The Food-Energy-Water (FEW) Nexus: Using Hydroviz to Support Undergraduate Students' Learning about Complex Socio-Hydrologic Issues

Authors

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The Curricular Module and Hydroviz

- Three-week module (Figure 1) offered to undergraduate students from STEM and non-STEM majors in 2020 and 2021.
- Learning goals: (1) To describe the components and overall socio-economic and environmental importance of the FEW Nexus, (2) To examine real data about the different components of the FEW Nexus, and (3) to engage in evidence-based systematic decision-making challenges about the FEW Nexus.
- Students engaged with authentic data using Hydroviz, a data visualization tool, (Figure 2) to describe patterns of water, energy, and food production in a region. Then they apply this knowledge in a case.

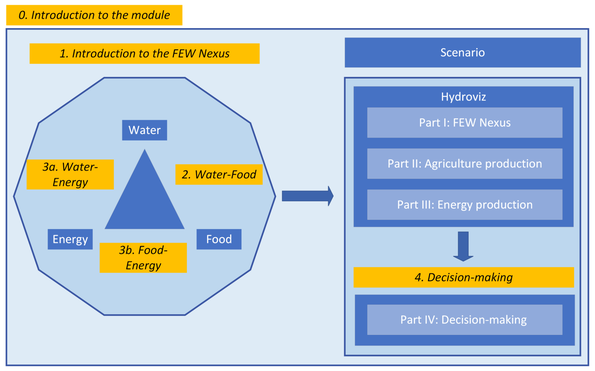

Figure 1: Curricular module: https://bit.ly/FEWmodule

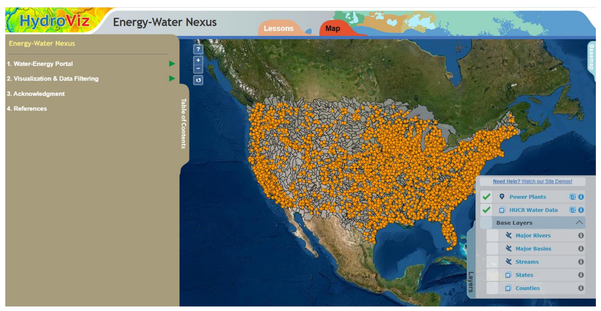

Figure 2: Hydroviz interface: https://bit.ly/hydroviz

- The decision-making outcomes were relatively high (mean ≈ 82%)
- Students may need support with the identification of all the components of the problem.
  - Students with higher scores better contextualized the problem in their region, describing the causes, consequences, and constraints of the need of a cleaner energy matrix.
- Students' systems thinking skills may help explain 36% of their decision making outcomes.
  - Students may need support to better describe the interactions between technical and conceptual components of information needs, unintended consequences and implementation challenges; and the importance of obtaining buy-in from the community.

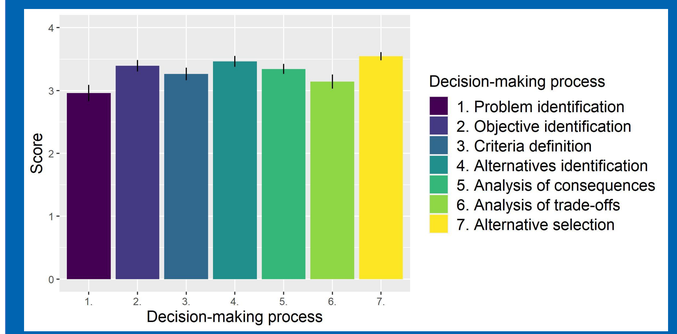

Figure 3: Decision-making components (mean and s.e.)

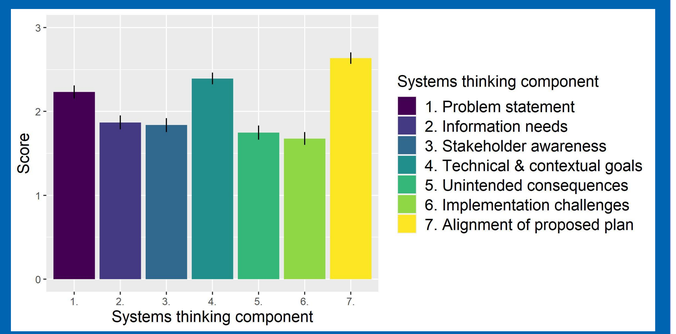

Figure 4: Systems thinking components (mean and s.e.)

Measure	*df*	*N*	X^2	*P value*
Decision-making (Figure 3)	6 Wilcoxon test*	99 (1.Problem identification < 7.Alternative selection)	26.85	.000
Systems thinking (Figure 4)	6 Wilcoxon test*	99	145.42	.000

	1	2	3	4	5	6
2	*	-	-	-	-	-
3	*		-	-	-	-
4		*	*	-	-	-
5	*			*	-	-
6	*			*		-
7	*	*	*		*	*

* Statistically-significant at p = .05

Table 1. Results from Friedman tests

Decision making outcome (M=23.11, SD=4.37, Max=28)

Systems thinking outcome (M=14.4, SD=3.42, Max=21)

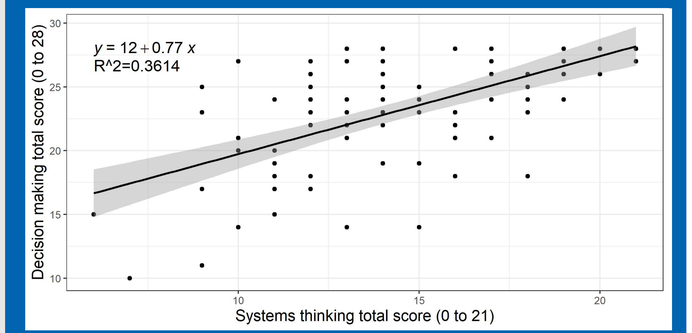

Figure 5: Influence of Systems thinking over Decision-making outcomes

Research Questions

- **RQ 1:** To what extent is a decision-making task supporting students' problem-solving outcomes about a FEW Nexus issue?
- **RQ 2:** What areas in the decision-making process were students able to engage in most effectively?
- **RQ 3:** To what extent do students' systems thinking skills support their overall problem-solving outcomes?
- **RQ 4:** In what ways do students' decision-making process with higher scores differ from students with lower scores?

Theoretical framework

- Multiple Criteria Decision Making:
  - Series of decision-making processes to address an issue (Figure 2).
- Systems thinking competency framework:
  - Problem solving considering:
    - Analysis of technical and contextual elements of the problem.
    - Perspectives from multiple stakeholders

Methods

- Student data from 2021 (*n=99)*
- Statistical analyses:
  - Descriptive statistics, Friedman tests, and Simple Linear Regression
- Review of interviews and students' tasks

Discussion

- The results from Hydroviz allowed students to gain critical understanding about the uses of water for agriculture and energy production, and the extent of their impacts in a selected region.

Resources

- Module: https://bit.ly/FEWmodule
- Hydroviz: https://bit.ly/hydroviz
- References: https://bit.ly/HvzRef
- Group studies: https://bit.ly/109Studies

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