Industry Driven Integrated STEM and Systems Approach to Innovative Incubation

Corresponding Author Name: Hui-Hui Wang, Purdue University, 915 W. State Street, Lilly Hall, 3-223, West Lafayette, IN, 47907, 765-494-6897. Email: huiwang@purdue.edu

Co-Author Name: Bryanna J. Nelson, Purdue University, 915 W. State Street, Lilly Hall, 3-223, West Lafayette, IN, 47907, 765-494-6897. Email: nelso421@purdue.edu

Co-Author Name: Neil A. Knobloch, Purdue University, 915 W. State Street, Lilly Hall, 3-232, West Lafayette, IN, 47907 765-494-8439. Email: nknobloc@purdue.edu

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Introduction/Need for Strategy

Agricultural grand challenges are "intertwined with other disciplines in the natural and social science" (National Research Council, 2009a, p. 4); to solve the grand challenges facing agriculture, interdisciplinary collaboration is inevitable. The National Science and Technology Council (2018) states, "the best science, technology, engineering, and mathematics (STEM) education provides an interdisciplinary approach to learning, where rigorous academic concepts are coupled with real-world applications and students use STEM in contexts that make connections between school, community, work, and the wider world" (p. 1). Integrated STEM (iSTEM) teaching approaches attempt to mirror solving a real-world problem in a complex designed system and help students make sense out of the fragmented and departmentalized knowledge that is typically taught in disciplinary silos.

The **IN**dustry-dri**V**en **I**ntegrated STEM and **S**ystems Approach to **I**nnovative Incubati**ON** (IN-VISION) project, was uniquely positioned to advance knowledge about teaching and learning in iSTEM that uses agro-ecosystem thinking situated in agricultural design challenges to develop and practice data-based decision making. The IN-VISION project aimed to provide a meaningful and supportive context in which students can contextualize STEM in their own lives and the lives of others, see the interdisciplinary connections, navigate the deluge of scientific data that is available, and learn through authentic communication of their understandings. It was a direct response to calls for the demand for talents to fill the U.S. STEM and agriculture, food, and nature resources (AFNR) pipeline (USDA, 2015).

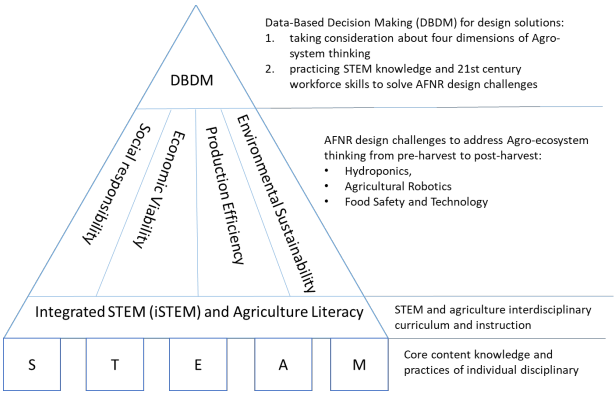
Connection to Literature

The project was guided by literature in K-12 STEM curriculum and instruction, citing it's urgent need for transformation (USDA, 2015; U.S. Department of Education, Office of Innovation and Improvement, 2016). This includes work in iSTEM education, or integrated STEM education, which works to bring real-world, authentic problems to the classroom to connect school learning with personal lives and future work (Bryan et al., 2016; Mahoney, 2010; NRC, 2014; Wang & Knobloch, 2018).

How It Works & Implementation of Strategy

The IN-VISION project used the conceptual model (Figure 1) to structure a year long Incubation Design Challenges (IDC). Through involving a holistic experience of IDCs, the participants, in-service high school STEM and agriculture teachers, participated in: (1) a one-week immersive learning experience and face-to-face summer professional development (PD); (2) small learning community (SLC) meetings to design iSTEM and AFNR educational materials that is solidly grounded in Agro-ecosystem thinking; (3) interaction with scientists; and, (4) the student award event, to provide students a comprehensive iSTEM through AFNR learning environment.

In each high school, 3-4 STEM and agriculture teachers, form a team to participate in the project for three years. IDCs are driven by solving a complex food system problem that is facilitated by scientists and industry partners to develop high school students' workforce STEM outcomes. For



example, the hydroponics IDC includes (1) Designing a hydroponics system, 2) Scientific experiment with the hydroponics system using sensors, 3) Sustainability challenge--food waste study with the school's cafeteria, and 4) Sustainability challenge--design sustainable and safe food product. Students worked in teams to complete the IDCs and present their project at the end of year IN-VISION project period.

Figure 1. Conceptual Model of IN-VISION project

To introduce teachers to general integrated STEM teaching approaches and the IDC's, a summer professional development was held. The focus was to provide teachers with the time and tools needed for their integrated lessons like STEM and AFNR integration, context in culture, community and careers, models of STEM integration and agroecosystem thinking, and assessment. In the summer PD, teachers also had the opportunity to interact with the scientists and ask them field specific questions, relevant to implementing their IDC.

Results to Date/Implications/Impact

There were six high schools and 15 teachers from the midwestern region of the United States that participated in the project in 2021. The participants taught a variety of subjects including science, agriculture, math, and technology. In response to the COVID-19 pandemic, the summer professional development events were transitioned to an at-home, online learning environment using recorded videos and Google Classroom. The event was divided into two parts, an asynchronous session and two synchronous sessions. Participants completed six modules, including videos and assignments, about general integrated STEM teaching approaches, and three modules from scientists to describe the food systems design challenges in June and July. The synchronous session was structured as two, half-day trainings that focused on helping teachers co-develop their integrated STEM through AFNR lessons and implement the lessons to help their students to complete the IDC and present their projects. Oval the post evaluation result showed that the teachers enjoyed the hybrid training format. Their comments included flexibility and opportunities to revisit the content if they did not understand the first time. They also mentioned short and separate day professional development program was better than intensive professional development program. They also enjoyed the teamwork time that was structured at the training.

Future Plans/Advice to Others

We will develop a IN-VISION website to upload all the online professional development materials in late summer 2021, and public will have access to them. Based on the data that we collected in 2021, we might consider both hybrid training in the future. COVID-19 created some challenges for our project, and we took a different approach to structure the professional development. Implications for future teacher professional development will be shared.

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