Engaging Citizen Scientists in Model-Based Reasoning

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Abstract: We discuss initial findings from a citizen science research project focused on engaging lay people in collaborative model-based reasoning for natural resource management. We created collaborative online training and project development space for generating models and collaboration among peers to develop management plans for local environmental concern.

Keywords: citizen science, model-based reasoning, informal learning, collaboration

Introduction

Citizen science programs engage the public in authentic scientific research and provide an ideal venue for informal science learning. In co-created citizen science projects, participants who are actively involved in research endeavor to develop questions of common interest (Bonney et al., 2009). The projects are popular among individuals seeking to play an active role in environmental resource management and have the potential to draw individuals from diverse perspectives, from audiences that might not otherwise be engaged in science to those motivated by scientific interest who lack formal training in the field. Technology has transformed the way that citizen scientists are able to use computational techniques to engage in scientific practices (Bonney et al., 2014). Here, we report on the early implementation of CSCL in a co-created citizen science project.

In CollaborativeScience.org, members of the general public, who engage in environmental management courses through the volunteer Virginia Master Naturalist program, are given the opportunity to address environmental issues of local concern through planning project goals and actions in a hybrid in-person and online learning program. Thus, through the use of disciplinary tools in authentic activity, participants are enculturated into the wider community of environmental management practice and research (Brown et al., 1989). The first two stages of our adaptive management cycle include learning about the conceptual basis for their work and engaging in forums and model development. *Stage 1* provides conceptual information and background knowledge. The conceptual learning plan contains training modules: (1) ecosystem function and assessment; (2) adaptive resource management; (3) modeling and the practices of research. *Stage 2* consists of online forums and model development. After completing the conceptual stage, participant groups are given collaborative "forum" tasks which are designed to (1) define an open-land management issue of concern to study participants; and (2) develop a conceptual model of the local problem. Participants develop their models using an online tool (mentalmodeler.org) for Fuzzy Cognitive Mapping (FCMs; shown in Figure 1). An FCM is a cognitive map, in which the relations between the elements can be used to compute the strength of impact of these elements. These have been used to capture group mental models (Gray et al. 2011). The online forums and FCM's provide opportunities for learning to engage in intersubjective meaning making as they negotiate their models (e.g. Suthers, 2006). Here we examine models that participants generated from collaboratively generated parts, examining model development over time to see how participants used the model as a representational tool.

Methods

Our group of participants created models and a subsequent management plan on the suitability of certain public parklands for Red Cockaded Woodpecker habitat. The participants' initial inspection of this habitat determined that Japanese Stilt Grass, an invasive grass, was decreasing habitat quality. As Figure 1 shows, FCMs include not only components but also arrows representing relationships between the components. Each of these arrows contains a direction and strength (ranging from strong positive to strong negative influence). Within *Stage 1*, participants completed two FCMs, before and following collaborative component consensus. After the first year of their ongoing project, during *Stage 2*, a third set of individual models were collected. From the second (n=5) and third (n=6) sets of models based on collaborative components, we coded the participants' component connections by impact strength. To determine how models changed, we focused on the six most commonly connected components. Given our small sample, we present our qualitative exploration of these changes.

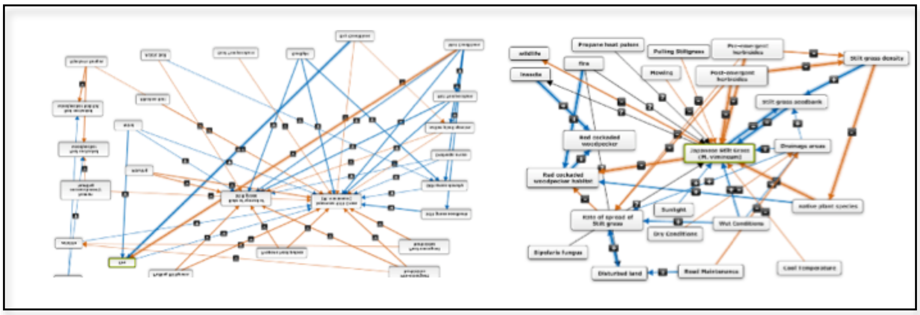

Figure 1. Example collaborative models at Phases 3 (left) and 4 (right)

Findings

Participants increasingly focus on more detailed aspects of their particular environmental problem as they learned from observational experiences after interventions (e.g., pulling and mowing, controlled forest burn). Initially, their individual models reflected little knowledge of more specific aspects related to their project that might curtail Stilt Grass: its rate of spread, seed bank, and density; however, their final models included many more connections to these elements within the system. Generally, the participants' final individual models reflected greater refinement of the relative impact of interventions tested within their activity, and components not investigated either remained stagnant or, more often, were not connected in the final model. Because participants developed a set of components via consensus, some included components not connected with any others (e.g., road maintenance, shade-dense canopy) or removed consensus components completely from their models. Components removed from or not connected within both early and final individual models were often abiotic, and in particular, less mutable factors like soil acidity, wind strength, or temperature.

Conclusions and implications

From our preliminary data, we draw two conclusions. First, final models reflect less complexity, as measured by the number of connections between components, but greater refinement of ideas. Our conclusion is consistent with Dauer et al. (2013) who found that model complexity peaked in the middle of an undergraduate life science course that used models to learn. Our second conclusion is that understanding of the complex ecosystem improved, noted by the reduction of abiotic factors, which in this particular problem are less likely the drivers of habitat suitability. Overall, models with greater accuracy were less complex; perhaps because irrelevant and less parsimonious explanations were removed, as increasing expertise eliminates extraneous detail. Further analysis needs to examine how the participants use adaptive management to develop their activity, the practices developed by meeting project goals, and the role of FCMs as boundary objects for collaboration.

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Acknowledgments

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