Systematic Literature Review: Learning Science Literacy through Citizen Science

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Introduction

Agriculture and science are closely connected and cannot be considered separately from each other. Exploring the issues in agriculture, food, and natural resources (AFNR) could potentially increase people's understanding of science literacy. It has been highlighted that agricultural education has capacities to promote science skills (Dailey et al., 2001), and agriculture teachers are seeking for opportunities to improve agriscience instructions to integrate science literacy (Blyth, et al., 2015). In K-12 formal education, AFNR issues provide an authentic context for teachers to cultivate students' science literacy. As in non-formal education, numerous citizen science projects attracting millions of participants in collecting and/or processing scientific data have escalated worldwide over the past 20 years (Bonney et al., 2016). Research most often associated with citizen science, including the analysis of water quality and weather data, observations of species distributions (e.g., birds and butterflies), and other natural phenomena, has taken place within the realm of AFNR (Bonney et al. 2009, Zoellick et al. 2012). Empirical studies have highlighted the potential of citizen science to increase scientific literacy, the promotion of knowledge, and the understanding of scientific concepts and processes (e.g., Trumbull et al. 2000; Brossard 2005; Bonney et al. 2009). However, educational citizen science projects are yet to be evaluated extensively. This article examined the educational citizen science projects trends over the past 20 years and their contribution to scientific literacy, emphasizing the instruments used for measurements. This systematic literature review article focused on three research questions: 1) What research methods did authors tend to use in conducting or evaluating educational Citizen Science research? (2) What were the status and trends in educational Citizen Science Projects, and how does that relate to science literacy in the past 20 years? (3) What has been done to measure scientific literacy, and how does that relate to evaluating scientific literacy in Citizen Science projects participants?

Conceptual Framework

Citizen science is recognized as a tool to engage the community in science (Bird et al., 2014). Bonney et al. (2016) found limited but growing evidence on citizen science projects participants' knowledge gain increase on both science content and process and an increase in public awareness of the diversity of scientific research. This can explain the need for exploration of the educational citizen science projects trends and how they relate to the participants' scientific literacy understanding. Scientific literacy is defined as "a broad and functional understanding of science for general education purposes and not preparation for specific scientific and technical careers" (Fives et al., 2014). In an event scientific literacy is perceived to be emphasizing scientific knowledge and the use of that knowledge in different contexts, it provides citizens with the necessary tools to engage with science critically, reinforcing a more humanistic culture based on rational thinking (Harlen, 2010).

Methodology

This study included publications that are peer-reviewed and are published between 2000-2020. The databases searched were ERIC, ProQuest, Google Scholar, and scholarly journals. Three keywords, Citizen Science, Science Literacy, and Education were used to search for articles. Only empirical peer-reviewed research articles that have high-quality reports with well-cited references were included. After initial title screening, we found 40 articles that at least have one of the keywords in the title. The authors read through the abstract and method to screen for inclusion. We only selected publications that aligned with one or all research questions. After

screening for inclusion, we found 28 articles that fit our study. In the next step, a coding system was developed to help us further evaluate the quality of the articles. The codes included scientific process, going beyond science understanding, nature of science, science content knowledge, motivation, attitude, and awareness which are the constituents of scientific literacy. Two researchers independently coded two full-text articles, and the internal coder reliability for the first round of coding was about 95%. After the first round of coding, any discrepancies in their coding were discussed and resolved. In the second round of coding, a concept map was generated to connect and synthesize the coding for the total 28 articles.

Results/Findings

The results show that researchers tend to use quantitative research method more than other methods in educational citizen science projects. Overall, 12 articles used quantitative methods, 8 used mixed methods, while systematic literature review, and qualitative research method used 5 and 3 articles, respectively. Non-formal settings prevailed the formal settings as researchers' preference. Nearly 60% of the analyzed articles reported citizen science projects conducted in non-formal settings. The results show that the majority of the articles (17) were published in the past six years while the remaining (11) were published between year 2000 and 2014 which shows a substantial increased interest in educational citizen science projects in recent years. Nearly 70% of all articles reported an increase in science process understanding. As for attitude toward science and science content knowledge, around 50% and 65% increase were reported, respectively. The least evaluated among the scientific literacy components was awareness accounting for less than 10%. About what has been done in terms of measuring scientific literacy, only two articles covered all seven components of science (scientific) literacy that has identified in the coding system. 21 articles used one or more instruments to measure one or more components of scientific literacy mentioned above in the coding. However, no common ground on tools to use while evaluating citizen science projects outcomes is set.

Conclusion

The systematic analysis of articles considered for selection in this review showed huge growth in scholarship in this field from 2000 to 2020, especially over the past 6 years. Among the seven Scientific Literacy components evaluated; science process, science content knowledge, and attitude towards science were the most assessed components. The results showed an urgent need for developing an effective and reliable instrument to evaluate science literacy in citizen science project.

Implication and Recommendations

The paper contributes to the interests of AAAE members in twofold. First, integrated AFNR in citizen science projects is a promising strategy to increase certain parts of science literacy (e.g. scientific knowledge). Second, the study also reveals potential opportunities for agriculture teachers to adapt citizen science project in their teaching to integrate social and behavioral sciences with agricultural, life, environmental, and natural resource sciences (American Association for Agricultural Education, 2015). We would like also to recommend future reviews to analyze publications on Educational citizen science projects in other settings such as books, and grant proposals.

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