Using the EOP Framework to Develop and Integrate "Sustainable Engineering Stories" for Science Teacher Education

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Introduction

- K-12 science reform emphasizes the integration of authentic, real-world engineering ideas and practices. However, teachers are often unfamiliar with engineering (e.g., Pleasants, 2022; Radloff et al., 2023).

- We employed the EOP Framework at two universities to create a set of **Sustainable Engineering Stories** to illustrate *how* and *why* sustainable engineers do their work.

- Stories were integrated into our **science pedagogy courses** to expand preservice teachers' (PSTs') knowledge of sustainable engineering, focusing on **environmental literacy, responsible business and economy, and social responsibility** as they connect **to environmental science.**

Sustainable Engineering Stories

- In the summer of 2024, sustainable engineers were recruited for interviews about **who they are, what they do, and why they do it** (see QR code below for full protocol).

- Transcribed interviews were used to create **Sustainable Engineering Stories** (n = 8) or short profiles introducing PSTs to engineering with open-ended reflection questions.

- These stories were used as entry points into K-12 engineering and environmental science within the pedagogy courses focusing on **social responsibility, environmental literacy, and responsible business and economy** (see QR code for complete stories).

Story Topics and Profiles

- Lori - Nature-Based Ag Solutions
- Terri – Air Quality Evaluation
- Reza – Forever Chemical Reduction
- Katelyn – Airplane Life Cycle Analysis
- James – Justice-focused Engineering
- Crista – Sustainable Construction
- Nick - Natural Area Restoration
- Ian – Geotechnical Solutions

ENVIRONMENTAL LITERACY

Knowledge & Understanding

The EOP Framework

RESPONSIBLE BUSINESS & ECONOMY

SOCIAL RESPONSIBILITY

Interview Protocol   Complete Stories

Methods

Story Creation: Engineers were recruited and interviewed. Transcribed interviews were used to create the Stories that were member-checked by engineers.

Integration: Science methods curricula were appraised using the EOP framework for entry points aligned with already-existing engineering design tasks whenever possible.

Survey Creation: A **'Sustainability Survey'** was created and employed at the beginning and end of the semester with an already-published **Scope of Engineering Survey** (Pleasants, 2022).

Evaluation: **Individual survey responses, group story-specific questions, and course reflections** were collected and analyzed using open coding and descriptive statistics (Creswell & Creswell, 2017).

Progress and Plan for Scaling Up

Fall 2024: Piloting Stories & New Learning Activities
- Stories were implemented in three elementary preservice teacher science methods courses (one at OU, two at SUNY Cortland) with all enrolled. Evaluation data were gathered from students who completed all activities (n = 44).
- Participants were primarily White (84%) and Female (97%), reflecting teacher education trends (Banilower et al., 2018).
- 76% had no prior engineering learning experiences, and only 26% knew an engineering personally (family or friend).

Findings
- Students indicated a strong interest in addressing sustainability both **before and after** the course.
- Perceived challenges to incorporating sustainability into their teaching shifted from **limited knowledge & experiences** beforehand to **support and time to do so** afterward.
- Definitions of sustainability appeared to move from **more general to informed,** and self-efficacy for teaching engineering increased **significantly**.

How strongly do you agree with each statement (from 1-5)?	PRE Mean (SD)	POST Mean (SD)	p
I value sustainability as a goal in my personal life	3.57 (0.90)	4.09 (0.80)	.00*
It is important for society as a whole to pursue sustainability	4.50 (0.70)	4.66 (0.61)	.07
It is important for students to learn about sustainability in school	4.61 (0.58)	4.77 (0.57)	.03*
Sustainability concepts should be included in the school curriculum	4.34 (0.83)	4.66 (0.61)	.01*
Students should learn about sustainability at all grade levels	4.32 (0.83)	4.64 (0.65)	.01*
Sustainability should be a central theme in science instruction	3.98 (0.95)	4.48 (0.76)	.00*

How does this fit with your view of sustainability (from 1-5)?	PRE Mean (SD)	POST Mean (SD)	p
Acting in socially responsible ways	3.93 (0.95)	4.23 (0.94)	.04*
Supporting responsible business practices	3.95 (0.86)	4.20 (0.82)	.10
Promoting citizens' environmental literacy	4.02 (1.00)	4.36 (0.78)	.02*
Ensuring that humans recycle and reuse materials	4.30 (0.95)	4.59 (0.62)	.01*
Preventing climate change	4.11 (1.02)	4.30 (0.85)	.24
Limiting the growth of the human population	2.93 (1.10)	3.18 (1.17)	.15
Promoting economic equality	3.68 (0.93)	4.05 (0.89)	.02*
Considering the needs of future generations	4.41 (0.79)	4.64 (0.61)	.14
Using renewable energy sources	4.30 (0.95)	4.57 (0.79)	.03*
Limiting human consumption of resources	4.32 (0.86)	4.45 (0.82)	.20
Reducing pollution and waste	4.43 (0.85)	4.59 (0.69)	.16
Encouraging organic farming practices	4.18 (0.81)	4.36 (0.89)	.10

Spring 2025: Scaling Up
In the spring semester, we plan to:
- Implement Stories across additional sections of the methods courses (n = 4)
- Conduct more formal data collection and analysis efforts (e.g., validating surveys; analyzing NOE surveys, Story responses)
- Develop engineering tasks aligned with the stories

Evaluation and Impact

- Findings suggest the Stories **offered practical pedagogical tools** for engaging future teachers with sustainable engineering.
- Trends **support similar literature** (Pleasants, 2021, 2022) and expand upon it to emphasize sustainable engineering and related foci.
- Results **revealed discrete areas** for exploration and scaling up.

Example Reflection Responses:

Engineering stories help me understand what it means to be an engineer - behind the scenes. I learned that engineering isn't just about technical skills or solving problems; it is creative, collaborative, and makes real-world impacts. (Kelly)

I found it interesting when we read stories of real-life sustainable engineers and how they execute their work. This is something I would love to do in my class to show examples of how engineering may work. (Paula)

I really enjoyed the Stories because we not only understood the outcome of their projects, but we got the "why" behind them, and it helped me better connect to STEM. (Connie)

Engineering stories and the hands-on lessons really changed my views on what science teaching can look like and how fun and engaging it can be! (Haley)

References

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