Course design elements of a Vertically Integrated Project (VIP) course that foster undergraduate students' project ownership
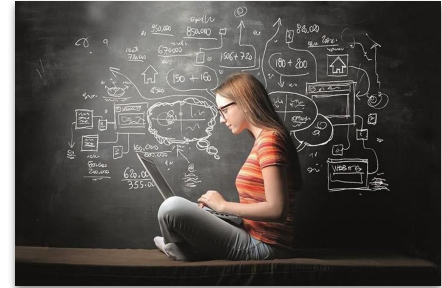
Kasey Wozniak

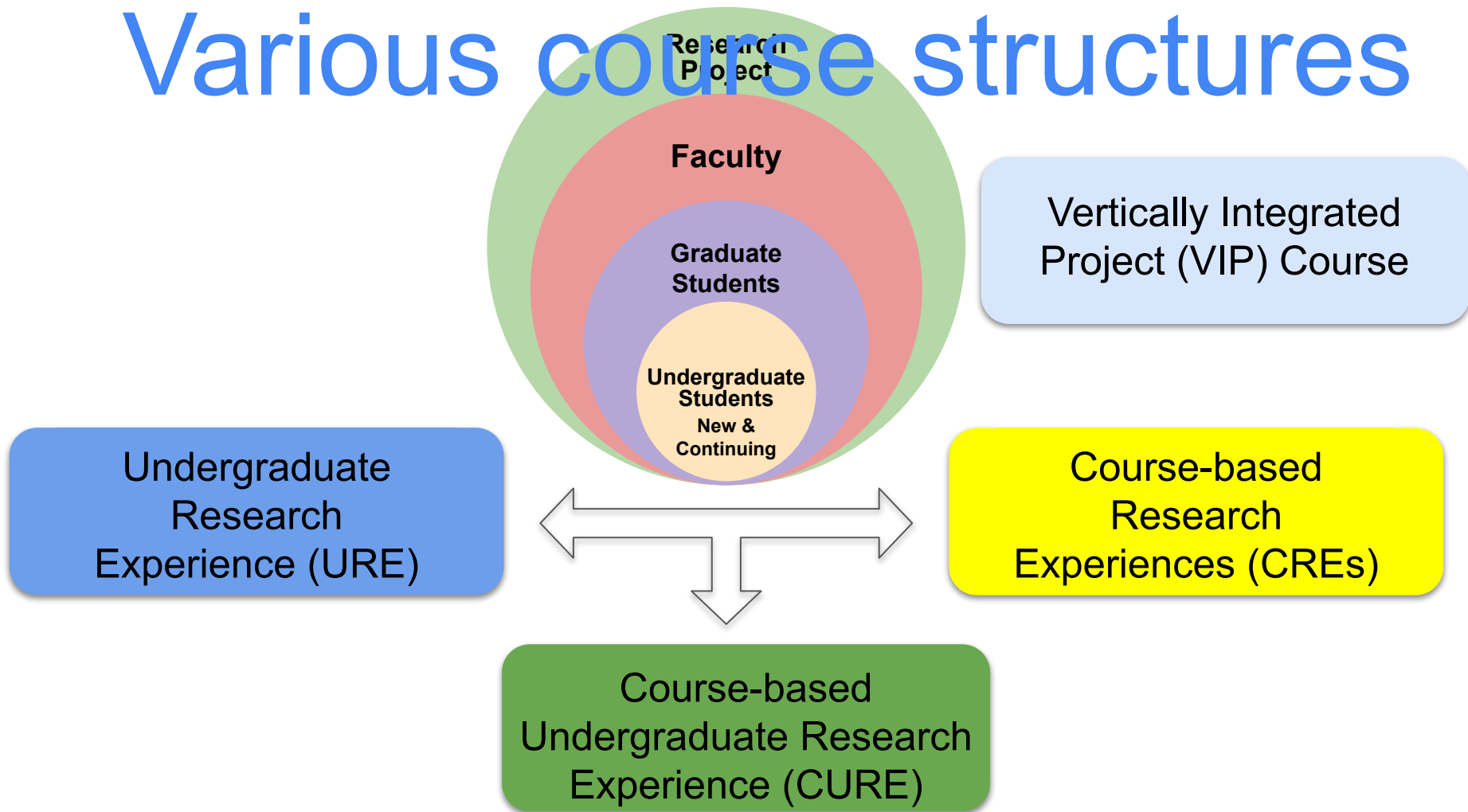Dr. Anna Grinath, Dr. Heather Ray, Dr. Devaleena Pradhan

ISU is located within the boundaries of the original Fort Hall Reservation on the traditional land of the Shoshone and Bannock peoples
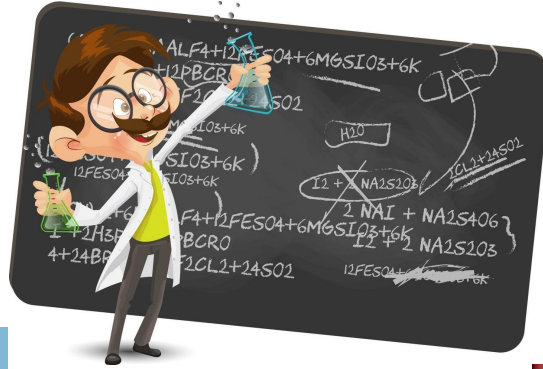
ROAR

Opportunities to authentically engage in the disciplinary work of biologists is critical for biology learning...

Various course structures

Research Project

Faculty

Graduate Students

Undergraduate Students
New & Continuing

Vertically Integrated Project (VIP) Course

Undergraduate Research Experience (URE)

Course-based Research Experiences (CREs)

Course-based Undergraduate Research Experience (CURE)

A key component of an authentic research experience…
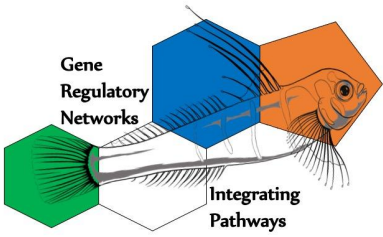
Hanauer et al 2012
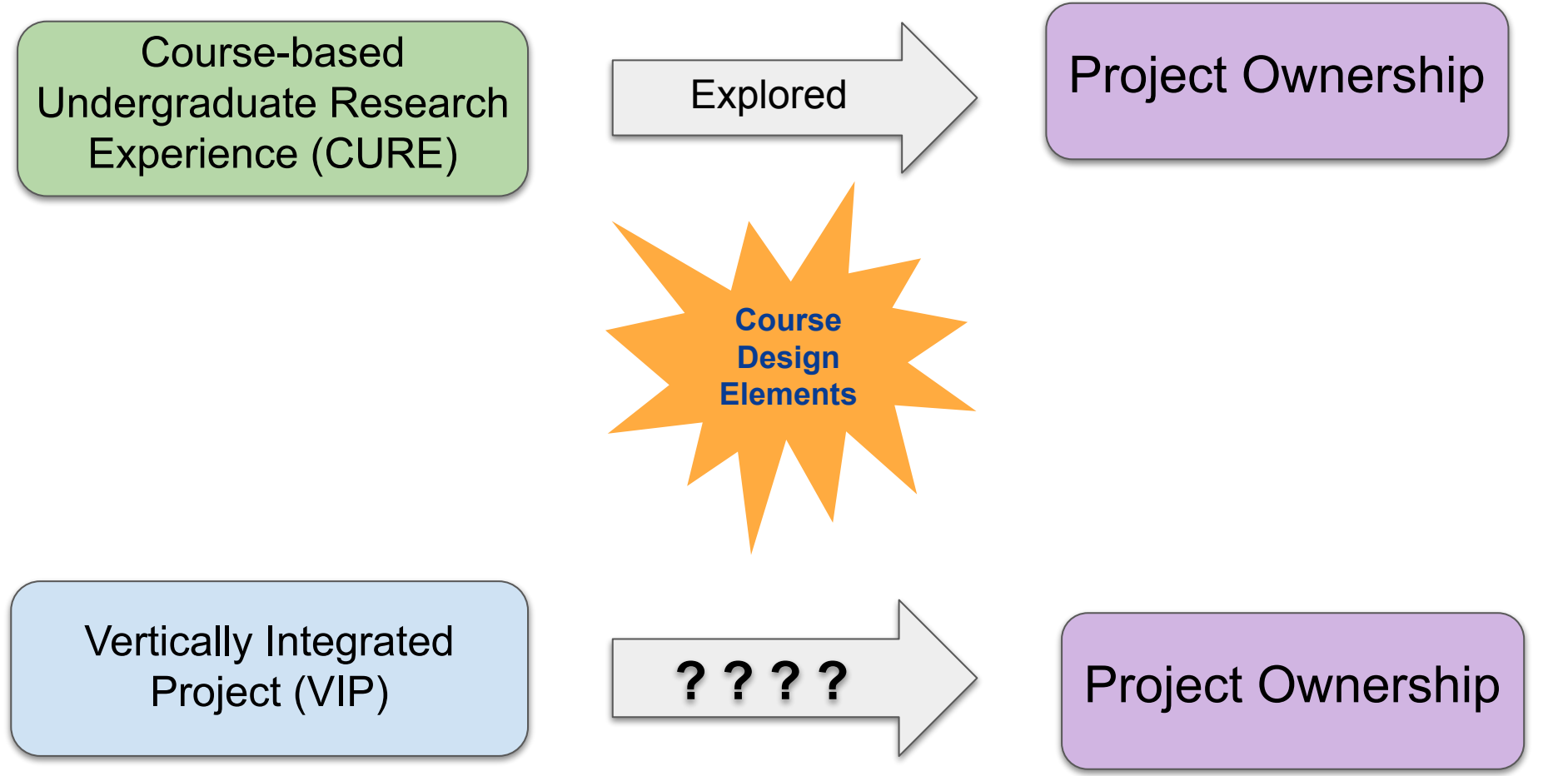
Research questions

01 How undergraduate biology students develop project ownership in a Vertically Integrated Project course?

02 What course design elements of the VIP structure fosters project ownership?
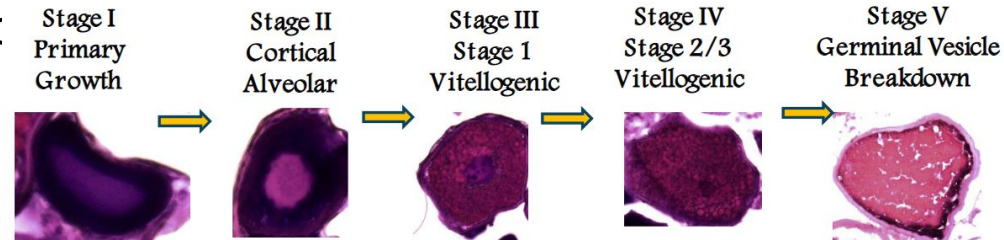
VIP: Gene Regulatory Networks (VIP-GRN)

Determine relationship between ovary phase and follicle stage

- Lay foundation for future experiments on sex changing fish

- Identify endocrine and developmental genes and their patterning involved in sexual plasticity

Phase 1   Phase 2   Phase 3   Phase 4

| Stage I Primary Growth | Stage II Cortical Alveolar | Stage III Stage 1 Vitellogenic | Stage IV Stage 2/3 Vitellogenic | Stage V Germinal Vesicle Breakdown |

Data sources

- **Student Interviews**
  Past and present

- **Student Written Reflections**
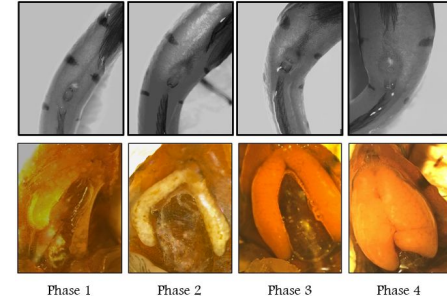
- **Faculty Interviews**
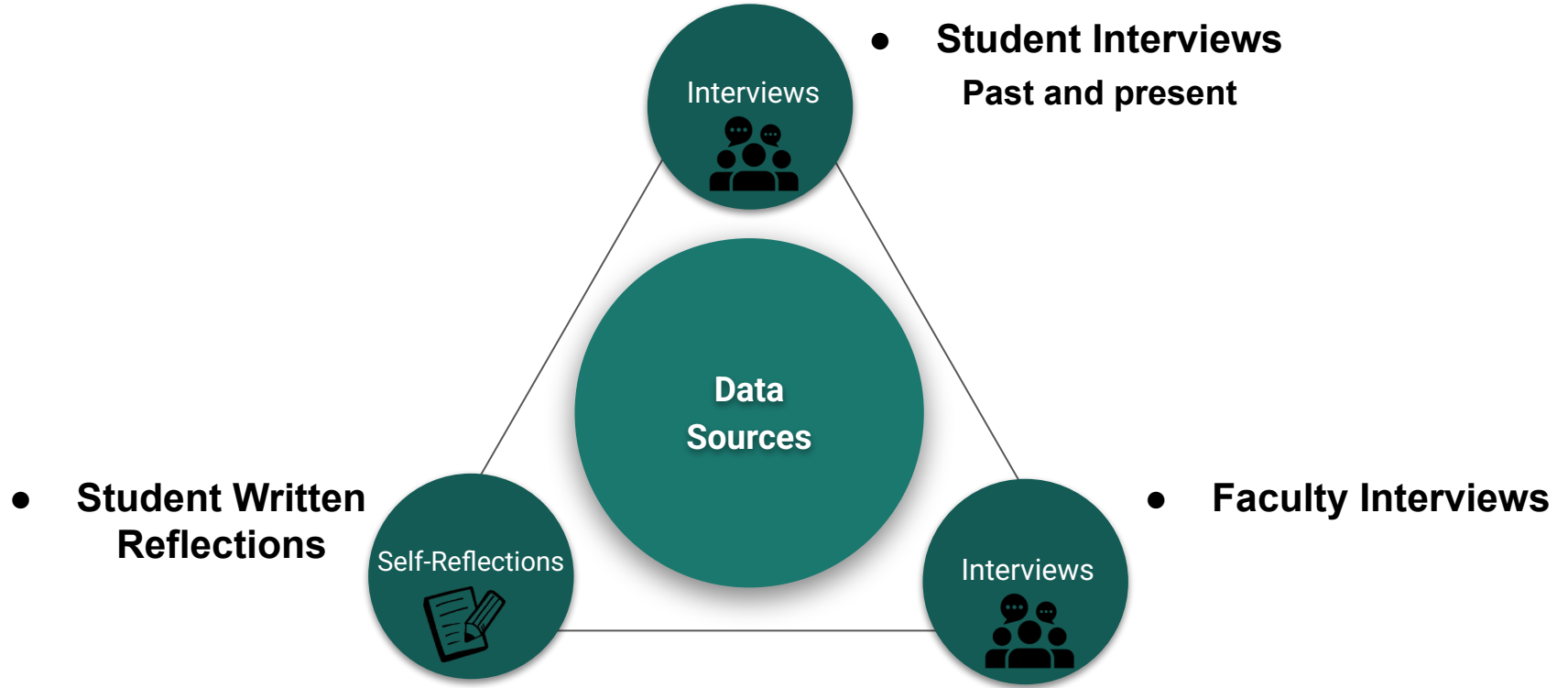
Elements of Project Ownership

1. Facilitating personal agency

2. Personal significance for the research project

3. Scientific value for the scientific inquiry

4. Social interaction and mentorship

5. Research that demands problem solving

A priori coding framework for Course Design Elements

(Hanauer et al. 2012)

Data collection and analysis

Data — **Data** — **Analysis phase 1** — **Analysis phase 2**

Collection | **Transcription** | **Processing** | **Interpretation**

Interviews

Written Reflections

Recordings sent for transcription

Initial literature review based coding scheme

Check coding repeatability

Resolve and refine coding comparison

Look for any emerged instances

ATLAS.ti
QUALITATIVE DATA ANALYSIS

Computational Linguistic software

Example of document coding and analysis

[Britany] 13:50:55 Yeah. The most work I've done. Would definitely be with measuring the focal area. In which that data is used to. Identify a size comparison with. Follicle stages. And I've only been here to work on ovarian phase one. But to see how each identification correlates with size. And. I've. A lot of data on that and then I was able to. Learn what each Ovarian. Nope follicle stage. Looked like and so I was able to go in then and count follicles and identify them for each stage they were in. And that ended up being what I did most of the second semester that I was. Which then other students would take that information and measure the area like how I began with.

[Researcher] 13:52:08 Okay. So thinking back on your VIP work, is there something that you are particularly proud of.

[Britany] 13:52:21 I'm really proud of how my poster turned out for the research roundup. The AMH poster. I enjoyed again the creative freedom but also I think with only working on it for one semester and a couple months at that. Learning what I did about AMH in general, peaked my interest in The comparative analysis with humans, specifically in that of adult females with PCOS. So I was kind of able to take that interest and take it with. Other courses and I did a project based on that in my endocrinology class. My favorite part of that project would probably be seeing the AMH and immuno fluorescent. Like after the staining. Seeing that presence between different stages and phases of each follicle and ovary. Was really cool. Any fun to compare and contrast.

PO: Agency combined w/ ment... KW 50
PO: Expressions of a sense of p... KW 55
PO(Wiley): Buy-in KW 55
PO(Wiley) Responsibility KW 48

CD: Social interaction w/ ment... KW 93
CD: Facilitating Personal Agency KW 73

CD: Personal significance for pr... KW 19
CD: Sci Value for the sci inquiry KW 25
CD: Presentation opportunities ... KW 40
CD: Leads to new research opp... KW 29
CD: Facilitating Personal Agency KW 73

PO: Constructing connections ... KW 20
PO: Expressions of excitement + KW 47
PO: Expressions of a sense of p... KW 55
PO: Scientific outcomes with re... KW 15
PO(-): Descriptions of procedures KW 15
PO: Disseminate for sci commu... KW 33
PO(Wiley): Buy-in KW 55
PO(Wiley): self-identification KW 66
PO(Wiley) Responsibility KW 48

Coded Instances of Course Design Elements

- **Facilitating personal agency**

- **Research demands problem solving**

- **Social interaction and mentorship**

- **Scientific value for scientific inquiry**

- **Personal significance for research project**

3 Main Codes Emerged

> Vertical Structure: mixture of new and returning students at various stages in their academic careers

Presentation opportunities to local science community

Flexibility: ability to adapt and alter the course to allow students to shape their roles

3 Main Codes Emerged

Vertical Structure: mixture of new and returning students at various stages in their academic careers

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3 Main Codes Emerged

Vertical Structure: mixture of new and returning students at various stages in their academic careers

Presentation opportunities to local science community

Flexibility: ability to adapt and alter the course to allow students to shape their roles

	Total	Students (n=7 interviews)	Faculty (n=2 interviews)

Emerged code: Vertical structure

Co-occurance with Course Design codes

→ Facilitating Personal Agency

Personal Significance for the Research Project

Scientific Value for the Scientific Inquiry

→ Social Interaction & Mentorship

→ Research that Demands Problem solving

Emerged code: Designing & presenting research posters

Co-occurance with Course Design codes

→ Facilitating Personal Agency

Personal Significance for the Research Project

Scientific Value for the Scientific Inquiry

→ Social Interaction & Mentorship

Research that Demands Problem solving

Emerged code: Flexibility

Co-occurance with Course Design codes

→ Facilitating Personal Agency

Personal Significance for the Research Project

Scientific Value for the Scientific Inquiry

Social Interaction & Mentorship

Research that Demands Problem solving

Duration

Interviews and Reflections

Emerged code: Vertical structure

Co-occurance with Course Design codes

Facilitating Personal Agency

Personal Significance for the Research Project

Scientific Value for the Scientific Inquiry

Social Interaction & Mentorship

Research that Demands Problem solving

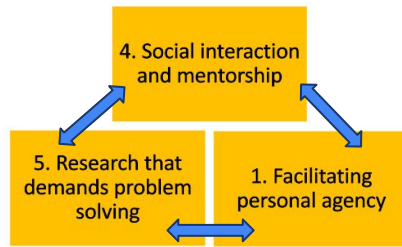## Emerged code: Designing & presenting research posters

Co-occurance with Course Design codes

Facilitating Personal Agency

Personal Significance for the Research Project

Scientific Value for the Scientific Inquiry

Social Interaction & Mentorship

Research that Demands Problem solving

Emerged code: Flexibility

Co-occurance with Course Design codes

Facilitating Personal Agency

Personal Significance for the Research Project

Scientific Value for the Scientific Inquiry

Social Interaction & Mentorship

Research that Demands Problem solving

Column 1:

4. Social interaction and mentorship

5. Research that demands problem solving

1. Facilitating personal agency

How to implement in VIP structure?

Vertical structure: mixture of new and continuing students at different stages in their degrees

Operationalized into VIP course design

- Opportunities for students to anticipate how to mentor newcomers
- Students organize pieces of project for successful continuation by newcomers
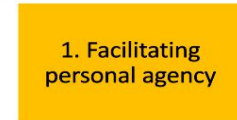
Column 2:

1. Facilitating personal agency

4. Social interaction and mentorship
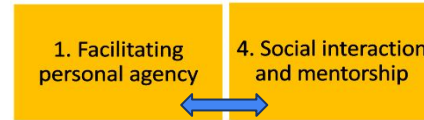
How to implement in VIP structure?

Designing & presenting research poster

Operationalized into VIP course design

Low-stakes poster session within department

Column 3:

1. Facilitating personal agency

How to implement in VIP structure?

Flexibility: allow students to shape the project and their roles within it.

Operationalized into VIP course design

Student goal setting and written reflection assignments

Wozniak et al. 2025

Special Thanks

Research

Funding
Biological Science
Research Committee

Idaho State University | Graduate School

Biology Graduate
Student Association

GEM3
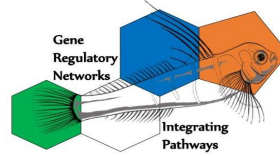Genes by Environment
Modeling · Mechanisms · Mapping

NSF
Faculty Early Career
Development Program
(CAREER) Award

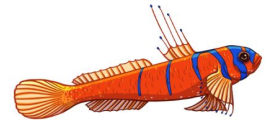## Committee
Dr. A Grinath
Dr. D Pradhan
Dr. H Ray

VIP: Gene
Regulatory
Networks

Special Thanks
Jeremy Starkey
Family and Friends

Lab

I ♥ KOALATATIVE RESEARCH
BLT Lab

Integrative
Physiology Lab

In Memory of

ROAR

Citations

Auchincloss, Lisa Corwin, Sandra L. Laursen, Janet L. Branchaw, Kevin Eagan, Mark Graham, David I. Hanauer, Gwendolyn Lawrie, et al. 2014. "Assessment of Course-Based Undergraduate Research Experiences: A Meeting Report." *CBE—Life Sciences Education* 13 (1): 29–40. https://doi.org/10.1187/cbe.14-01-0004.

Creswell, John W, and Cheryl N Poth. 2018. *Qualitative Inquiry & Research Design: Choosing among Five Approaches*. 4th ed. Los Angeles: SAGE Publications.

Goodwin, Emma C., Vladimir Anokhin, MacKenzie J. Gray, Daniel E. Zajic, Jason E. Podrabsky, and Erin E. Shortlidge. 2021. "Is This Science? Students' Experiences of Failure Make a Research-Based Course Feel Authentic." Edited by Rachelle Spell. *CBE—Life Sciences Education* 20 (1): ar10. https://doi.org/10.1187/cbe.20-07-0149.

Hanauer, D. I., J. Frederick, B. Fotinakes, and S. A. Strobel. 2012. "Linguistic Analysis of Project Ownership for Undergraduate Research Experiences." Edited by Hannah Sevian. *CBE—Life Sciences Education* 11 (4): 378–85. https://doi.org/10.1187/cbe.12-04-0043.

Hanauer, David I., and Erin L. Dolan. 2014. "The Project Ownership Survey: Measuring Differences in Scientific Inquiry Experiences." Edited by Michelle Smith. *CBE—Life Sciences Education* 13 (1): 149–58. https://doi.org/10.1187/cbe.13-06-0123.

Hanauer, David I., Mark J. Graham, Rachel J. Arnold, Mary A. Ayuk, Mitchell F. Balish, Andrea R. Beyer, Kristen A. Butela, et al. 2022. "Instructional Models for Course-Based Research Experience (CRE) Teaching." Edited by James Hewlett. *CBE—Life Sciences Education* 21 (1). https://doi.org/10.1187/cbe.21-03-0057.

Handelsman, Jo, Sarah Elgin, Mica Estrada, Shan Hays, Tracy Johnson, Sarah Miller, Vida Mingo, Christopher Shaffer, and Jason Williams. 2022. "Achieving STEM Diversity: Fix the Classrooms." *Science* 376 (6597): 1057–59. https://doi.org/10.1126/science.abn9515.

Linn, Marcia C., Erin Palmer, Anne Baranger, Elizabeth Gerard, and Elisa Stone. 2015. "Undergraduate Research Experiences: Impacts and Opportunities." *Science* 347 (6222): 1261757. https://doi.org/10.1126/science.1261757.

Miller, Emily, Eve Manz, Rosemary Russ, David Stroupe, and Leema Berland. 2018. "Addressing the Epistemic Elephant in the Room: Epistemic Agency and the next Generation Science Standards." *Journal of Research in Science Teaching* 55 (7): 1053–75. https://doi.org/10.1002/tea.21459.

Strachan, Scott Munro, Stephen Marshall, Paul Murray, Edward J. Coyle, and Julia Sonnenberg-Klein. 2019. "Using Vertically Integrated Projects to Embed Research-Based Education for Sustainable Development in Undergraduate Curricula." *International Journal of Sustainability in Higher Education* 20 (8): 1313–28. https://doi.org/10.1108/ijshe-10-2018-0198.

Walker, Joi P, William E Allen, Lindsey Clevenger, Kathryn N Hosbein, Anthony M Kennedy, Heather Vance-Chalcraft, and Brandon Whiting. 2023. "Course-Based Undergraduate Research Experiences as a Community of Practice (CoP)." *Journal of Chemical Education* 100 (7): 2520–28. https://doi.org/10.1021/acs.jchemed.2c00844.

Inquiry-based concepts and skills of VIP: Gene Regulatory Networks

Short term effects

Active learning

Outcomes

Long term effects

Constructing connections between personal history and scientific inquiry

Students learn tissue sectioning, embedding, and staining

Students learn to read, write, and present scientific information

Project Ownership

Students gain valuable lab techniques

Sense of personal scientific achievement

Overcoming challenging moments in science

Students learn microscopy

Data collection and organization

Inquiry agency

Students learn to interpret their data and results

Excitement toward scientific inquiry

Multi-level mentoring

Students learn how to identify tissue

Personal scientific achievement

Students see themselves as capable scientists

Students see how they fit into the scientific community

Students form small scientific networks

Students engage with the scientific community

Students continued interest in STEM field

See if goals and personal values align with scientific work earlier in their academic career

Continue higher education

What is project ownership?
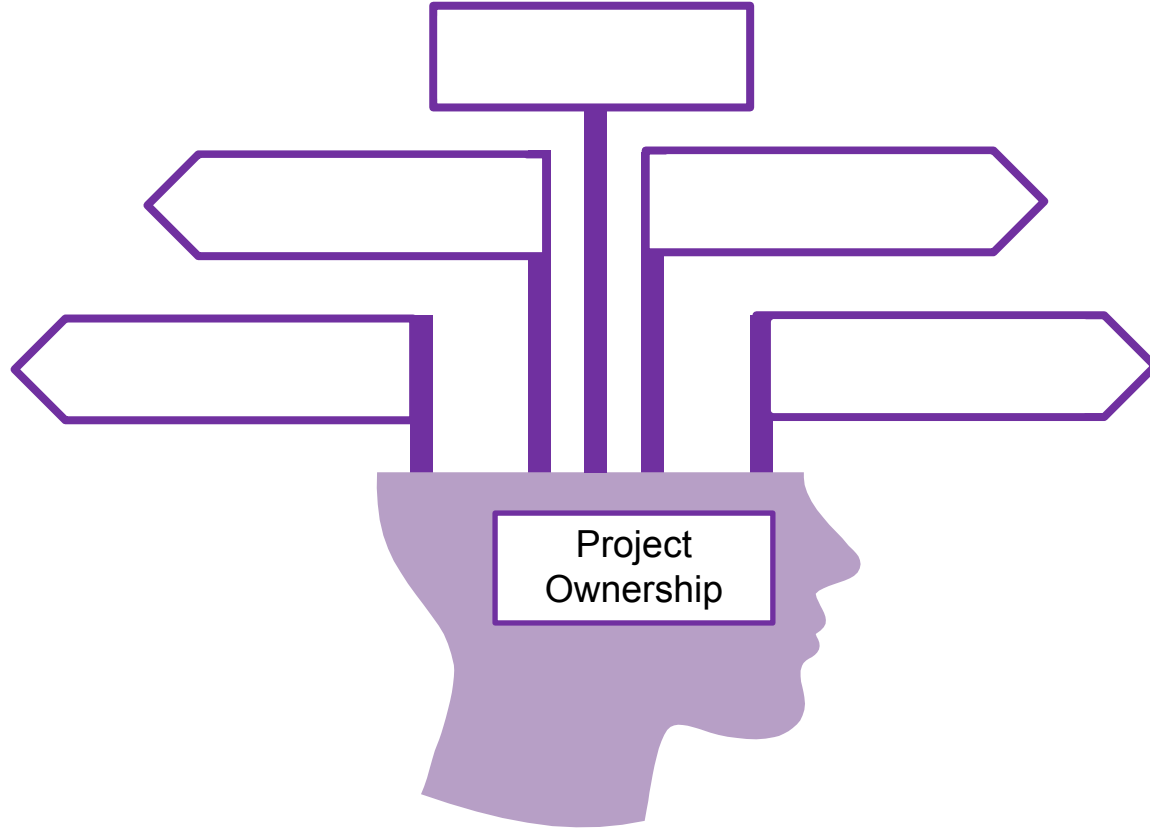
Project Ownership

What course design elements of the VIP structure fosters project ownership?

Facilitate personal agency

Personal significance for the research

Scientific value for the scientific inquiry

Research that demands problem solving

Mentorship and social community