Innovative Solutions to Persistent Challenges

October 15, 2026

Caselet: Case-based Approach for Developing Data Science Problem-Solving Competency

Presenter: Lujie Karen Chen
Associate Professor, Department of Information Systems
University of Maryland, Baltimore County (UMBC)

IGE PI Meeting 2026

Collaborators: Shimei Pan (UMBC); Roger Azevedo (University of Central Florida)

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Graduate Education Challenge: Data Science Problem Solving

Component Knowledge/Skills



E.g. Knowledge of Logistic Regression and skills of writing code

Caselet

Specialized Skill to "assemble" the components

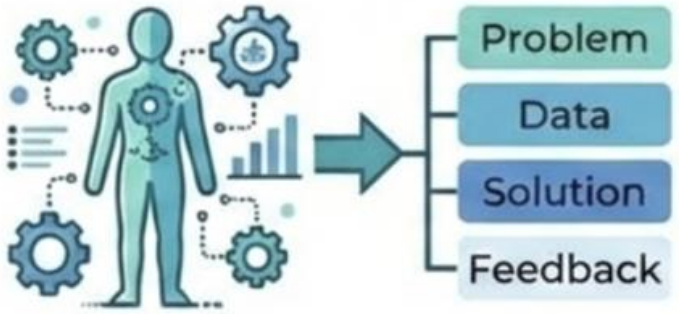
Becoming more valuable in era of Gen AI

Real-world Problem Solving



E.g. Build a model to predict customer churn

Talk Outline



The anatomy of a Caselet



Results from Pilot Study with Caselets



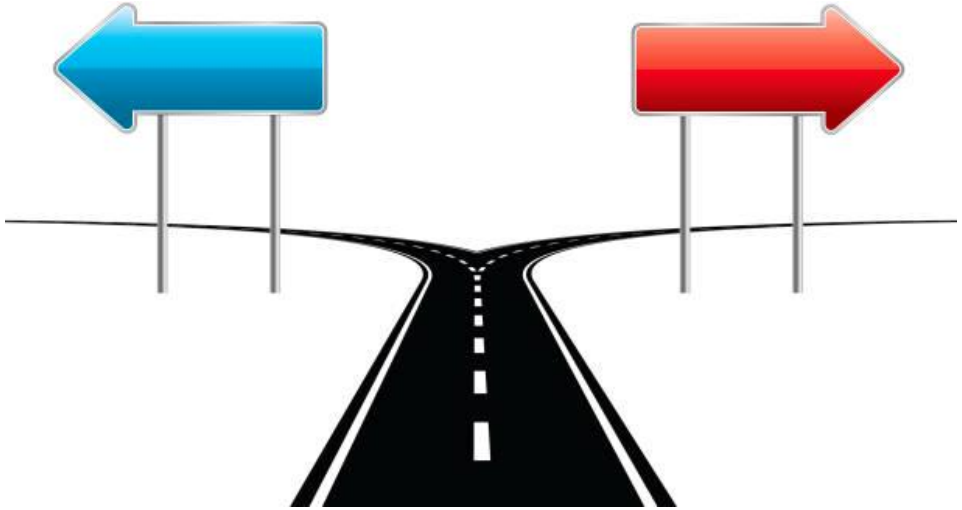
Reflections and future work

Caselet is …

Bite-size Case Study



Highlight Critical Decision-points



Caselet is Comprised of …

Note: Caselet is decoupled from coding

Problem Context

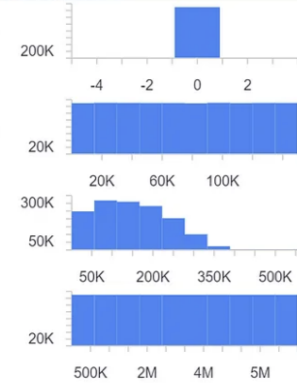


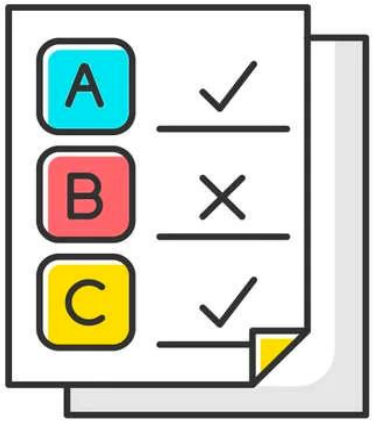
Data Summary

Numeric Features (4)

	count	missing	mean	std dev	zeros	min	median	max	custom
o_shippriority	1.50M	0%	0	0	100%	0	0	0	data type: Number
o_custkey	1.50M	0%	75.0k	43.3k	0%	1	75.0k	150k	data type: Number
o_totalprice	1.50M	0%	151k	88.6k	0%	857.71	144k	555k	data type: Number
o_orderkey	1.50M	0%	3.00M	1.73M	0%	1	3.00M	6.00M	data type: Number

Chart to show: Standard; log; expand





5-7 Multiple Choice Questions



Immediate Feedback



Adaptive Explanation

Example Caselet

Example Caselet

Caselet: Predicting Student Dropout Risk

Problem Context. You are a data analyst working with the Office of Student Success at a mid-sized university. The university is concerned about rising dropout rates, especially among first-year students. They have collected historical data over the past five academic years, including demographics, academic performance, and engagement metrics.

Data Profile. The data includes 15,000 student records with the following attributes including Demographics, Academic Performance, Engagement, Financial, and Dropout status (biarny; 0=retained, 1= dropped out).

Sample Question (Mapped to Problem Formulation KC).

Which of the following best describes a suitable *technical* problem formulation?

A) Build a regression model

B) Cluster students based on engagement patterns to discover new personas.

C) *Build a classification model*

D) Calculate the average GPA of students who dropped out vs. those stayed.

Correct Answer: C

Explanation. Option C correctly translates the institutional goal into a supervised machine learning task—binary classification—well aligned with the objective of identifying students at risk of dropping out.

Caselet is Grounded in Learning Science Principles

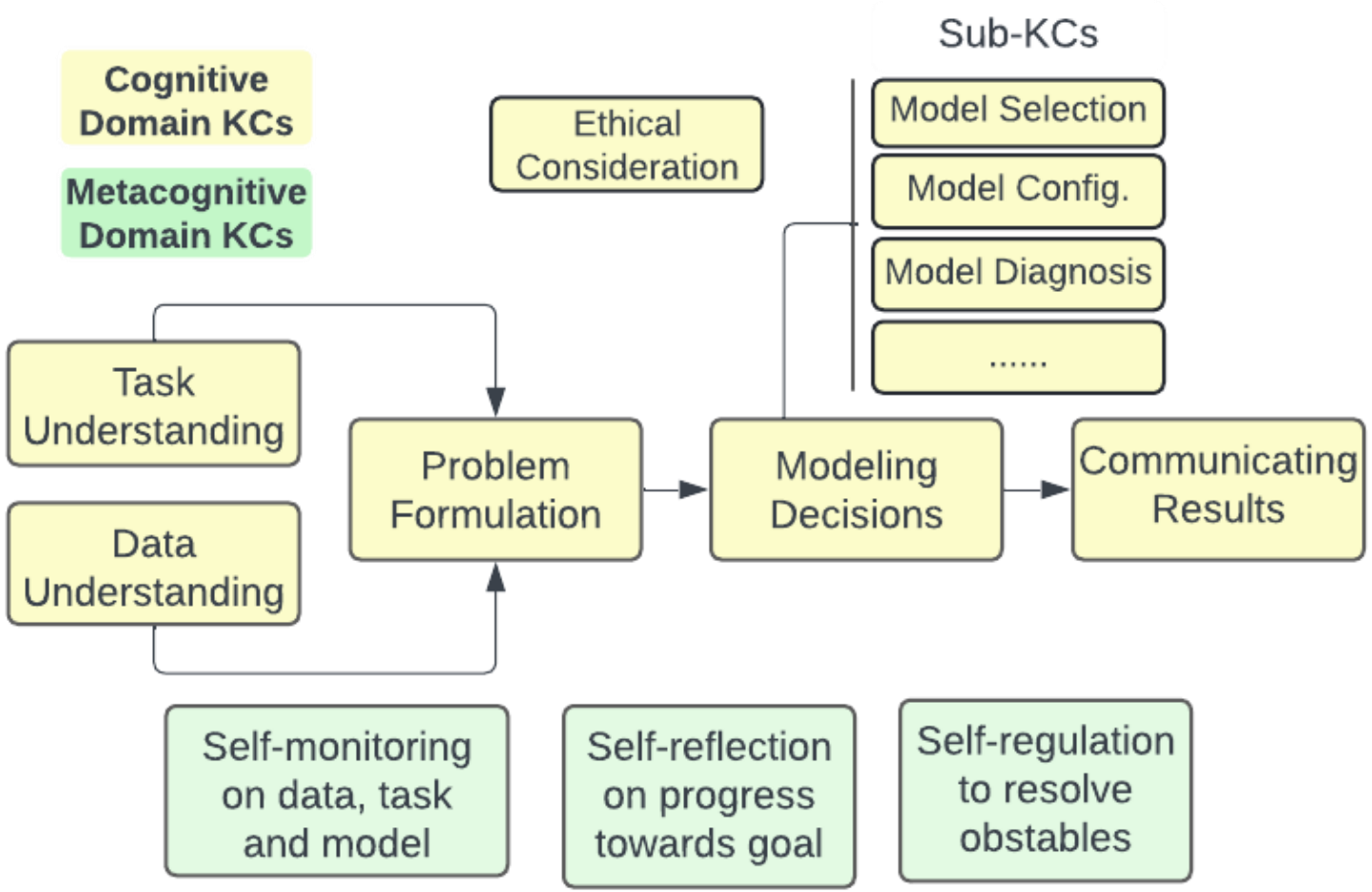
1. Deliberate Practice [Ericsson] on *using* component skills to solve problems

1. Cognitive Flexibility [Spiro et al] using Varied contexts and authentic scenarios to encourage skill transfer

1. Learning-by-doing with feedback and explanation for effective and equitable apprenticeship at scale

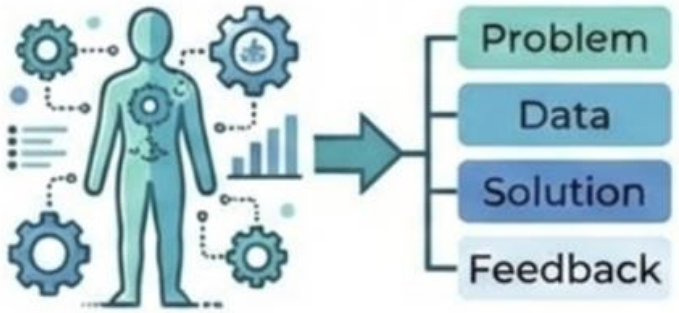
1. Metacognition and self-regulated learning

Data Science Problem Solving Knowledge Components Covered in Caselets



A draft white paper is here

Talk Outline



The anatomy of a Caselet



Results from Pilot Study with Caselets



Reflections and future work

Pilot Overview

- Caselet has been piloted
  - 14 cohorts of graduate students (N= 273)
  - 2 graduate programs
    - MS Information Systems and MPS Data Science
  - 8 instructors
  - 2 different course contexts with various integration strategy
- Institution/program supports are essential!

Course Context and Caselet Integration - Course #1

- Course Context
  - Graduate level method-focused data science course
  - Typical enrollment 20-30 students
- Caselet Integration
  - Carefully scheduled to be aligned with the method covered
  - As take-home assignment

Course Context and Caselet Integration - Course #2

- Course Context
  - Graduate level capstone project course
  - Students have completed multiple method courses
  - Typical enrollment 10-15 students
- Caselet Integration
  - Caselets were used as take-home assignments
  - Instructor-led Caselet debrief and extensions

Non-Course Based Pilot

- Screened students for 37 concepts (self-assessed confidence level)
- To qualify, students need to meet certain thresholds
- Small monetary incentive

Performance By Knowledge Components

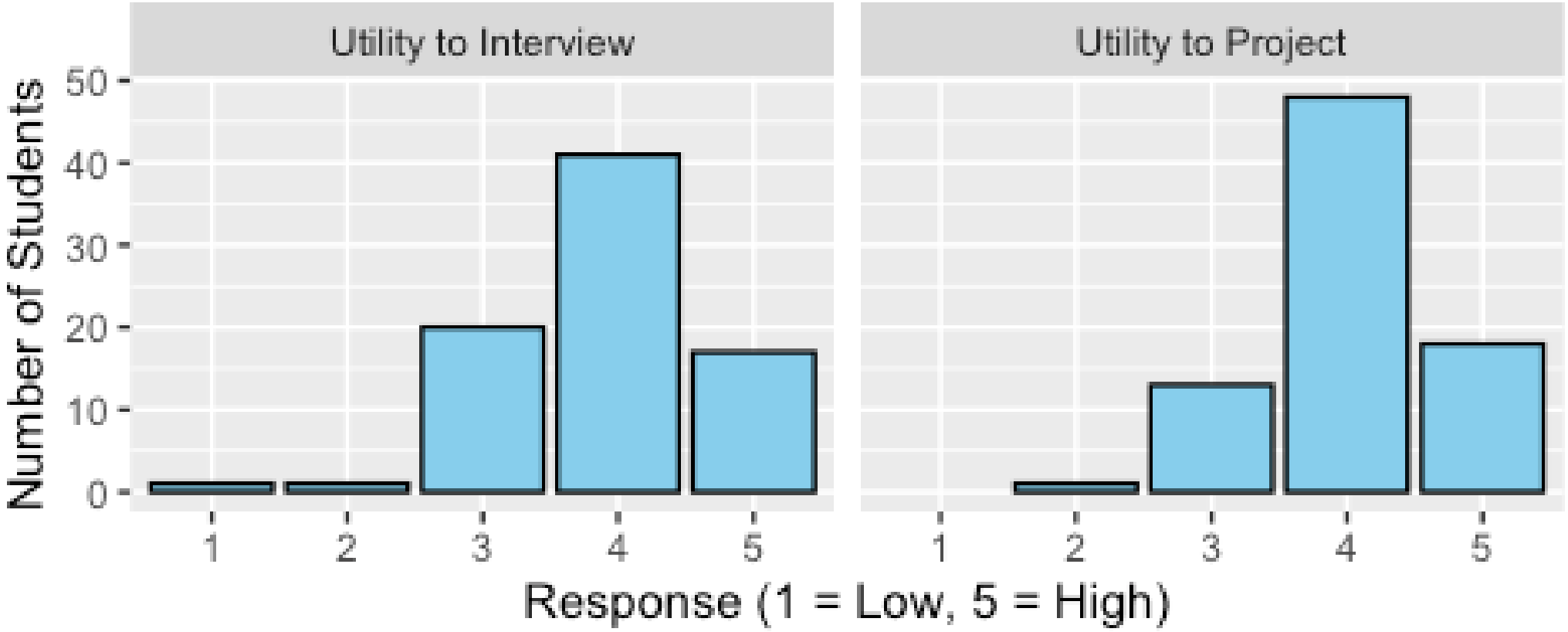
Knowledge Componets (KCs)	Accuracy						# of Questions					
	C01	C02	C03	C04	C05	Overall	C01	C02	C03	C04	C05	Total
Problem Formulation		0.79	0.63	0.41		*0.62*		1	3	1		*5*
Data Understanding	0.69			0.81		*0.72*	3			1		*4*
Data Cleaning/Preprocessing		0.41				*0.41*		1				*1*
Experiment Design				0.42		*0.42*				1		*1*
Model Selection		0.58				*0.58*		1				*1*
Model Configuration	0.72		0.49		0.56	*0.59*	1		1		1	*3*
Model Diagnosis	0.55	0.64	0.50	0.47	0.53	*0.52*	2	1	1	4	3	*11*
Model Deployment		0.28				*0.28*		1				*1*
Modeling Misc.		0.60				*0.60*		1				*1*
All KCs	**0.64**	**0.55**	**0.58**	**0.50**	**0.53**	***0.57***	**6**	**6**	**5**	**7**	**4**	***28***

Learning Gain Analysis

Pre= 1st exposure
Post = last exposure

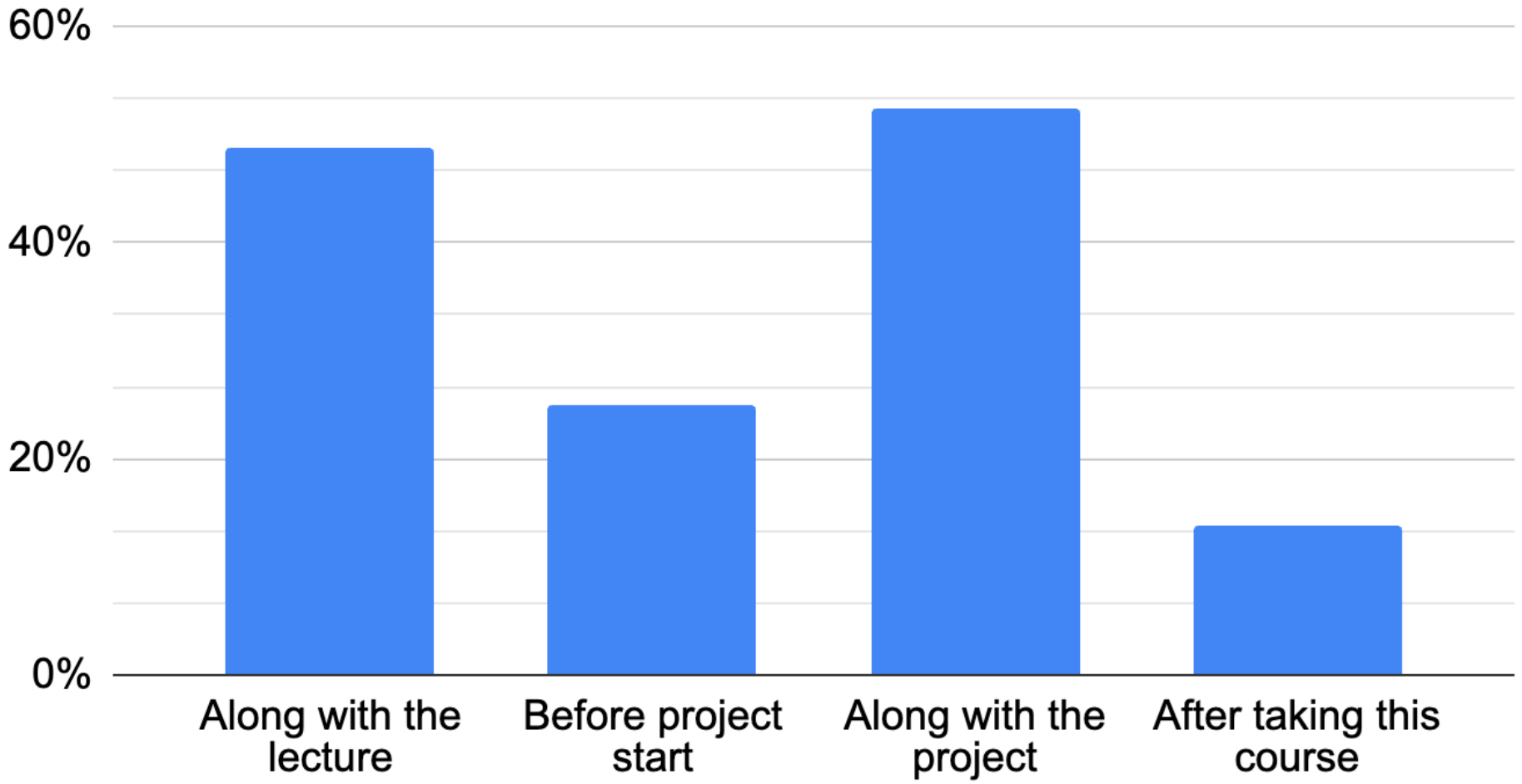


Students' Post-Caselet Feedback (N=80)

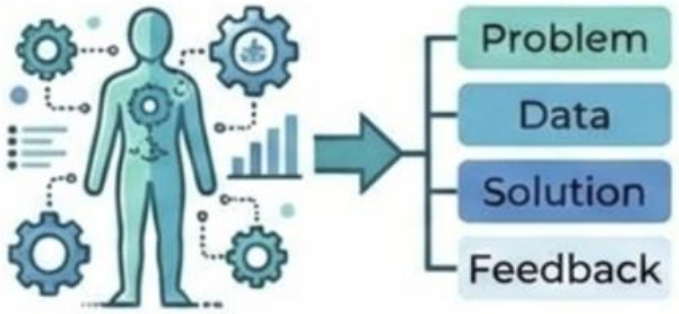


Students' Post-Caselet Feedback (N=80)

When is the good time to introduce Caselet?



Talk Outline



The anatomy of a Caselet



Results from Pilot Study with Caselets



Reflections and future work

Reflections on Caselet Pilots

- The mysterious trajectory toward mastery
  - The challenges of transferring skills from one context to another
  - The critical roles of foundational knowledges
- Supporting Motivation
  - The challenge of Caselet (accuracy < 60%) may undermine motivation
  - Offer Caselet at suitable level of challenge and provides scaffolding

Reflections on Caselet Pilots - Instructors' Perspective

- Creative Approach to Integrate Caselet into Courses
  - Used as open-ended Case studies as small group activities
  - Used as "worked-example" to guide students' project
  - "Just-in-case" practice - students search for Caselet suits their needs

- Feedback Analytics to Empower Instructors and Students
  - Instructors express desires to gain insights of students' learning
  - Mastery at Knowledge Component level as formative assessment
  - Feedback to students to identify strengths and weaknesses

Publications

1. Chen, L.K., Alomair, M.M*., Ali Yousuf, M. and Pan, S., 2026. Developing problem-solving competency in data science: Exploring a case-based approach. *Proceedings of the 57th ACM Technical Symposium on Computer Science Education (SIGCSE TS 2026), Vol. 1*, pp.204–210.

2. Sourove, M.*, Pan, S. , and Chen, L.K. 2026. An LLM-Based Agentic AI System for Automated Construction of Knowledge Taxonomies in Data Science Problem Solving. In Proceedings of the Thirteenth ACM Conference on Learning @ Scale (L@S '26). Association for Computing Machinery, New York, NY, USA, 525–529.

3. Priyanka Rani, F. N. U*., Alomair, M*., Pan, S., & Chen, L. K. (2025, July). Systematically Identifying, Defining and Organizing Knowledge Components for Data Science Problem Solving through Human-LLM Collaboration. In Proceedings of the Twelfth ACM Conference on Learning@ Scale (pp. 341-345).

Interested in Piloting or Knowing More about Caselet?

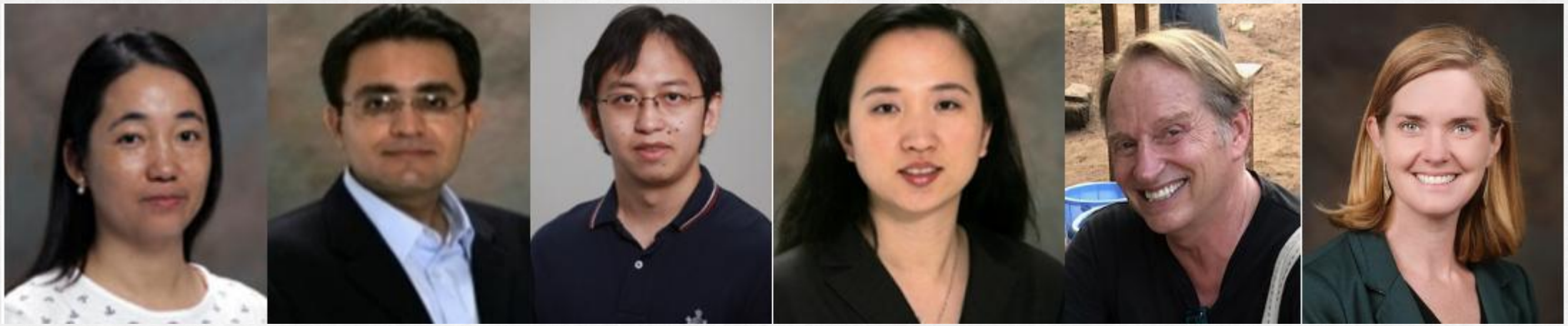
Karen Chen
lujiec@umbc.edu

https://forms.gle/UUFQsXtWd82eqXrKA

Innovation in Graduate Education: Transdisciplinary Research in Engineering Education

Dr. Hua Li
Texas A&M University-Kingsville

Project Team



Dr. Jianhong Ren, Co-PI, Professor, Environmental Engineering
Dr. David Ramirez, Co-PI, Professor, Environmental Engineering
Dr. Hua Li, PI, Professor, Mechanical and Industrial Engineering
Dr. Kai Jin, Senior Personnel, Professor, Mechanical and Industrial Engineering
Dr. Ari Sherris, Co-PI, Professor, Bilingual Education
Dr. Christine Reiser Robbins, Co-PI, Associate Professor, Anthropology

Graduate Education Challenge Addressed

- Seeking innovative solutions to many of the greatest challenges facing this nation and the world, including the 21st century grand challenges summarized by the National Academies of Sciences, Engineering, and Medicine, will depend upon having a highly skilled workforce, who should not and cannot consider these issues in isolation.
- It is critical to educate graduate students in integrating knowledge, methods, data, languages, and expertise from different disciplines to pursue common research challenges across multiple communities.
- While developing hard skills is essential for students competing in the job market, employers are even more united in the opinion that recent graduates lack necessary soft skills.
- Tasks such as identifying efficient alternative energy sources, improving water and air resource management, and understanding other cultures that must coexist in the global village will require individuals with transdisciplinary research ability.

How did we approach it?

- Transdisciplinarity is an approach to human communication, meaning-making, and collaborative decisions that not only supports interdisciplinary thinking but also supports the co-construction of complex models that value the input and design of soft structures across disciplines, from problem conception through to end processes
- Intercultural Communication
- Community Engagement
- Qualitative and Quantitative Mixed Research Method



How did we approach it?

- The **Project Goal** is to pilot and test transformative approaches to develop and improve engineering graduate students' ability to conduct transdisciplinary research that helps reach sustainable solutions respecting the interdependence of natural, social, and engineering systems on local and translocal scales that resonate globally.
- Twelve highly interactive workshops in two semesters
  - Bi-weekly and three hours each
  - Six fundamental workshops in one semester
  - Six advanced workshops plus service-learning project in the following semester
- The project activities are not associated with any course credit
  - A paper certificate of completion
  - Two digital badges

How did we approach it?

- Highly Interactive Activities
- Each workshop started with an ice breaker activities, such as

  Introduction to the Issue: Anticipation of Knowledge/Continuum Activity
  Stage 1: Take a pencil and place **a tally mark** on each continuum (posted around the room). You can go in any order. Please sit down when finished.

  Stage 2: You will be given a paragraph. Find the person in the room that has the same paragraph. Then, together, find the continua that are addressed by your paragraph.

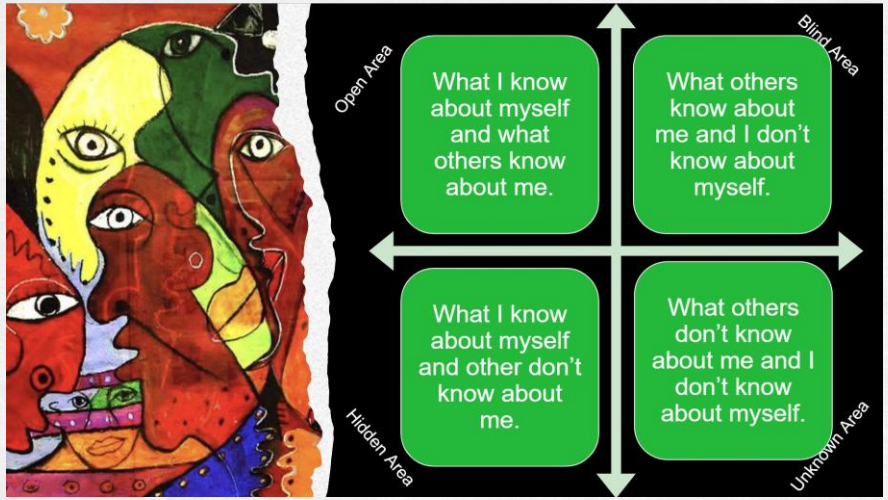
  Stage 3: Take a piece of chart paper and place the continua on the chart paper. Develop a quick presentation of bullet points on **what the research says** is the correct answer to the continua topic and **how we voted**.

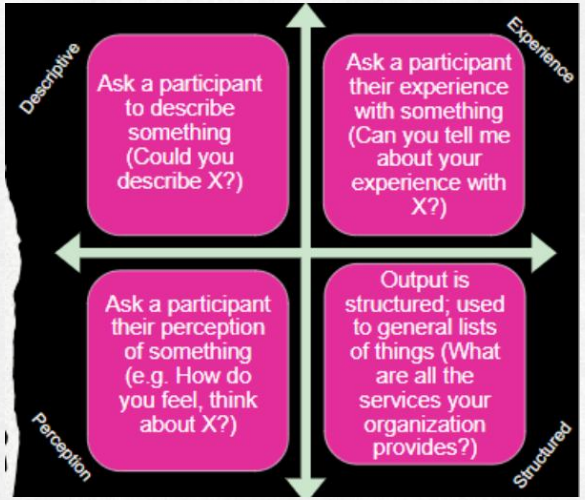
  Stage 4: Quickly present the findings on the convergence of what the research says versus what our continua tallies anticipated.

- Each workshop ended with students submitting reflection through online forms, and their reflections will be shared at the beginning of next workshop

How did we approach it?

- Highly Interactive Activities:
  - Big 5, Johari Window, Subject Positioning, Values Continuum, Community Engagement Guiding Principles, Community Engagement Strategies, Consensus Building, Four-stage Model for Initial Transdisciplinary Collaboration, Rapid Ethnographic Assessment, Scope/Statement of Work with Community Partners, In-depth Interviews, Data Interpretation, Street/Clipboard Interviews







How did we approach it?

- Service Learning Projects in Microplastics/Recycling and Circular Economy/Advanced Air Mobility/Extreme Weather Events
- Collaboration: Gulf Reach Institute (NGO), Texas General Land Office (State Government), Aerospace Club (Student Organization), etc.
- Texas Coastal Roundup, Teen Science Café, Texas Plastic Pollution Symposium, Kaffie Middle School Classroom Visit, and Earth Day Event, Interviews with University Administrators, and Campus Workshops.





What are our findings?

- Baseline survey, Pre-participation survey, Post-participation survey after first six workshops (Post-1), Post-participation survey after 12 workshops and service-learning projects (Post-2).
- Students' confidence levels on 18 different tasks were asked in the surveys, covering different skills/activities related to the three competencies.
- The average scores of all 18 tasks increased while most of the standard deviations decreased if comparing the results from Post-1 survey with Pre survey.
- Based on the t-test results, only tasks four tasks show significant differences (p-value < 0.05) between the average scores after participating the first six workshops.
  - Task #10: Improves communication among teammates, asks for feedback, and uses suggestions;
  - Task #14: Uses appropriate tools to analyze data and verifies and validates results;
  - Task #15: Ability to incorporate intercultural skills in identifying and describing complex real-world problems utilizing principles of engineering and science;
  - Task #16: Ability to produce or enhance solutions with consideration of specified community needs, especially cultural, social, environmental, and economic factors.

What are our findings?

- When comparing the results from Post-2 survey with Pre survey, the number of tasks with significant differences (p-value < 0.05) increased to 14, with only three tasks not showing significant differences.
  - Task #5: Evaluates and analyzes the cultural, economic, social, and environmental impacts of a problem solution;
  - Task #6: Uses data analysis techniques to characterize and respond to community needs in solution-seeking processes;
  - Task #12: Observes good community practice and operates professionally at the level of community participants;
- This observation demonstrates that the advanced workshops and service learning projects had significant impact on students' confidence levels of different tasks.

What are our findings?

- Co-interviews after each semester with individual student participant
  - Two or three faculty interview individual student via Zoom following a set of pre-defined questions in 15 to 25 minutes.
  - Zoom produced very good transcripts
  - In-depth understanding of students' experience in the project
  - Diverse perspectives and better quality probing for deep follow-up questions
  - Using Rapid Ethnographic Assessment to analyze the transcripts for a rich understanding of students' perceptions, feelings, and thoughts about what they learned in the project.

Sherris, A., Li, H., Robbins, C. R., Reyes-Cabrera, J., Ramirez, D., & Jin, K. (2025, June). Documenting takes on recycling, honing rapid ethnographic skills: Transdisciplinary graduate student explorations in a rural US southwestern campus community. In *2025 ASEE Annual Conference & Exposition*.

Lessons Learned

- Credit bearing versus Non-Credit Bearing
  - Attendance/Retention
  - Continuation to Advanced Workshops
  - Motivation
- Faculty Availability versus Students Availability
- Sustainability beyond project period
  - Leverage of other funded projects
  - Introduction to graduate courses
- Institutional Support for Transdisciplinary Research Efforts

The authors are thankful for the support from National Foundation Science (Awards #2225109 and #2244523) and Texas A&M University-Kingsville



Innovative Solutions to Persistent Challenges

Advancing Innovation in Graduate Education: Innovations in Graduate Education (IGE) Principal Investigators' Meeting

10/15/2026

Focus: Research and insights from complete and nearly complete IGE projects; guidance on research and implementation challenges.

Moderator: Dr. Kathleen Ehm, Program Director
Directorate of STEM Education (EDU), National Science Foundation

Collaborative Research: Scalable Storytelling Interventions to Support Graduate Student Success in STEM

Presenters: Krishna Pakala & Angela Minichiello

BOISE STATE UNIVERSITY

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Disclaimer: Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

College of Engineering
UtahStateUniversity

The Graduate Education Challenge







- Graduate STEM students navigate identity, belonging, confidence, transition, and uncertainty.
- Traditional graduate education does not always create structured opportunities to reflect on these experiences.

Need to create a space where students can share and make meaning of their experiences

Our approach:
Using Storytelling to Create Space for Reflection





Building the Project Through Collaboration

Boise State University (BSU)


Krishna Pakala


Eric Jankowski


Anne Hamby


Jelena Pokimica


Kayleigh Hynes

Utah State University (USU)


Angela Minichiello


Uyen Nguyen

THE STORY COLLIDER
TRUE, PERSONAL STORIES ABOUT SCIENCE

What We Set Out to Explore

What We Do

- Develop storytelling curriculum (with The Story Collider)
- Implement with STEM graduate students
- Measure identity, belonging, impostorism
- Analyze stories for structure and meaning-making
- Disseminate via open-source platforms

What We Ask

1. How are personal STEM narratives structured?
2. Does storytelling shift identity, belonging, impostor feelings?
3. How do narrative features relate to those shifts?

From Idea to Implementation

- Year 1: Initial pilot + Develop storytelling curriculum + Implementation at Boise.
- Year 2: Continued BSU implementation and refinement.
- Year 3: Translated to USU + Continued at BSU

- 2 workshops/year Years 1-2 (n~100)
- 4 workshops Year 3 (n~100)
- Story assignment + stipend
- Storytelling coaching
- Telling & Performance event

From Idea to Implementation

Mixed Methods



Pre/Post surveys (identity, belonging, impostorism)



Post Interviews



Written narratives



Audience pre/post survey



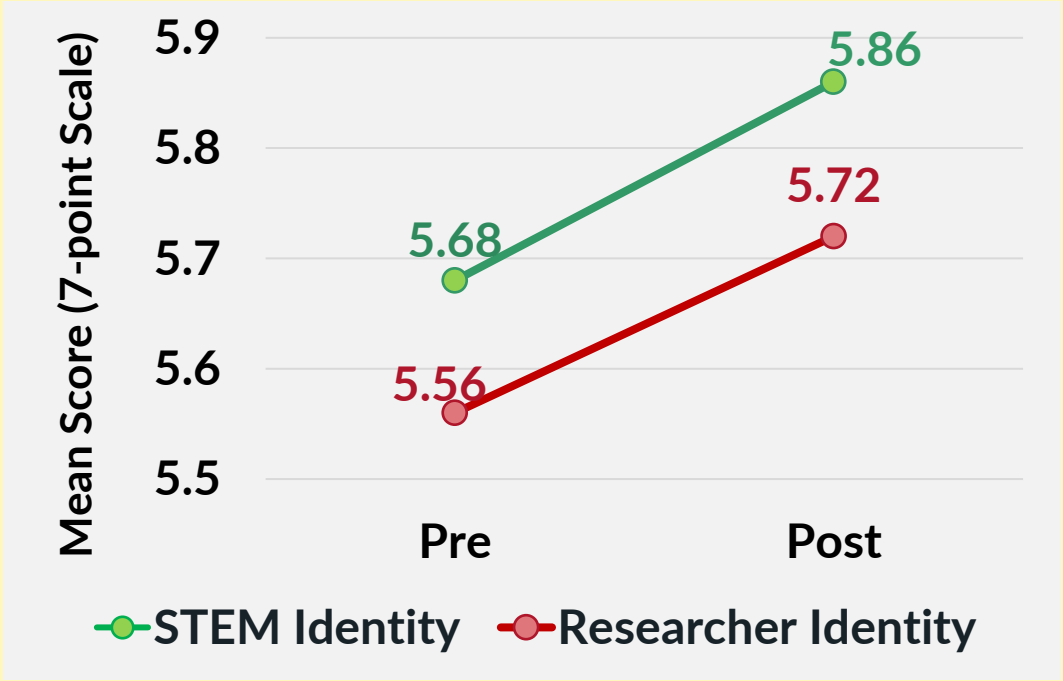
What Did We Hear in the Stories?

The dataset: 178 stories across 3 years at 2 institutions

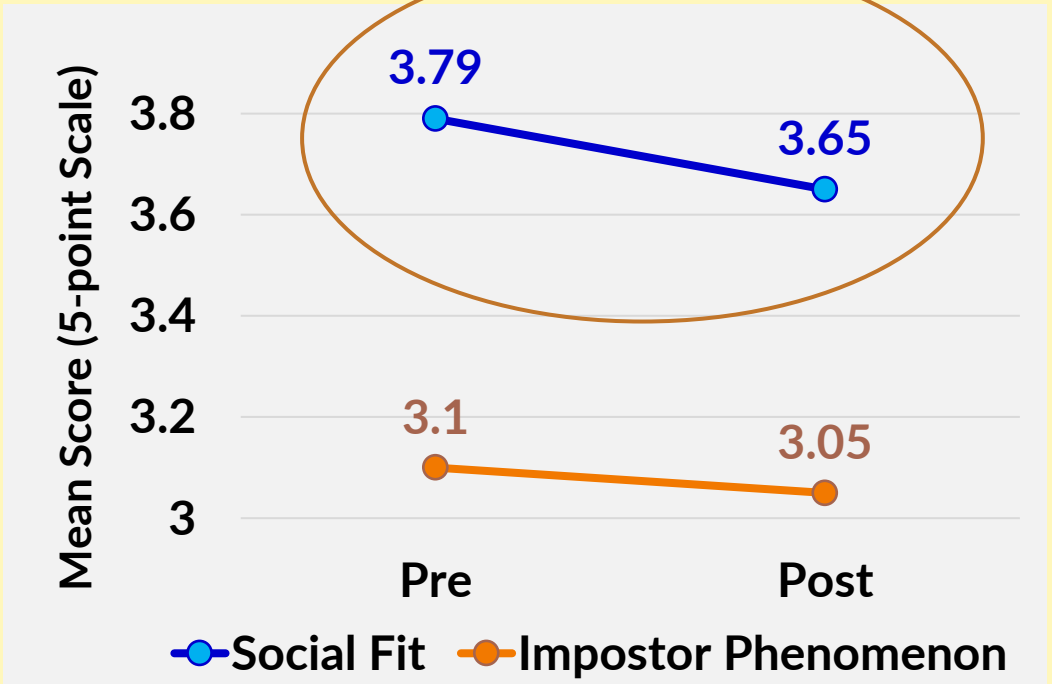
Identity Shift Triggers	Narrative Patterns	Meaning-Making Mechanism
• Critical incidents • Emotional turning points	• Overcoming hardship • STEM Career negotiation • International transition • Unexpected moment of growth	• Redemptive growth arcs • Shared vulnerability builds belonging • Resilience develops from facing vulnerability • *Resilience supercedes belonging ???*

What Surprised Us?

Change in STEM and Researcher Identity (3-year combined, N=159)



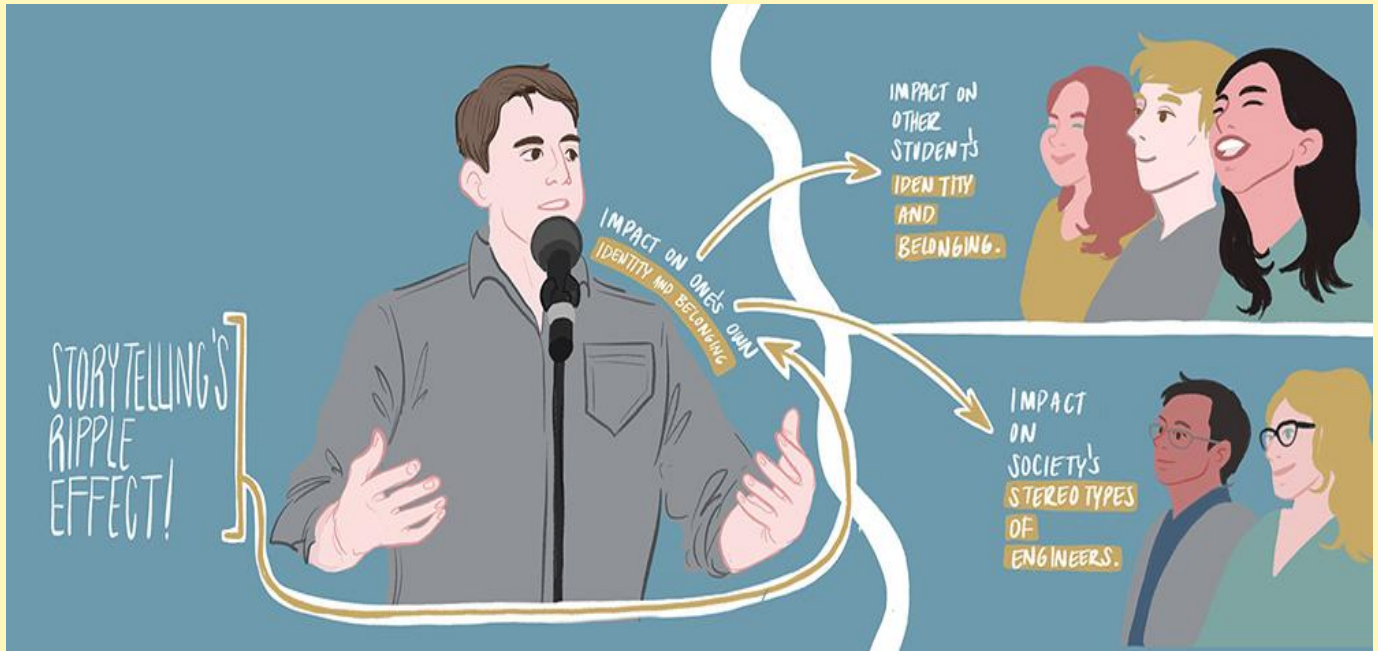
Change in Social Fit and Impostor Phenomenon (3-year combined, N=157)



- **Patterns:** Icarus in Year 2 & Tragedy in Year 3 USU
- **Structures:** ↑ Unexpected moment of growth & ↓ International Transition

What We Learned About Doing This Work

- **Storytelling needs time, structure and support, not just an invitation to share.**
- **Students' narratives linked identity shifts to critical incidents and emotional turning points.**
- **Across 70 participants, STEM and researcher identity increased significantly.**
- **Partnerships and institutional context shaped the work across Boise State and Utah State.**



What We Would Tell Another IGE PIs

- Start with a clear graduate education challenge and connect it to the intervention.
- Build interdisciplinary partnerships and adapt the approach to your institutional context.
- Combine surveys with interviews and narrative analysis to understand both outcomes and how students make meaning.
- Give students clear guidance and support, and plan how you'll share the work with others.

STORIES


“IT'S OKAY TO NOT HAVE THAT CONTROL.
I'VE ALSO FOUND THAT IT'S OKAY TO TALK AND JOKE ABOUT HAVING OCD, BECAUSE THE MORE AWARENESS THAT I BRING, I'VE FOUND A LOT MORE SUPPORT. AND SOMETIMES, I JUST LET MY LAUNDRY SIT IN THE BASKET AND I WAIT UNTIL I'M READY.”
Hannah Hedelius


“I MIGHT NOT BE THE BEST LEADER, BUT AT LEAST I KNOW I CAN GET IN THERE, GET DIRTY, AND GET THINGS DONE.”
Molly Astell

STORIES


“I'M STILL THAT SAME PERSON, WALKING THE SAME STREETS IN MY MEMORY, TALKING TO THE SAME PEOPLE ON MY PHONE, BUT I'M ALSO SOMEBODY WHO TRAVELED ACROSS THE WORLD, FACED THE UNKNOWN, AND FOUND A WAY TO THRIVE.”
Saba Banaian


“EVERYTHING WAS GOING WELL UNTIL THE QUESTION ABOUT MY IMMIGRATION STATUS CAME. EVERY SINGLE TIME, THINGS WENT WELL UNTIL THEY ASKED ME. BECAUSE TO WORK ON AVIATION, YOU NEED TO HAVE CLEARANCE FROM THE GOVERNMENT. AND SINCE I'M NOT A US CITIZEN, I JUST CAN'T HAVE IT. I JUST CAN'T GET IT.”
Michelle Lanuza

STORIES


“EVERYBODY WAS ECSTATIC AND EXCITED. IT WAS A TECHNOLOGICAL REVOLUTION. WE'RE USING IT EVERY DAY IN OUR PHONES, IN OUR COMPUTERS AND WHATNOT. BUT ME, I WAS SCARED. BECAUSE WHILE I WAS LOOKING AND READING MY JOURNALS, I ACTUALLY SAW THAT THE CHATGPT 3 MODEL, THE CARBON EMISSION THAT IT PRODUCED WAS AROUND 552 METRIC TONS OF CO2 DURING TRAINING CHATGPT 3.”
Omiya Hassan


“AS I GROW AS A SCIENTIST AND I NEED TO MAKE LOTS OF TOUGH DECISIONS. I'VE LEARNED THAT INSTINCT ISN'T JUST A WHIM. IT CAN COME FROM RICH LIVED EXPERIENCES AND YEARS OF TRAINING.”
Stephanie Galla

Closing & Acknowledgement

- Creating space for graduate students to tell and make meaning of their stories can become a powerful form of graduate education.
- This material is based on work supported by the NSF under Grants #2325041 and #2325042.
- All findings, opinions, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of the NSF.
- Thanks to Story Collider for supporting and creating a platform for graduate student storytelling.



krishnapakala@boisestate.edu
angie.minichiello@usu.edu