide more evidence in the development of ECE quality and equality. The partnerships could include stakeholders of Early Childhood (EC) educators, children, families, early learning education centres, and related professional partners. EC researchers traditionally constructed research questions and invited the stakeholders, such as parents, Early Childhood Education Care (ECEC) centers, and EC educators to join research studies (Ihmeideh & Coughlin, 2015). Children The participants objectively finished a series of tasks that were assigned by the researchers. A consequence, on the completion of the projects, the researchers and participants might not have a strong tie for them to be both involved in the model design for the next stage. This partnership model is described as a contribution model by Bonney and his colleagues (2009). However, this model is very limited for civic involvement in making contributions to increase education outcomes (Heiss & Matthes, 2017). For example, children’s involvement and participation timelines would be heavily dependent on their parents’ perceptions on the consent forms. Therefore, a higher level of cooperation and civic involvement would be essential for improving project sharing between educators and academics (Newman & Mowbray, 2012).

3. Building an evidence base in ECE research
Before exploring a higher level of cooperation in using Citizen Science projects, we need to take a further look into ECEC policy documents in both Australia and other countries to explore the current research to strengthen the evidence-based studies in the ECE field and this is worthwhile to be explored in Citizen Science projects. Building the evidence base in ECE has long been a focus of attention, from policy documents to research studies both domestically and internationally. For example, in the United States, federal law mandates that early childhood practitioners implement evidence-based practices (EBPs). Moreover, the “Evidence Informed Policy-making in Education in Europe (EIPEE)” Project’s recommendations suggest increasing the use of systematic reviews of research in order to “ensure complete, relevant, quality assured and accessible research evidence” (Gough et al., 2011, p. 10). In China, influenced by the West, the Ministry of Education (MOE) emphasized that strengthening evidenced-based ECE research could provide better support to help children with special needs (Li & Yang, 2016). The Early Childhood Special Education Assistive Technology (EC-SEAT) project SEAT aimed to use iPads as a teaching tool to help children with special needs. Also, the project benefited early childhood educators acquiring information to become highly skilled evidence-based practitioners at early childhood centers and schools. Although many early childhood educators struggle with how to identify which practices are evidence based, scholars (Hedges & Cullen, 2012; Law et al., 2018) generally agree that children from birth to five years of age with a high quality of early learning would be likely to have a more positive learning outcome later at schools.
In Europe, the OECD launched the International Early Learning and Child Well-being Study (IELS) that aims to “encompass a collection of robust empirical information and in-depth insights on children’s learning development at a critical age” (2017, p. 14). Though concerns were raised about quantitative methods in the IELS (Moss & Urban, 2017), this project provides opportunities for international organizations and countries with common languages to be involved in using the learning framework to share resources in order to improve the children’s learning outcomes and wellbeing. The project titled “EU Kids Online” is another recent example that aims to produce an evidence base which can inform policy making across Europe to make the Internet become a better place for children (Livingstone et al., 2019). Interdisciplinary researchers across Europe have been involved in projects to focus upon development of evidenced-based research across Europe to benefit children and families. Research studies in other European countries such as Netherlands showed that though “there is no pan-European perspective on evidence-based working in child welfare”, the evidence-based practice is closely related to child welfare (Grietens, 2013, p. 161).

In Australia, following its Inquiry into National Education Evidence Base, the Productivity Commission (2016) reports the need for: “… a national evidence base to inform policy development and improve education outcomes in early childhood and school education” (p. 3). The emphasis of improving children’s education equity and wellbeing so as to have better educational outcomes is also committed as an education goal (Australian Government, 2016). In order to achieve the goals of sustainably providing excellent ECE, the National Education Evidence Base (Productivity Commission, 2016) has called for a national education evidence base in line with their mission. This extended evidence-based requirement is not only beneficial for improving the quality of ECEC but also enhancing the efficiency of policy decision-makers.

The Report explains that effective national education evidence not only requires data collection in an accessible data warehouse, but also needs wider community engagement to support decision-makers to make a more cost-effective policy. Figure 1 shows the differences between the data and evidence (Productivity Commission, 2016, p. 5)

The report shows that these data sets, such as the National Assessment Program—Literacy and Numeracy (NAPLAN), Programme for International Student Assessment (PISA), Longitudinal Study of Australian Children (LSAC), and Australian Early Development Census (AEDC) all present a simple accumulation of data but critically they lack systematic education evidence at all levels (e.g.,
teachers, families and ECEC settings) (Australian Government, 2016). Although these data sets provided measurement in education outcomes to some extent, they majorly focused on measuring students’ education outcomes from a limited perspective of formal schooling. Consequently, there is a lack of education evidence about children’s quality of learning and quality of life. ECE is a key stage for children with significant benefit with short- and long-term positive outcomes if they are provided with high-quality early childhood programs prior to formal school years (Bauchmüller et al., 2014). Also, longitudinal studies conducted in Australia and overseas indicate that children’s early learning environment and learning outcomes will influence their formal schooling learning outcomes and subsequently influence their future academic performance at schools (Bowes et al., 2009; Sammons et al., 2015).

In 2016, the Productivity Commission Inquiry into the National Education Evidence Base received more than 100 submissions. A majority of respondents believed that it was necessary to strengthen the evidence base prior to 4 years old as the younger stage is of vital importance through long-term impacts on education and developmental outcomes. The gap between the current datasets and the proposed shared database from all the resources could benefit decision-makers at all levels to provide children and families with better support. Similar perceptions were found in an empirical study conducted in Australia to show evidence about what the everyday work of educators entails (Wong et al., 2015). Wong and her colleagues considered that “collection of educators’ records of their work activities over the day (time-use diary)” would be an important step to develop the taxonomy “a tool to capture generalisable data on the everyday work of educators so as to inform effective workforce policy” (Wong et al., 2015, p. 79). Based on this study, Press and her colleagues (Press, 2017) have been developing a large empirical data base to show the complexity of ECE educators’ work activities via the Random Time Sampling Time Use Diary smart phone app. Harrison et al. (2019) further used Taxonomy of Early Childhood Work to identify the types of ECE educators’ daily activities, the time they spent in each activity, and changes in work activities. The research findings show the benefits of the time-use methodology as a data-driven method to objectively identify and quantify the complexity of early childhood educators’ work across a day.

Both domestic and international decision-making evidence and research studies demonstrate that more empirical evidence will be needed to provide benefits towards improving children’s learning outcomes and as a consequence to provide effective evidence for policy decision-makers. In this decision-making process, “top down and bottom up processes are essential and complementary” (Productivity Commission, 2016, p. 7). In this case, it is appropriate to explore if using a Citizen Science approach could become a new type of collaborative focus among stakeholders in ECE activities. Also, it is timely to explore whether using Citizen Science as an innovative research method could strengthen the evidence base in the ECE field in Australia.

3.1. A higher level of design model

As mentioned previously, contributive and collaborative models have been discussed broadly in Citizen Science research projects (Bonney et al., 2009). However, the co-design model could allow both volunteers and researchers to be involved in every stage of the research process (Bonney et al., 2016). Also, this is a major difference between the citizen science co-design model and participatory action research (PAR), which could allow participants to be fully involved in the community at every step (Walter, 2009). In a co-design project, both researchers and civic participants could define research questions, actively participate in data collection and analysis, and discuss future research direction. In this process, new research questions are likely to arise. Heiss and Matthes (2017) believe that this higher level cooperative model could increase educational outcomes. This provides particular benefits to ECE research. The idea of using a co-design model is to include children as “equal stakeholders throughout the entire experience, contributing to the process as experts of their own lives” (Hansen, 2017, p. 1). By using this method, children can become equal active participants to adults. For example, in order to strengthen the diverse needs of children and young people in the care system in Australia, the project titled ‘The Out of Home Care Strategy 2015–2020’ plans to deliver services over a five-year period for children and
young people who cannot safely live with their birth parents. The project used a co-design approach to understand the experience of out of home care for service users. Citizens and stakeholders with diverse language and cultural backgrounds were engaged, including indigenous families, service providers and community members to understand how Australians experienced out of home care service (Evans & Terrey, 2016).

Another example can be found in the project undertaken by Zeegers and her colleagues in South Australia (2012). This study has made a significant contribution to science education as teacher educators, environmental scientists and a local radio station collaborated strongly in the whole research process. The research project not only introduced an innovative method in science teaching in schools, but also brought potential benefits for the improvement of the English curriculum. Although Citizen Science as an innovative research method has been used in more recent studies in the education field, there are still very few studies in the ECE field. Key challenges are also discussed by researchers.

4. Challenges

Although an increasing number of research projects and ECE policy documents emphasized that using evidence-based research could be an effective way to strengthen children's learning outcomes, challenges of using the Citizen Science approach in the ECE field are discussed majorly in three aspects. First, uncritical heavily dependent on quantitative evidence could be questionable in the decision-making process for planning for ECE projects and further research reports. For example, Urban (2017) criticized that “young children and standardized assessment don't go well together” (p. 19) if the research project lacks the “international initiatives to create in-depth understandings of complex early childhood systems, develop meaningful systemic evaluation and support much-needed improvement of experiences and outcomes for all children” (p. 19). Similar opinions are found in Moss and Urban’s research which claimed that “the findings produced by quantitative methods must always be treated critically and subjected to careful questioning and interpretation” (2017, p. 256). However, without the citizens’ involvement in contribution to the data consistently, the evidence would not be strong enough and indicative for decision-makers. In this case, ECE researchers might need to consider whether using a Citizen Science approach could be appropriate at the beginning of the research as this is a key step to ensure the success of a research project.

Second, data quality has been contested in some Citizen Science projects (Nature, 2015). As mentioned previously, Social Science research, such as ECE studies, rely on gathering participants’ perceptions via using observations and interviews. So, this might cause bias between non-professional actors and trained researchers when they collect and analyze data together. For example, Hackett used “Parents as co-researchers” to describe “a way of doing ethnographic research collaboratively with parents in order to understand the lives of young children better” (2017, p. 17). Although using the innovative research methodology could enhance parents’ understandings of their children’s emotion, behaviour and experiences (Elwick et al., 2014), the boundaries could still be blurred to those who are both researchers and parents. Also, their identity? and how this position in their work might lead to question in data quality. This issue is similarly contested with scientific research. For example, Mitchell et al. (2017) undertook a project titled “ClimateWatch” to investigate the benefits and challenges of partnering with university students by using a Citizen Science approach. The result showed that “only 31% of students agreed with the statement that data collected by citizen scientists are reliable at the end of the project” (Mitchell et al., 2017, p. 1).

Third, ethical questions can arise from the data co-production process and data analysis in the Citizen Science projects (Riesch & Potter, 2014). Though this issue has been widely discussed in scientific projects (Aungst et al., 2017; Woolley et al., 2016), it also exists in the Social Science field. The Citizen Science Association (CSA) and the European Citizen Science Association (ECSA) have worked on ethics and principles, but intellectual property and data management still need further exploration (Citizen Science Association, 2017; European Citizen Science Association [ECSA], 2016). For example, issues could emerge in Hackett’s research (Hackett, 2017) such as the ECE sensitive topics of children and how parents would share and use the collaborative data of their children with others. This
issue might lead to another emerging issue for using a large-scale online survey through using a Citizen Science approach. For example, Doyle et al. (2018) led the crowdsourcing project to investigate online citizen science participation in science education from an educational perspective in New Zealand schools. The research study reveals that the research process, data dissemination and research context might impact the success of the Citizen Science research.

Furthermore, as discussed earlier, ethical consent is needed from parents before children could be involved in ECE research projects. In this regard, the extent of participation in the research could not be decided by children themselves. This potentially could lead to misunderstanding of data interpretation in ECE citizen science projects. Some researchers demonstrated that “even at quite a young age, children can make informed decisions if given adequate information in terms they can understand” (Edwards & Allred, 1999, p. 266). Similar arguments can be found in Graham and Powell’s work (Graham & Powell, 2015) who believe that the consequence would “increases barriers to children’s participation in research” (p. 337). In this regard, it is necessary to explore the extent to which children can consent to their participation in ECE research studies.

5. Conclusion

Although the challenges discussed need further exploration, there are many good reasons to implement the Citizen Science projects in the ECE field. First of all, Citizen Science as an emerging approach in Social Science, particularly, in ECE field, emphasises civic engagement, an education evidence-base, and contribution to knowledge. Trans-disciplinarily in Mode 2 focuses on how knowledge production could be changed from traditional institutional results to be applied into broader fields. In this process, more trans-disciplinary group practitioners will be involved to develop the framework and solve problems. Meanwhile, knowledge production in Mode 2 is dynamic and diverse in organizations. As such, using a Citizen Science approach in the ECE field could beneficially and easily gather together those who have similar interests and skills from temporary team works and networks to solve problems or redefine them.

Second, in an Australian context, ECEC could benefit from undertaking research using a Citizen Science approach to call for evidence-based education. More importantly, a higher level collaboration between children, family, researchers and other stakeholders is likely to increase the opportunities for people to engage in knowledge production and transition. From a political perspective, an effective education evidence base could support decision-makers at all levels and also to drive continuous improvement.

Third, in a global context, as discussed above, an increasing number of ECE research studies have explored the use of multi-levels of collaborative research to further strengthen the education evidence base. It is worthwhile noting that net citizens could gradually become major participants in future online citizen science projects and as a consequence, broader civic involvement is likely to not only develop conceptual frameworks, solve problems and provide solutions in a sole context but also benefit a cross-national context.

To conclude, as Vasileiadou (2015, p. 1516) asserts:

By ignoring such dynamics we stand to lose: as decision makers, we stand to lose resources spent on projects that fail; as scientists we stand to lose time and effort in such projects. But as societies we also stand to lose insights into the changing dynamics of authority and expertise that citizen science entails.

Citizen Science projects in the ECE field should be promoted and utilised. We need to increasingly engage in Citizen Science processes and develop experience from our endeavours. Such a project should be allowed experimentation at the beginning of civic involvement of the research as a basis for further learning and progress.
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