Cultivating Systems Thinkers: Pedagogical Innovations in Global Food Production and Health

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Systems Thinking

The ability to conceptualize **complex problems** as intricate systems – **interconnected** set of elements organized in a way that achieves a **purpose**. (as a *worldview*)

A system of **synergistic analytic skills** used to improve the capability of identifying and understanding systems, predicting their behaviors, and devising modifications to produce desired effects. (as a *skill)*

1. Gaining insight – learning oriented
2. Using insight – action oriented

(Meadows, 2008; Arnold and Wade, 2017)

Conceptual Framework

Domain	Skill	Description
Content	Recognize systems	**"What is the system, What's inside it, and What's outside it?"**
Structure	Identify and classify relationships	**"How is the content of the system organized?"**
Behavior	Predict Future System Behavior (Emergent Properties)	**"How does the interaction produce existing or new behavior?"**
	Respond to changes over time (Leverage Points)	**"What can we do to change the behavior?"**
Mindset	Explore multiple perspectives	**"How do we approach systems and systemic problems?"**
	Consideration of Appropriate issues	

Arnold and Wade (2017)

Purpose of study

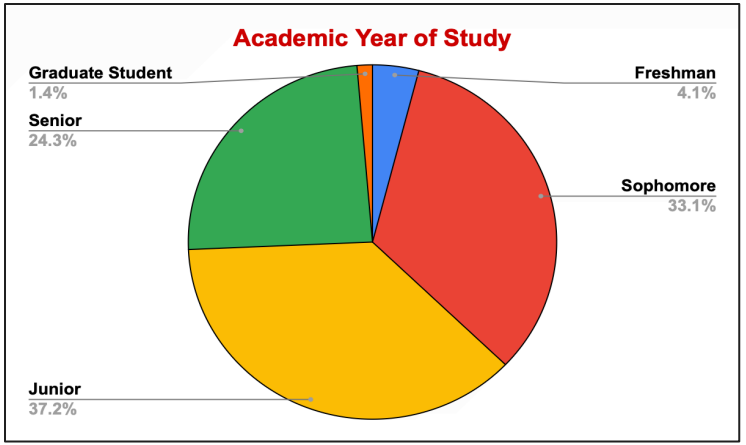
Explore the impact of **active learning pedagogical approaches** in fostering foundational Systems Thinking concepts.

Methodology

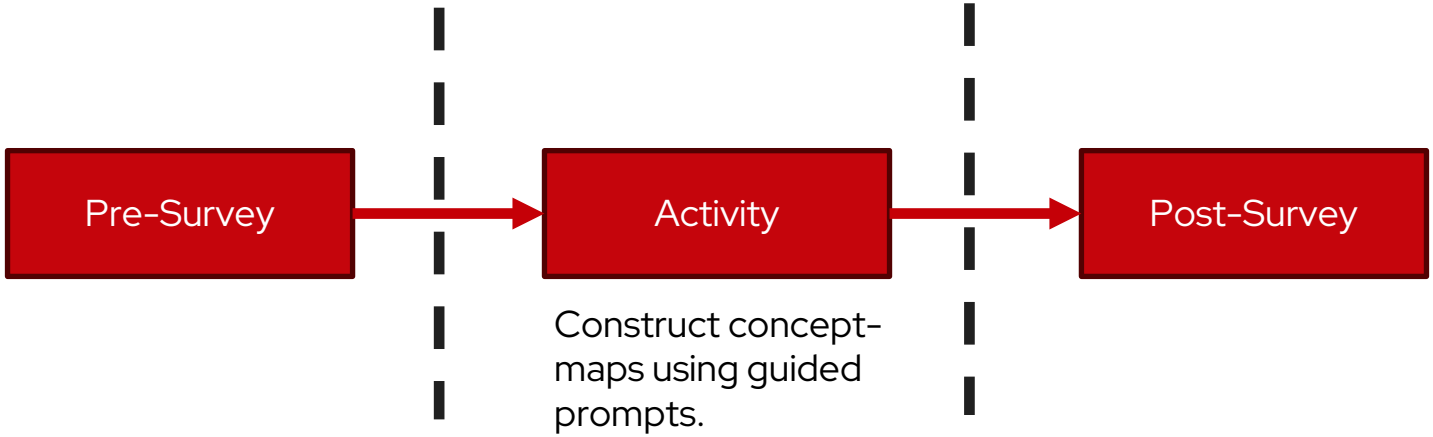
Global Food Production and Health

Introduction to crop biology, environmental requirements, and agronomic production practices of major food crops. Perform sustainability assessment across social, economic, and environmental dimensions of cropping systems (Systems Thinking as a pedagogical instrument).

- Spring 2024
- 3 credit (intermediate level course)
- Responses: 148 (70%)



Methodology (cont.)



Note: Survey consisted of Likert questions (6), slider questions (4), multiple choice question (2), and open-ended questions (2).

Methodology (cont.)

Dimension	Guiding Prompts
System configuration	Q1. Break the complex system into parts. Q2. Observe how the parts interact and decide if they are useful.
Feedback Loops	Q3. What parts are influencing each other in a circular way? a. Can you find loop(s) that amplifies change? b. Can you find loop(s) that stabilizes change?
Emergent Properties	Q4. Do you observe new patterns, behaviors, or properties emerging from these interactions as a whole?
Leverage Points	Q5. Which elements or connections have most influence on the overall system's behavior? Q6. What actions or changes can lead to long-term and short-term improvements?

Analysis

Pre-Survey

Post-Survey

Activity

Paired t-test to determine the difference in pre- and post- mean scores.

Rubric to assess concept-maps.

(Arnold & Wade, 2017; Khajeloo & Segal, 2022)

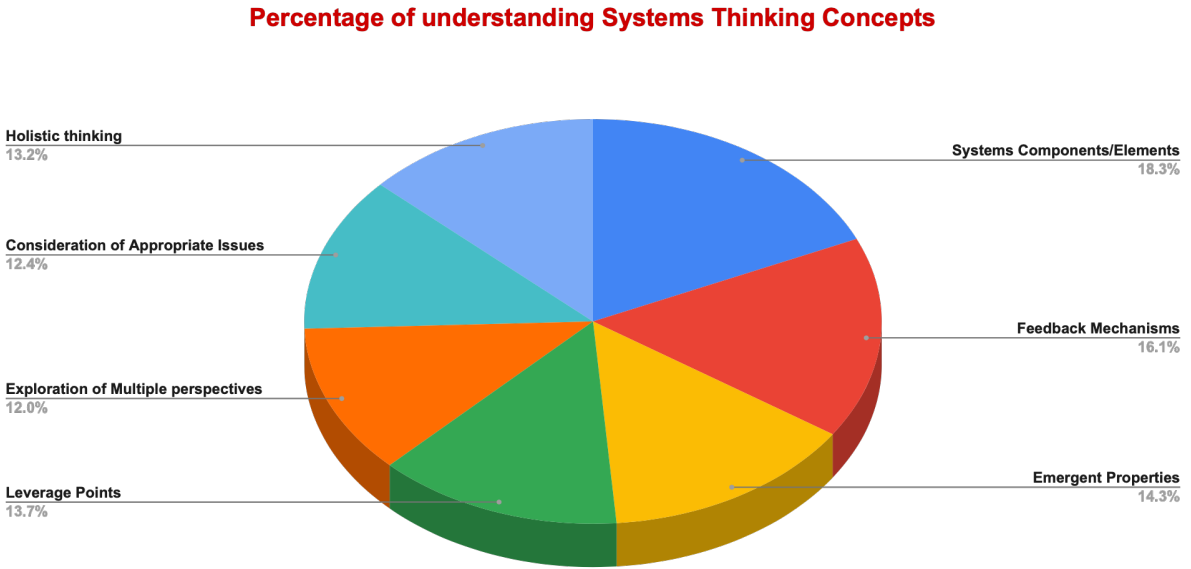
Analysis (cont.)

	Dimension	Criteria
1	Systems Configuration	Identifies of elements, relationships, and purpose of the system.
2	Feedback Mechanism	Identifies and explain feedback loops (positive, negative, and balancing) and their influence on system behavior.
3	Emergent Properties	Recognizes and describes properties or behaviors that evolve from interactions within system.
4	Leverage Points	Identifies intervention points within system where small changes can lead to significant impacts.
5	Exploration of Multiple Perspectives	Investigating into a complex problem from different perspectives and challenges existing conditions.
6	Consideration of Appropriate Issues	The ability to determine ‘essential’ and ‘relevant’ problems to the system context.
7	Holistic Thinking	Shifting perspectives on a micro- to macro-level (forest and trees).

(Arnold & Wade, 2017; Khajeloo & Segal, 2022)

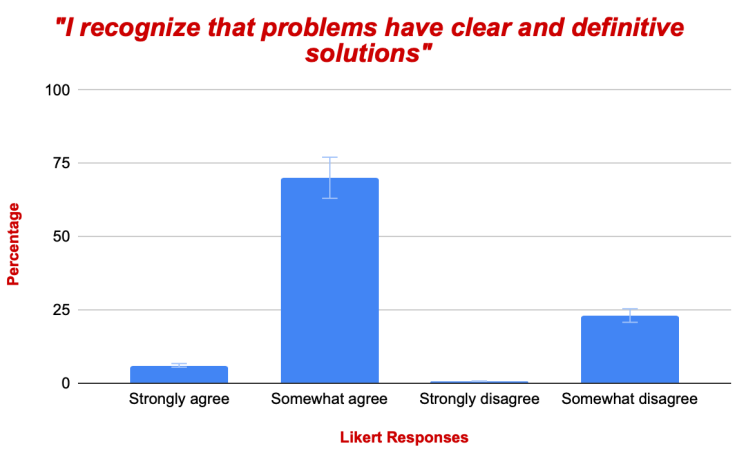
Findings

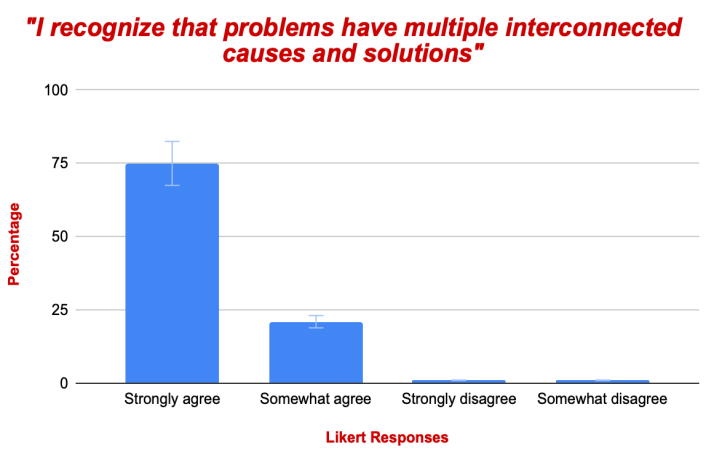
1. Concept-map analysis revealed that students demonstrated a moderate understanding of key Systems Thinking concepts, with an average score of **62%.**



Findings (cont.)

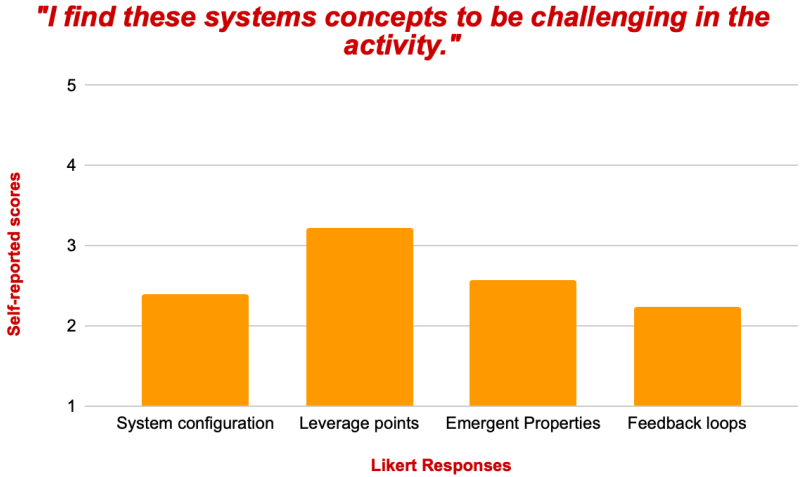
2. We found that concept-mapping had a **significant impact o**n participants' **perception of complex problems**.





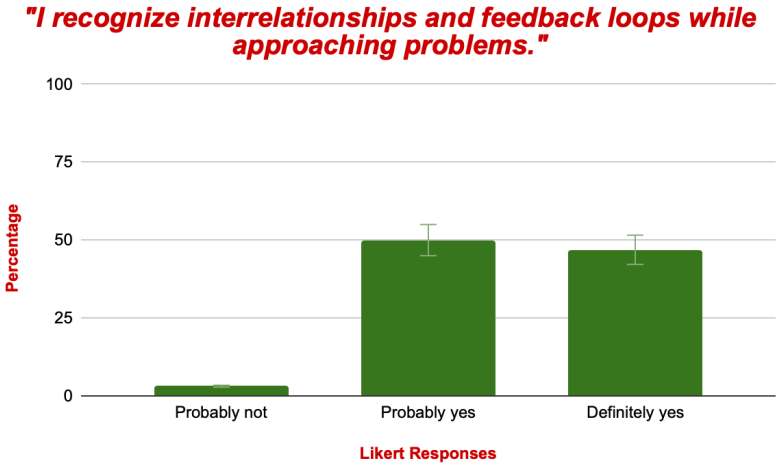
Findings (cont.)

3. Participants experienced **more challenges** in identifying **leverage points / interventions** inside the complex system.

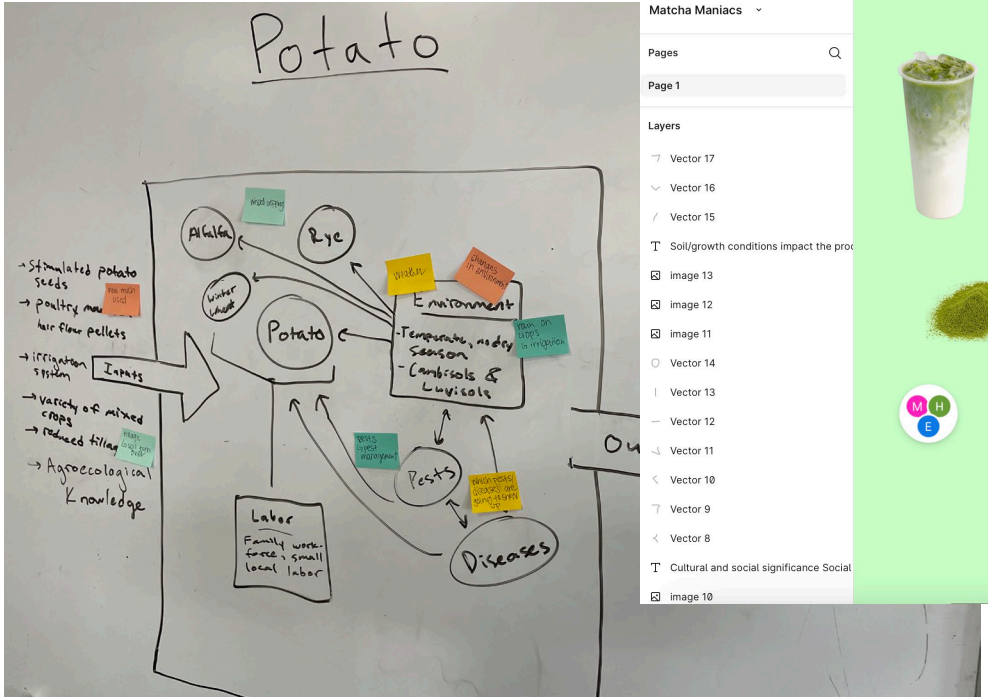


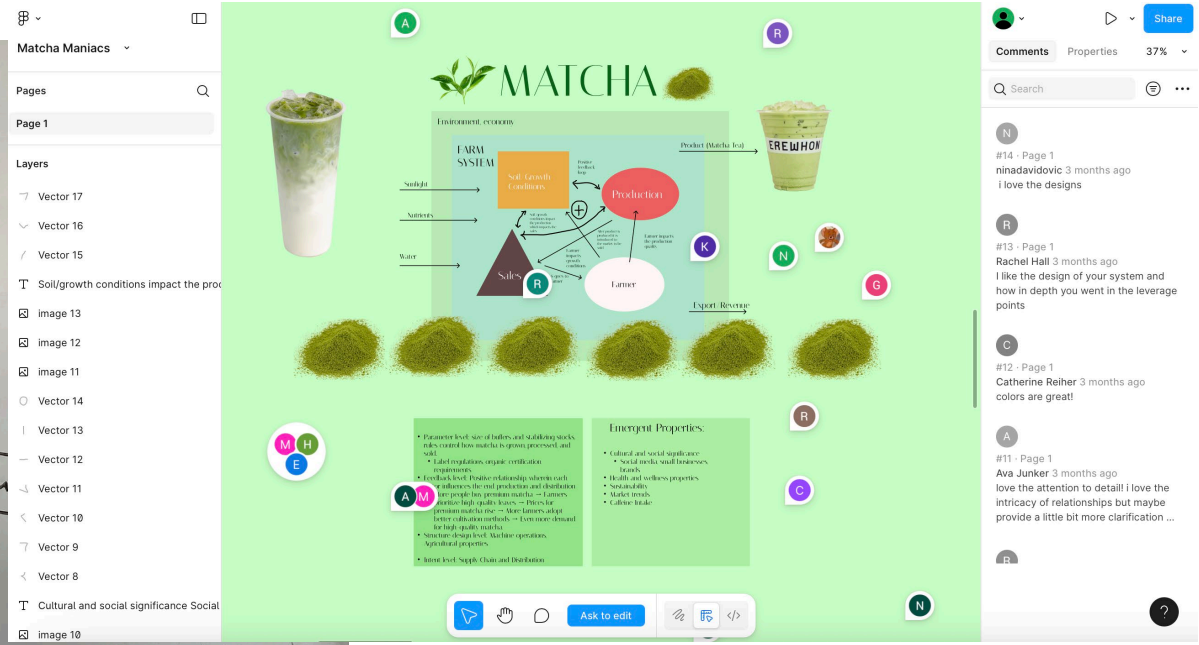
Findings (cont.)

4. Participants showed **increase** in consideration of **interrelationships and feedback loops** between various elements while approaching problems.



Visuals Artifacts





Conclusions and Implications

- Integration of Systems Thinking as a primary learning objective within the curriculum can foster systems mindset.
- Concept-mapping acted as an effective foundational pedagogical tool – significant impact on the visualization and representation of complex agroecosystems.
- Regular assessments are needed to measure systems thinking knowledge and application.

Future Directions

- Implementation of innovative pedagogical tools
  - FIGMA – Collaborative web-application for design
  - NetLogo – Simulation software
- Understanding the effectiveness of peer-feedback and reflection on learning and application systems thinking concepts.
- Fostering a real-time collaboration with systems thinkers within a Project-based learning environment.

References

Arnold, R. D., & Wade, J. P. (2017). A complete set of systems thinking skills. *Insight*, *20*(3), 9-17.

Khajeloo, M., & Siegel, M. A. (2022). Concept map as a tool to assess and enhance students' system thinking skills. *Instructional Science*, *50*(4), 571-597.

Meadows, D. H. (2008). *Thinking in systems: A primer*. chelsea green publishing.

THANK YOU!

QUESTIONS