Meeting Review

Review of COS 173-Education Research and Assessment: Pathways for Engaging Students in Socioecological Systems

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Introduction

The Ecological Society of America (ESA) supports professionals and students in the field of ecology, which is loosely defined as the study of organisms (including humans) and their interactions with the environment (i.e., natural, altered, and built). Each year the ESA hosts an annual meeting that attracts individuals from the US and around the world to share their work and according to the society's website (www.esa.org), ~4,000 individuals attend the meeting, which results in study abstracts being accessed for a year following the conference. In 2024, the 109th annual meeting was held in Long Beach, California, USA from August 3 to 9, and sessions were loosely organized around the theme of "Supporting Ecologists Throughout their Careers." This meeting review summarizes the thematic takeaways of Contributed Oral Session 173, *Education Research and Assessment 2*, held during the 2024 ESA Annual Meeting on August 8th, related to the conference theme.

Emergent from this session was a thematic focus on supporting students in learning within a discipline that inherently engages with wicked and complex socioecological problems. As E. P. Odum posited in 1977, ecology is inherently an "integrative discipline that links physical and biological processes and forms and bridge between the natural and social sciences." Presentations from this session addressed this integration both from a learning perspective, in supporting students in the practices of scaffolded reasoning across disciplinary boundaries to address SES problems, and applying theory and practice from the social sciences in support of ecological education.

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Session summary

Below, we will summarize the four presentations given in this session. Because several, but not all, authors have worked together, these presentations were placed in this single session. Below, we summarize the speaker's presentations and connection to the theme.

Rebecca Jordan (Michigan State University) shared a presentation on meeting students' educational goals around climate change education. In this session, Jordan focused on gaps in students' knowledge about climate change using the context of food systems (see Jordan et al. 2023a). While students were able to define the problem and some of the drivers, they struggled to discuss solutions. Indeed, students themselves acknowledged this gap and indicated that more climate change education, especially in the social sciences, is warranted and needed in ecological curriculum. Jordan proceeded to share a socioecological systems (SES) perspective where social, natural, and altered drivers work in concert to drive global change and ended the session with a call for more research on college students' understanding of SESs to tailor postsecondary climate change education to both ecology students and in general STEM education.

Maria Ceron (University of South Florida) shared information on the societal programs to support diverse communities in STEM particularly in the ecology field. She focused on the Alumni perceptions of Strategies for Ecology Education, Diversity, and Sustainability (SEEDS) Program. This critical program has been part of ESA for the past 28 years and has supported diverse undergraduates and graduate students interested in ecological careers. To evaluate the outcomes and impact of SEEDS, Ceron and colleagues conducted an online survey targeting almost 1,000 SEEDS alumni. Their responses showed high achievement in their education, and most SEEDS alumni are employed in academia and within US government agencies. Sixty percent of participants reported that SEEDS was very or extremely important in shaping their career decisions. Ceron concluded SEEDS has contributed significantly to broadening participation in ecology for students from diverse backgrounds.

Amanda Sorensen (Michigan State University) shared a study (Jordan et al. 2023b) focused on helping students engage with diverse perspectives in politicized socioecological systems. Sorensen opened with the argument that disagreements between people on different sides of popular issues in STEM are often rooted in differences in "mental models," which are rooted in emotions, logic, and otherwise (Stietz et al. 2019). To develop socioscientific thinking skills in ecology, students need learning materials nested in the context of real-world problems, which necessarily involve thinking in systems and across scales (Jacobson and Wilensky 2006). Sorensen and authors argued that model-based socioecological learning may provide said pedagogical support for integrating ideas and perspectives (Star and Griesemer 1989) in controversial sociobiological problems. Sorensen discussed how she and colleagues tested the assumption that this pedagogical approach will foster certain aspects of perspective-taking that can be used in systems thinking as students not only articulate their own understanding of an issue but also articulate the view of others. Sorensen and team found no significant difference in models as analyzed from the perspective students took, but they did, however, find that model structure changed through time; mostly representing a reduction of components and relationships with time.

Jordan, on behalf of Steven Gray, shared a study where conceptual mapping was used as an educational tool for learning about socio-ecological systems. In this session, Jordan detailed MentalModeler (i.e., an online freeware that aids students and their instructors in representing system and in particular SES drivers and outcomes and in creating multiple scenarios that enable decisions as to which driving variables can be changed to attain desired outcomes; Gray et al. 2013). Research with postsecondary students supports the notion that using a tool specifically focused on modeling SES variables can result in a measurable change in students' views on trade-offs and system leverage points, but such change is modest and likely requires a considerable amount of scaffolding for students to focus on scenario building (S.A. Gray, R.C. Jordan, A.E. Sorensen, et al., *unpublished manuscript*). Furthermore, Gray's data show that how students account for system variables in writing is not correlated to how students choose to represent variables in their model as a visual representation of their ideas in writing. Clearly, more data on how students represent SES ideas visually is warranted, especially given the high cognitive load that complex system understanding requires.

Conclusions

Taken together, the presentations in this session ask, how do we train and support future ecologists in complex socioecological systems? Though the topical matter in each presentation was somewhat different (i.e., focused on climate change, justice, perspective taking, or modeling), there is an undercurrent of complex socioecological systems being represented. Clearly, as students transition into professionals, and some as professional ecologists, the likely focus of these future careers will require SES understanding given the increasing focus on "green jobs" (e.g., Duke 2023). As the authors and audience discussed the major findings that were presented, it was noted that while ecologists and those studying ecology are often presented with complex ecological systems in the classroom that ecologists have considerable data about, how often are those systems socioecologically integrated?

Indeed, students' ability to integrate knowledge for sophisticated reasoning in a socioecological system is a core tenet of the ESA-endorsed 4 Dimensional Ecology Education framework (Prevost et al. 2019). However, an initial scan of the scientific literature finds learning scientists are investigating SES understanding and instruction primarily in K–12 audiences. There are much fewer research studies being shared with a focus of supporting and exploring teaching complex SES issues with postsecondary students. We highlight this gap and emphasize the need for more research and practice to focus on scaffolding instruction and study supports, both in and out of the classroom, to support student success in ecology and in life given the inherent complexity of socioecological systems; knowing that understanding such systems greatly aids in the finding and testing of complex SES problems and solutions.

Beyond training in the classroom to support future ecologists' ability to engage with SES, ecology often happens outside of the classroom. Walter P. Taylor reflected in his 1936 paper *What is ecology and what good is it*? The unique perspective ecologists bring to addressing environmental issues saying, "Will not his qualifications for the job be directly related to the richness of his experience, the comprehensiveness of his information and the breadth of his point of view?" (Taylor 1936). While Taylor uses the male pronoun referring to ecologists writ large, and this portrayal certainly does not represent the sole identity of ESA members or ecologists today, the sentiment highlights the importance of diversity of perspective. While Taylor implies breadth of the individual point of view

as critical, we argue breadth of perspective does not happen solely at the individual level (though also important) but also at the group. Modern scholars have consistently noted the importance of diversity for creativity in group problem-solving (Friedman et al. 2016) to collaboratively address global socioenvironmental issues (Baggio et al. 2022). When considering training of ecologists in a postsecondary environment, it is important to take a wholistic perspective. Not just ensuring students possess knowledge of ecological concepts, but supporting their ability to engage meaningfully across disciplines and ideological perspectives, and bring to bear their unique experiences in support of a field where ecologists can speak to both the social and ecological circumstances to create change for a resilient future.

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Open research statement

No data were collected for this study (i.e., theoretical, review, opinion, editorial papers).

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