Undergraduate Students’ Scientifically-Informed Decision-Making about Water-Based Socioscientific Issues

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INTRODUCTION

• Contemporary societies face an array of global challenges: population growth, food production, natural resource use, and environmental degradation.

• These kinds of socioscientific issues (SSIs) provide a strong rationale for the importance of an emphasis on systemic science education efforts aimed at cultivating a scientifically literate populace, including those at the post-secondary level (National Research Council, 2012).

• Water resource use and management is one critical SSI in the twenty-first century, sometimes referred to as the “Water Century”.

• Research has illustrated gaps in students’ knowledge of core hydrologic concepts (Forbes, Zangori, & Schwarz, 2015; Cowitt, Gunel, & Anderson, 2009; Halverson & Weiscoat, 2002) and epistemic dimensions of science (NOS; Lederman, 2007) across the K-12 continuum.

• To make decisions about how and by whom water should be utilized, individuals must confront the social, economic, legal, and political dimensions of water-based SSIs as well as their scientific dimensions.

• More work is needed to understand the structure of decision-making about SSIs, particularly among undergraduate students who will be tomorrow’s global citizens.

• To begin to address this gap in the literature, we investigate undergraduate students’ SSI decision-making, as well as how they leverage resources to make decisions about water-related SSIs.

SCIENCE LITERACY

• Leveraging contemporary perspectives in the field (e.g., Bybee, McCrae, Laurie, 2009; Feinstein, 2010; Rudolph, 2014) and work from decision science (Arvai, Campbell, Baird, & Rivers, 2004), we define science literacy as an enhanced capacity, both at the individual and collective levels, to make effective decisions grounded in STEM-informed analyses of complex, real-world challenges.

• Multi-criteria Decision Making (MCDM)

• Drawn from work from the decision sciences (Arvai et al., 2004) and the STEM education community (Halverson et al., 2009; Sadler & Zimmer, 2005).

• Involves weighing multiple options based on a complex set of interacting criteria.

• Accounts for how decisions about complex issues with many interrelated dimensions are made over periods of time.

R1 (overall decision)

Students completed an assignment focused on a water-based SSI: the use of groundwater from aquifers for agricultural irrigation.

(1) Write a one-sentence statement of what you value that is relevant to this issue. Explain how it is relevant.

(2) Using both your statement of value and the scientific information in the articles you’ve read or we’ve discussed in class, using both your statement of value and the scientific information in the articles you’ve read or we’ve discussed in class, using both your statement of value and the scientific information in the articles you’ve read or we’ve discussed in class, using both your statement of value and the scientific information in the articles you’ve read or we’ve discussed in class, using both your statement of value and the scientific information in the articles you’ve read or we’ve discussed in class, using both your statement of value and the scientific information in the articles you’ve read or we’ve discussed in class, using both your statement of value and the scientific information in the articles you’ve read or we’ve discussed in class.

(3) What would someone who disagrees with you say about whether or not we should restrict the amount of water used for agricultural irrigation in Nebraska?

(4) How would you address these arguments from someone who disagrees with you? Identify the best counter-argument.

Assignments scored with rubric designed for the project

• Each dimension scored on a four-point scale from 0-3.

• R1: decision students were asked to make regarding the issue of restricting the amount of water used for agricultural irrigation.

• R2: objective criteria students included for both correctness and relevance.

• R3: subjective criteria students included and focused on the degree to which they included reasoning to support their subjective statements.

• R4: consistency in the decision and support throughout all the assignment answers.

• 15 students participated in semi-structured interviews that focused on their content knowledge about water and their opinions and decision making about water resource management.

• Interviews coded with a priori codes: Making decisions, Forming opinions, Using/seeking out scientific information, Voting rationale

METHODS

• 201 primarily first-year undergraduate students

• Required, introductory course focused on local issues related to agriculture and the environment.

• Students completed an assignment focused on a water-based SSI: the use of groundwater from aquifers for agricultural irrigation

(1) Write a one-sentence statement of what you value that is relevant to this issue. Explain how it is relevant.

(2) Using both your statement of value and the scientific information in the articles you’ve read or we’ve discussed in class, answer the following question: What is your opinion about whether or not we should restrict the amount of water used for agricultural irrigation in our state? Why?

(3) What would someone who disagrees with you say about whether or not we should restrict the amount of water used for agricultural irrigation in Nebraska?

(4) How would you address these arguments from someone who disagrees with you? Identify the best counter-argument.

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FINDINGS

Research Question 1: What factors or resources do students use to make and support their decision about water-based SSIs?

• Students used resources from class to state and support their opinions, but did not use those resources when asked to make a decision regarding voting on that issue.

• When discussing their personal opinions, all students claimed that scientific information helped them form their opinions and many referenced readings from class.

• “I don’t think that we should restrict it a little bit, like cut back on a few areas in the state... There was one article... that talked about how the restrictions and stuff had even helped the aquifer come back or even raise a couple inches.” (Water Student GS Interview).

• When students were given a realistic voting scenario in which they were asked to make a decision about raising taxes to fund irrigation technology for farmers, they typically supported their decision with broad and vague claims.

• “I would vote for it. I think that our tax money would be going to a pretty good cause then. That seems like a dream come true with some more effective way of irrigating and it uses less water, so, yes I’ll go and vote for that.” (Water Student GS Interview)

Research Question 2: How do students who were able to engage more effectively in decision-making about water-based SSIs differ from those who engaged less effectively?

• Students with higher scores tended to state clear, explicit decisions and to incorporate support for their positions through their answers.

• “We should limit water usage to an amount that allows farmers to still remain profitable, but also allows the aquifer to be recharged in certain areas. This allows for the economic growth of the region, while providing a feasible way to ensure a water resource for future generations” (218_Water assignment).

• Students with lower scores tended to have much shorter answers and typically did not include as much, or any, support for their statements.

• “I don’t know if it is possible to restrict farmers from using a certain amount of water because they are ultimately going to take whatever they need to make money but they were restricted there would have to be strict rules and guidelines in place to enforce the farmers” (366_Water assignment).

Research Question 3: What factors or resources do students use to make and support their decision about water-based SSIs?

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IMPLICATIONS

• The study informs research on students’ understanding of core hydrologic concepts, epistemic dimensions of science, science literacy, and decision science. These scientific concepts, processes, and practices are an important foundation for post-secondary students to advance scientific literacy among citizens (NRC, 2012).

• Findings from this study contribute to the field by showing the aspects of decision-making students focus on and the resources they use to inform their decisions about water in real-world contexts.

• These findings have important implications for structuring interdisciplinary STEM learning environments across the PK-16 continuum that will effectively engage students in SSIs and in supporting them to incorporate rationale and evidence into the decisions they make both in the classroom and beyond.

• Findings from this research work provide important insight into undergraduate students’ development of scientific literacy and their engagement with decision-making about SSIs.