Examining the Development of Team Scientists: Experiences in an Interdisciplinary STEM Ph.D. Program

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Overview

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Purpose of Inquiry

- Scientific research necessitates collaboration (Stokols et al., 2008, Andersen, 2016; Sachmpazidi et al., 2021)
- STEM research is increasingly team-based (Anderdsen, 2016; Andersen & Wagenknecht, 2013)
- Students are often trained in mono-disciplinary contexts
- Data source: using data from NRT-HDR: Convergent Graduate Training and EmPOWERment for a Sustainable Energy Future (EmPOWERment) project

Literature Review

Interdisciplinary Teamwork in STEM

Benefits

- Developing skills in communication, leadership, and problem-solving (Sachmpazidi et al, 2018)
- Fostering a culture of community (Burt et al., 2022)

Shortcomings

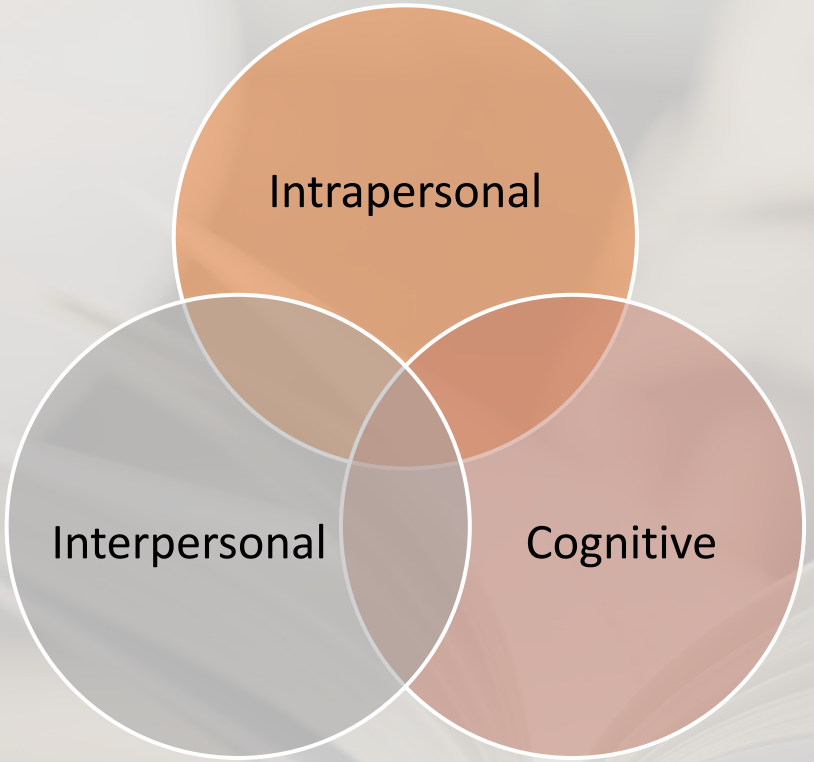
- Students lack explicit instruction on how to become effective team members (Wilson et al.,2018)
- It's not clear what makes an effective team (Sachmpazidi et al., 2021)

Team Scientist Identity Development

- Interdisciplinary training increases students' scientific skills (Wilson et al, 2018)
- Building a shared identity improves team members' collaborative work ecology (Stokols et al., 2008)
- Researchers have not created effective interventions to foster shared identities (Dehart 2017)

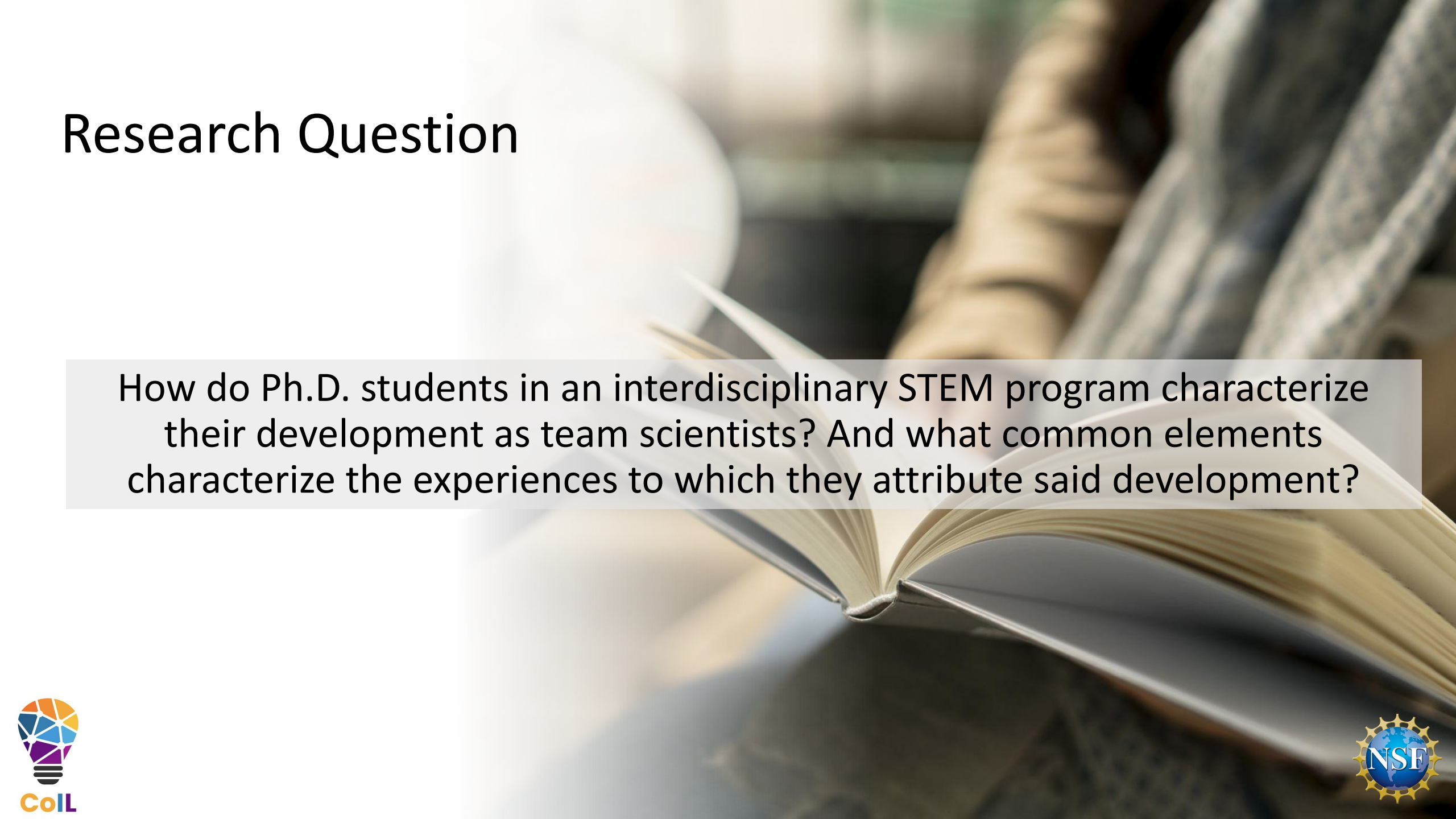
Conceptual Framework

Drawing on **Kegan's** (2018) lines of development



Students' perspectives and developmental experiences as team scientists in an interdisciplinary STEM Ph.D. program

Research Question



How do Ph.D. students in an interdisciplinary STEM program characterize their development as team scientists? And what common elements characterize the experiences to which they attribute said development?

CoIL

NSF

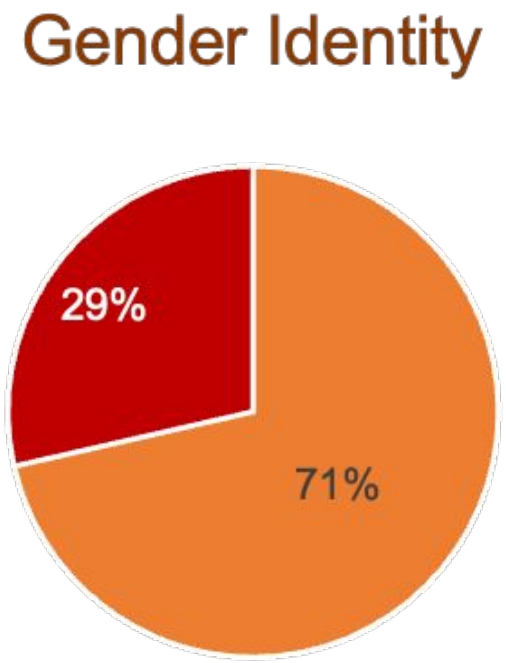
Research Method

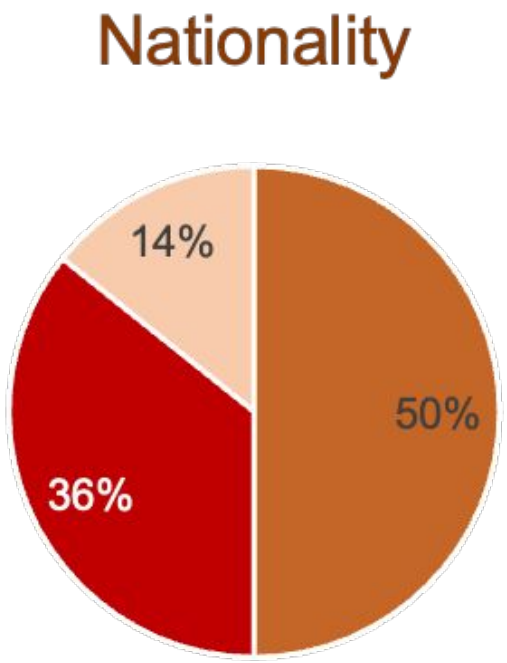
- Intrinsic, embedded case study (Stake, 2005)
- Data collected from 2020-2023
- 14 graduate students who participated in individual interview and focus group discussions.

Participants

Name	Cohort Year	Name	Cohort Year
Adam	Cohort 2	Golden Eagle	Cohort 3
Anne	Cohort 1	Heather	Cohort 1
Carly	Cohort 3	John	Cohort 2
Charles	Cohort 2	Jory	Cohort 1
Dominic	Cohort 1	Lily	Cohort 2
Emmanuel	Cohort 3	Michael	Cohort 3
Gary	Cohort 1	Ronald	Cohort 1

Demographic Data





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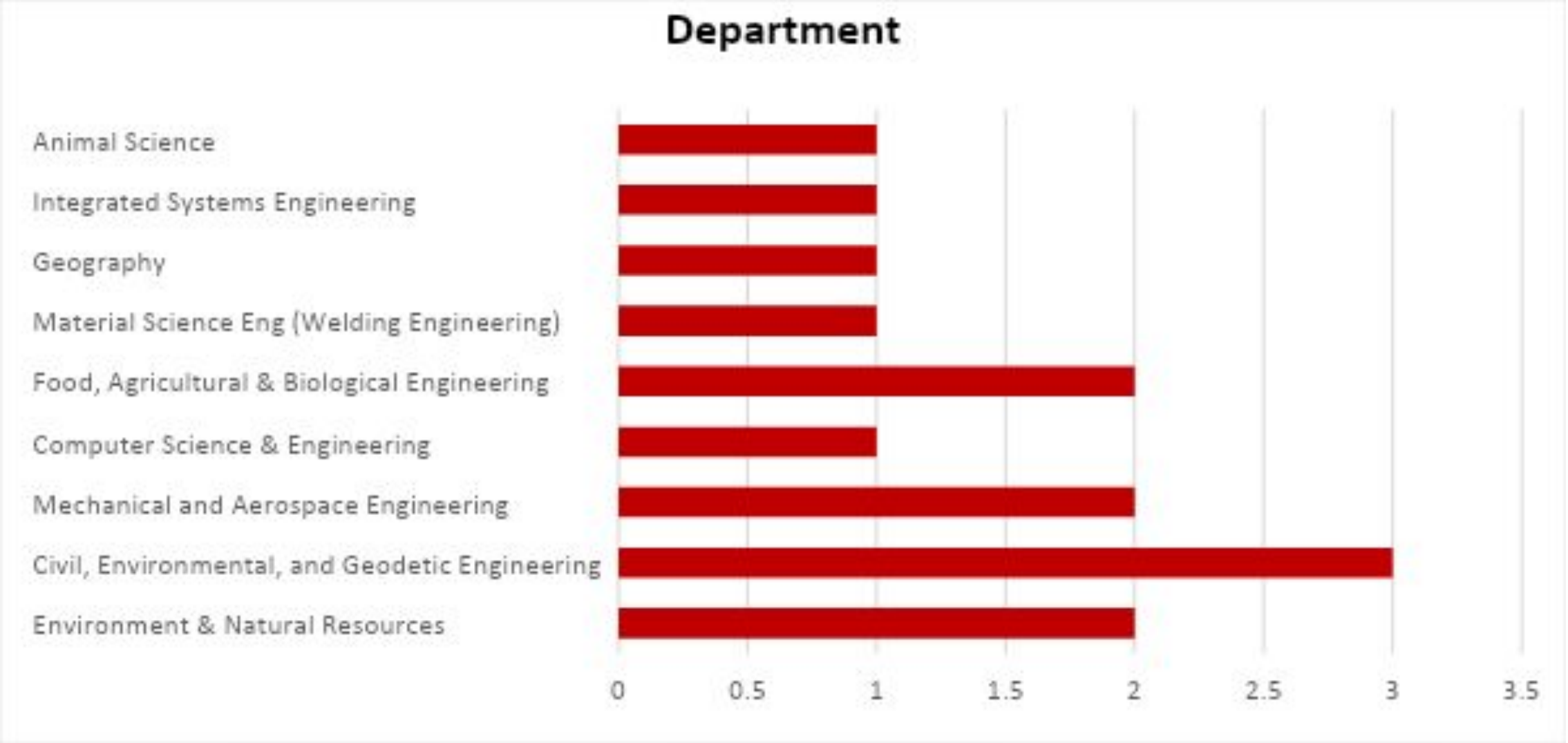


Cognitive

Changes to perceptions of problems
Changes to perceptions of scientific process
Changes to thinking about how team science works
Changes to how you approach/solve problems
Other examples of self-authorship stimulated by or relating to team science work

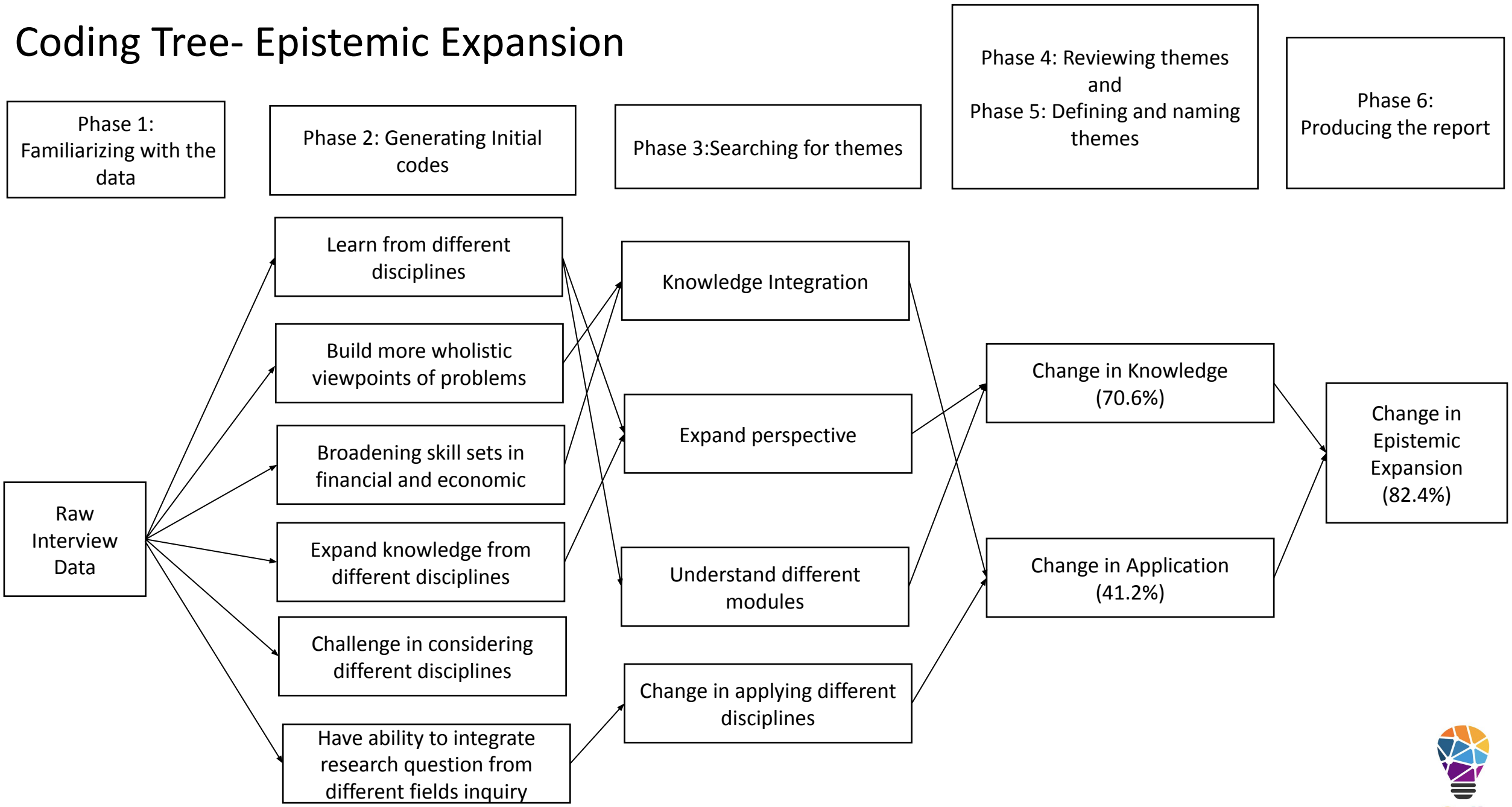
Interpersonal

Changes to how you perceive others due to team science experiences
Changes to how you relate to others
Changes to how you value others or conceive of team/work structures
Changes to sense of belonging or not belonging in various communities
Changes to how you communicate with others
Changes to how you conceptualize different communities/groups

Intrapersonal

Changes to how you view your identity
Changes to how you view your competence/self-efficacy
Changes to your motivations
Changes to your desired end-state as a scientist/other
Other realizations regarding the self caused by team science experiences

Coding Tree- Epistemic Expansion



Memo

Top-level Codes	Description
Epistemic Expansion	The process of trainees expanding their knowledge, perspectives, and expertise across different disciplines/areas of study. It requires a deep understanding of diverse fields, integrating this knowledge, and applying it to research within a team science environment.

Memo

Top-level Codes	Description
Collaboration Development	The deliberate and ongoing process of fostering effective teamwork and collaboration among scientists and researchers from diverse disciplines who come together to address complex problems or research questions. In this context, collaboration development involves effective communication, shared goals, and interdisciplinary strategies.

Epistemic Expansion: From Fragmented Knowledge to Integrated Knowledge

Jory

"I think I have learned most [is that] sometimes **the technical difficulty is the least.** And **the hardest barriers are from people [and] from policy**…and sometimes in a very limited time, you cannot bring up a proposal perfectly. So you'll need to do it very quickly, even if it is not perfect. But it is very good, it is enough, because the time is limited. So it is very bad if you always want to do everything 100%. And finally, you can finish. So that's the most the least thing you want to see."

Jory's perspective highlighted some essential insights into problem-solving. He shows the way that he integrated his discipline with other fields.

Carly

Some business models stuff and optimization, like modeling, that would apply. I thought that was interesting. It was like towards the end of [foundation course] last semester, that was really useful to know. And I feel like that could **apply to like a wide range of engineering disciplines. And, like, marine economics, and policy is always useful to know for any field**.

Carly experienced epistemic expansion through exposure to business models, optimization, and modeling concepts during a foundation course.

Collaboration: From Uncertainty to Confidence

Lily:

“I am engineers so [the way]I think it's just like an engineering so actually like I always thought I couldn’t express **I couldn't communicate with…people without engineering background** … [Yet] empowerment program **as I learned** a lot of things like the engineer needs to learn and need **to think about how to communicate… non tech knowledge to [an] audience** seems like that, so I think it's helps a lot.”

Heather:

"**Working on a team with economics majors, business majors, and things like that has been very useful** because they think about things much differently than I do. So I think it was very useful to learn how to both work with people like that, as well as trying to make a product or a presentation."

Heather's perspective underscored the value of working in diverse teams and considering different perspectives.

Dominic

“In my case, I think the most important thing in the interdisciplinary, like **interaction is maybe improved my collaboration and communication skills with other fields**. And sometimes having that glimpse of knowledge from other fields has been also available in the program. So that's positive.”

Dominic mentioned improved collaboration and communication skills as a result of interacting with individuals from other fields.

Professional Development: Shifting identity

Charles:

Two years ago I'd expected to **spend the rest of my life in a lab** basically doing experiments, but now, after some of the exposure, **I think I would like to work in like an interdisciplinary team, or maybe a policy space**. So definitely changed a little bit.

Charles' career paths are not fixed and can change based on experiences, exposure, and evolving interests.

Golden Eagle:

I've kind of figured that all out, but I think it's definitely been like a really good exposure for or finding out what I think is the most useful place to spend my time. I think **prior to this, I kind of had some maybe naive ideas about how the whole energy system operated**. And I think **I'm kind of more in tune with some of the realities and practicalities** of, of where it's useful to really kind of spend time.

Golden Eagle expresses a process of learning, self-discovery, and a shift in perspective regarding his understanding of the energy system.

Recommendations

Higher education institutions should

- Incorporate communication and collaboration training within interdisciplinary education to help students overcome uncertainty.
- Recognize the intrapersonal growth and career transitions that individuals may undergo as a result of interdisciplinary learning.
- Practitioners and faculty should support and guide trainees as they navigate these changes.

Implications

- Building a team scientist identity model
- Inform the development of curricula in interdisciplinary programs
- Provide insights for mentors to support STEM students
- Guide future interventions for interdisciplinary training

College Impact Laboratory

Scan the QR code to get a copy of our references and contact information.

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Concluding Questions

- How can we make the hidden curriculum of team science more explicit?
- How can we better generate community and sense of belonging across scientists with diverse and deeply-held perspectives?

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