

Faculty integrate TPCK through collaborative biomolecular storytelling

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“Goals”

Molecular CaseNet

TPCK

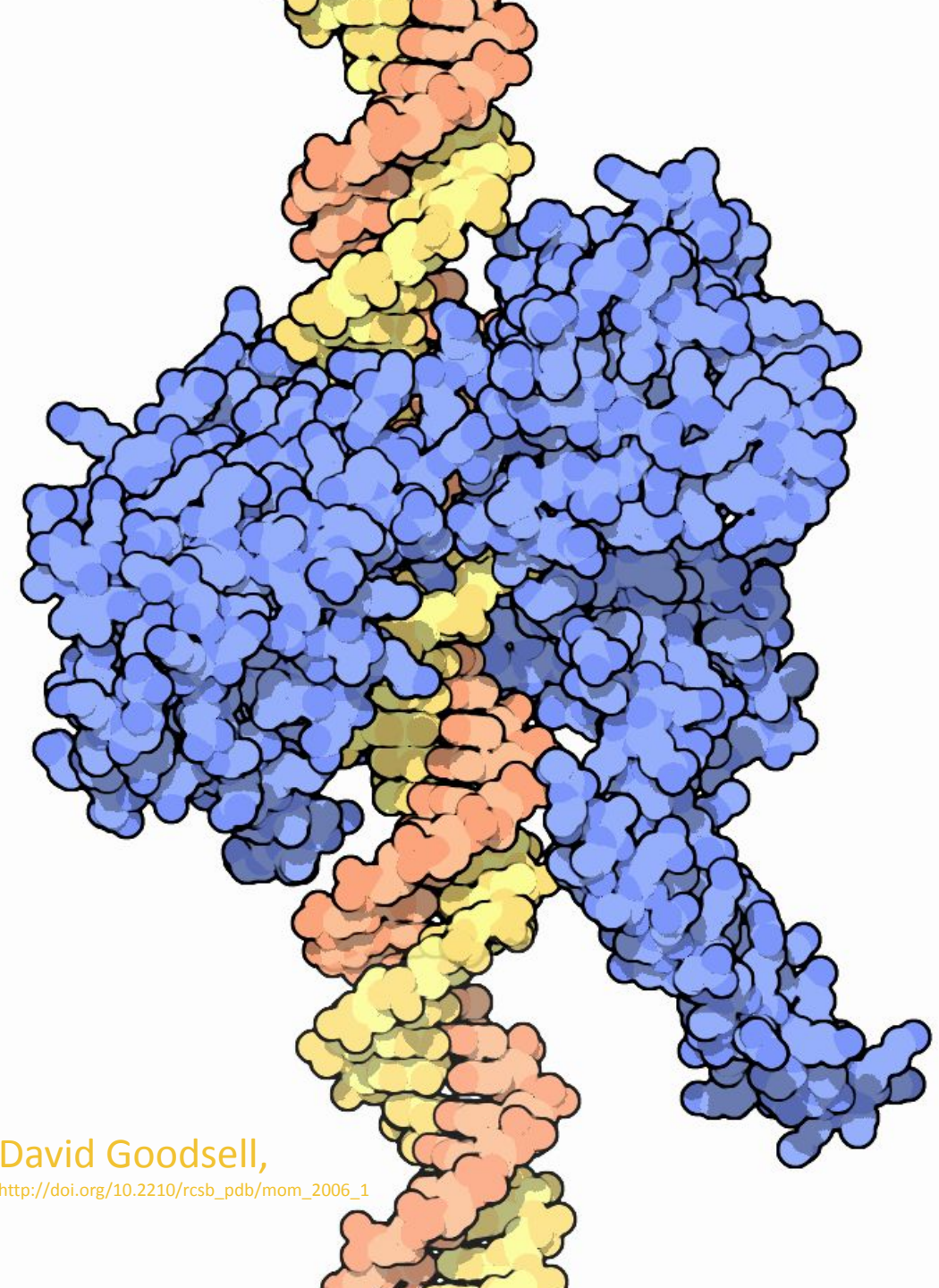
Longitudinal development

Embedded qualitative

Make Meaning

Takeaways

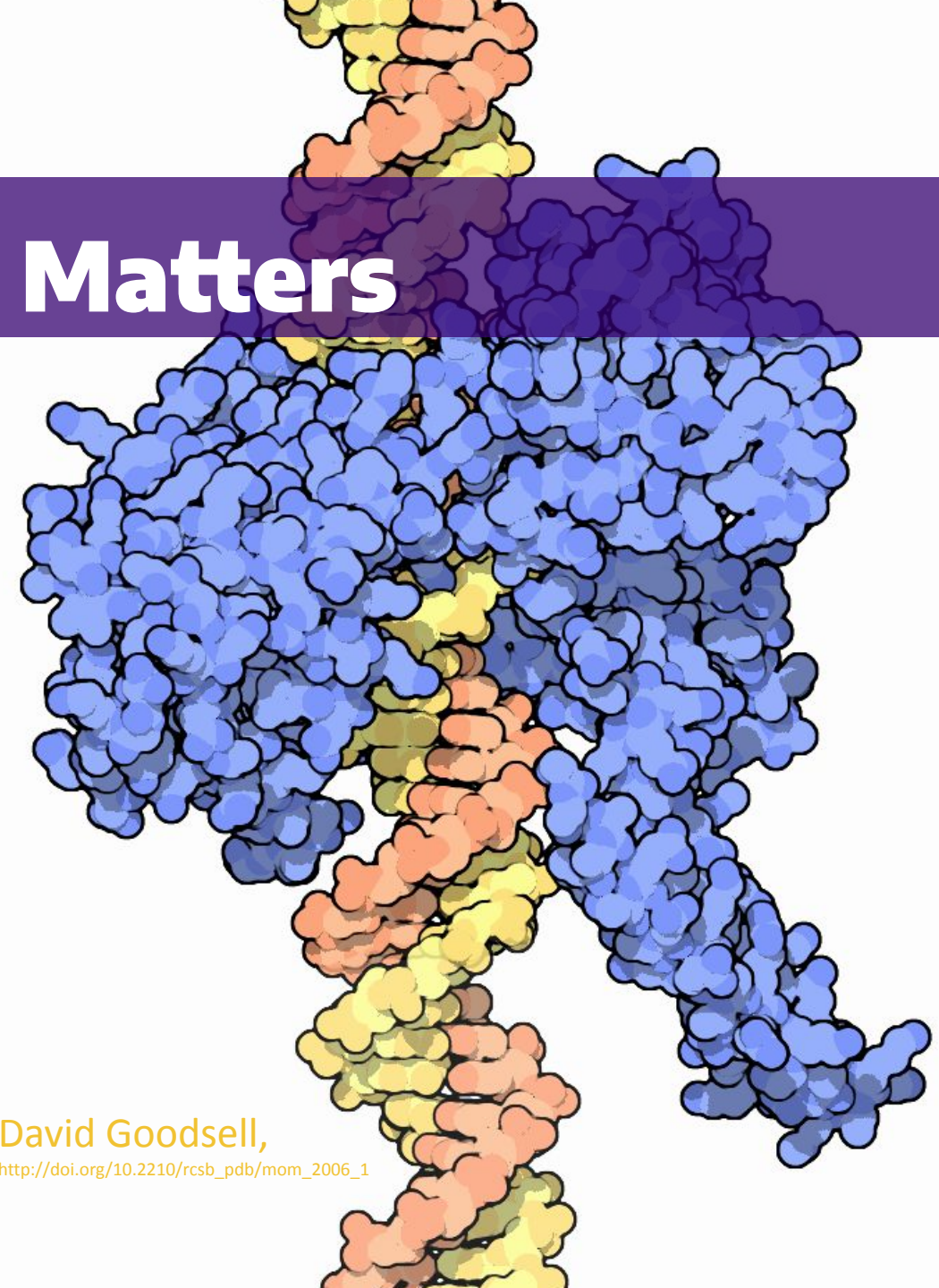
- > Faculty need effort to *integrate* molecular visualizations into their teaching
- > Collaboration is key
- > RCN “Lever of change” have impact for tech challenges.



David Goodsell,
http://doi.org/10.2210/rcsb_pdb/mom_2006_1

Why Structure-Function Matters

- > A core concept in biology & chemistry
- > Difficult to teach
- > Need integration of technology
- > Potential tech. skills gap



David Goodsell,

http://doi.org/10.2210/rcsb_pdb/mom_2006_1

Molecular CaseNet:

NSF-funded network goals

- **UG biology, chemistry, and biochemistry educators**
- **Develop molecular case studies**
- **Storytelling in various curricular contexts**
- **Study the development of faculty**





Happy Blue Baby; doi:10.25334/2R67-W933;

Molecules explored: Hemoglobin, including structures of native, mutant, and variant proteins



Nicholas' Story; doi:10.25334/H82J-3C28;

Molecules explored: Hemoglobin, including structures of native, mutant, and variant proteins; and complexes with drugs and gene therapy approaches



Waking up Anna; doi:10.25334/Y88F-9279;

Molecules explored: GABA-A receptor – a chloride ion channel



Evolution of Caffeine Biosynthesis Enzymes; doi:10.25334/225Z-KR22;

Molecules explored: Caffeine biosynthesis methyltransferases and their evolutionary relationships



COVID-19: Molecular Basis of Infection; doi:10.25334/HQCA-QD59;

Molecules explored: SARS-Cov-2 and SARS-CoV Spike protein complexes with Angiotensin-converting enzyme 2 (ACE2)



Piwi Matters; doi:10.25334/ZM3H-4149;

Molecules explored: Fruit fly Piwi protein structure, function, and design



A Case of Severe Insulin Resistance; doi:10.25334/DTTA-WW18;

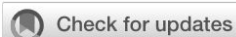
Molecules explored: Akt-2 kinase protein and mutation in insulin signaling



Maria vs Malaria; doi:10.25334/RSGM-5K8

Molecules explored: Lactate Dehydrogenase (parasitic and human), in complex with the coenzyme NADH and a competitive inhibitor





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storytelling: a conceptual framework for
teaching and learning with molecular case

Molecular storytelling: a conceptual framework for teaching and learning with molecular case studies

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¹Interdisciplinary Arts and Sciences, University of Washington Bothell, Bothell, WA, United States, ²Research Collaboratory for Structural Bioinformatics Protein Data Bank, Rutgers, The State University of New Jersey, New Brunswick, NJ, United States, ³Institute for Quantitative Biomedicine, Rutgers University, New Brunswick, NJ, United States, ⁴Cancer Institute of New Jersey, New Brunswick, NJ, United States

Molecular case studies (MCSs) provide educational opportunities to explore biomolecular structure and function using data from public bioinformatics resources. The conceptual basis for the design of MCSs has yet to be fully discussed in the literature, so we present molecular storytelling as a conceptual



Molecular Case Studies 3.0

THE HERO'S JOURNEY

Campbell 1949

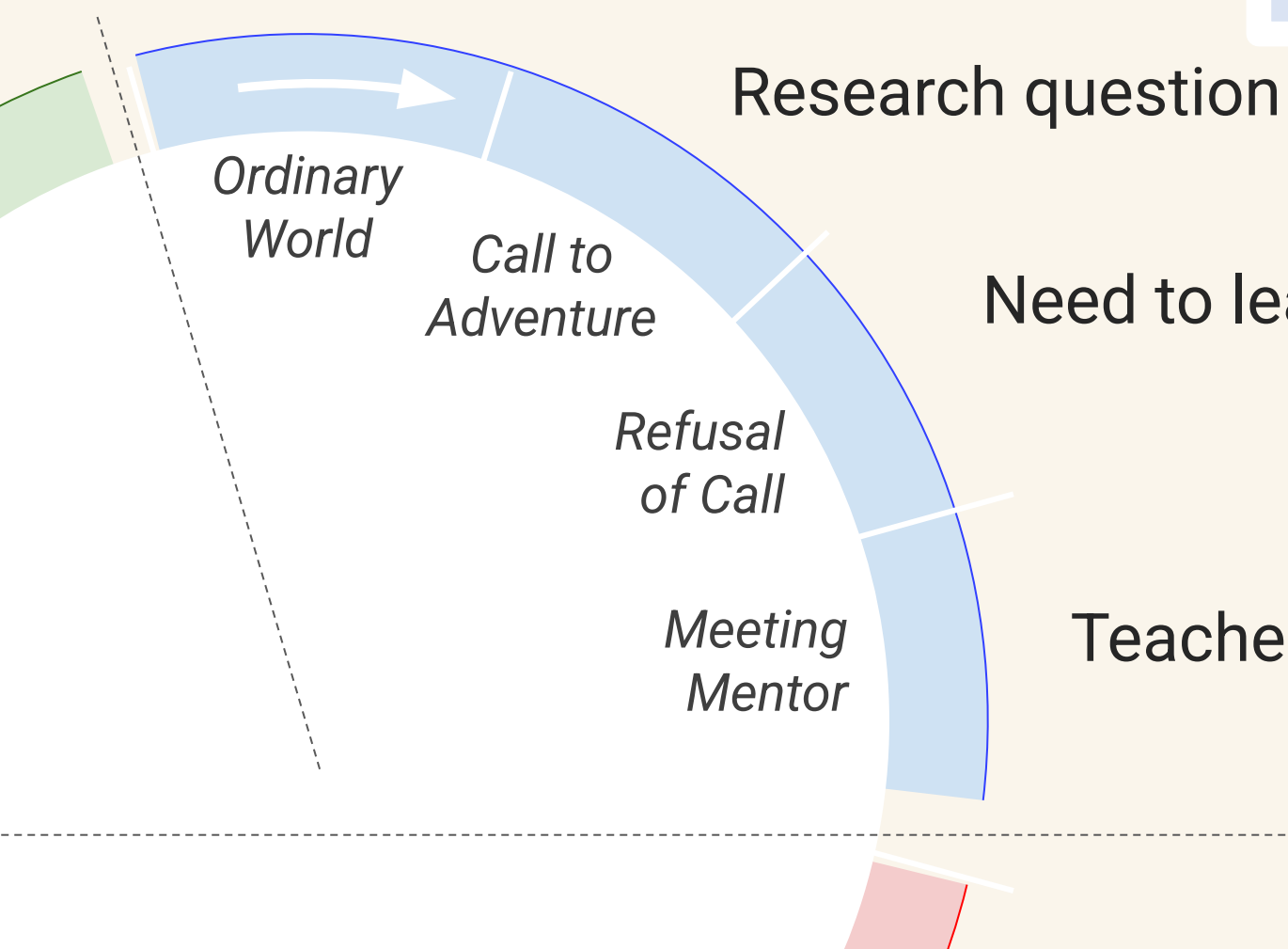
Volger 2007



MACROSCOPIC WORLD

Characters, contexts, and conflicts introduced

Introduce case



Research question

Need to learn

Teachers, lessons



Relate structure to function

The Reward

The Ordeal

Innermost Cave

Tests, Allies, Enemies

Crossing Threshold

Search for molecular structures and bioinformatics data

Analyze and compare relevant structures

Visualize info. on mol. structure

Identify case-relevant structures and data

MOLECULAR WORLD



CONNECTED WORLD

Relations between worlds are built

Apply new knowledge to
develop solutions

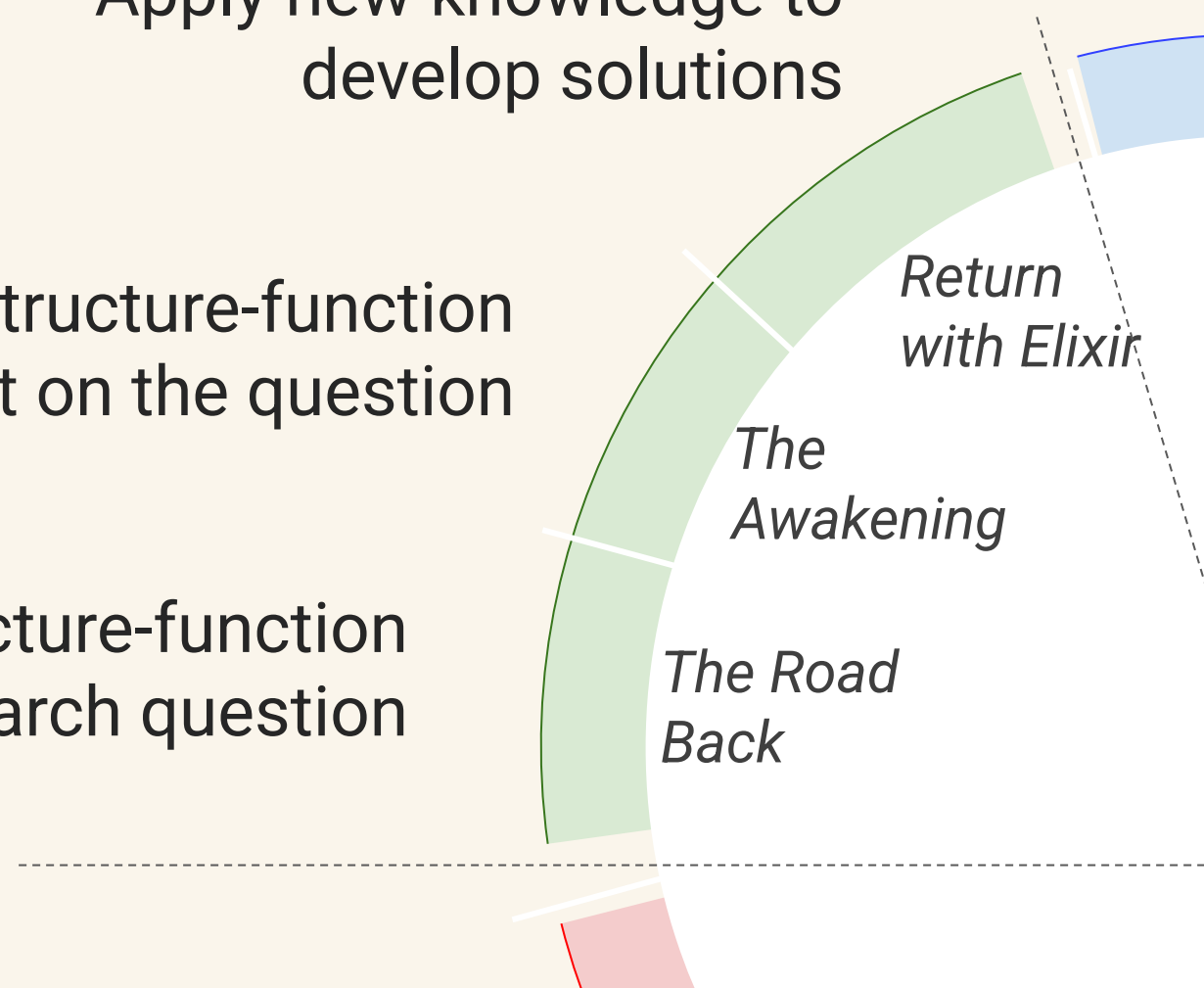
Explain structure-function
impact on the question

Relate structure-function
to the research question

*Return
with Elixir*

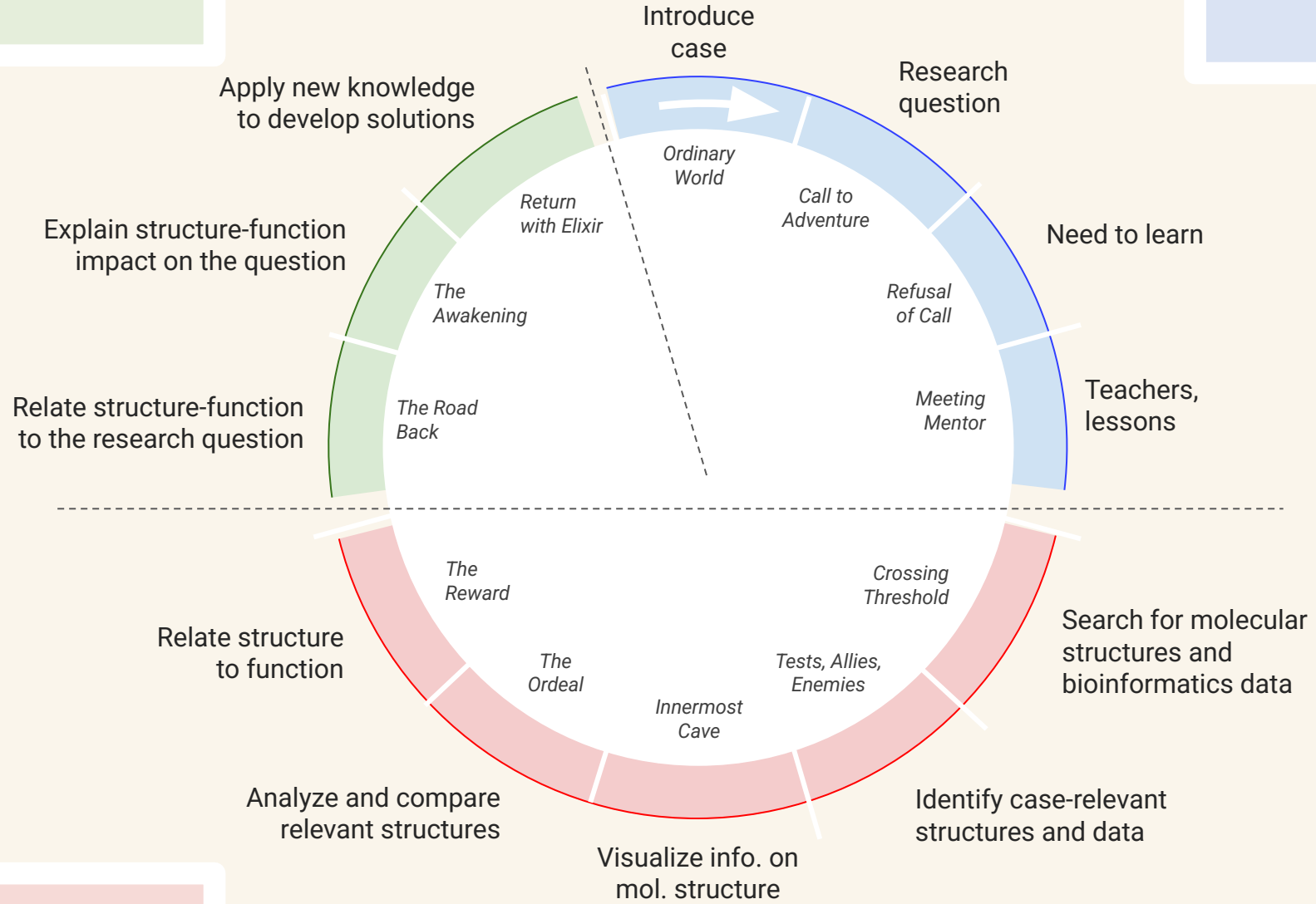
*The
Awakening*

*The Road
Back*



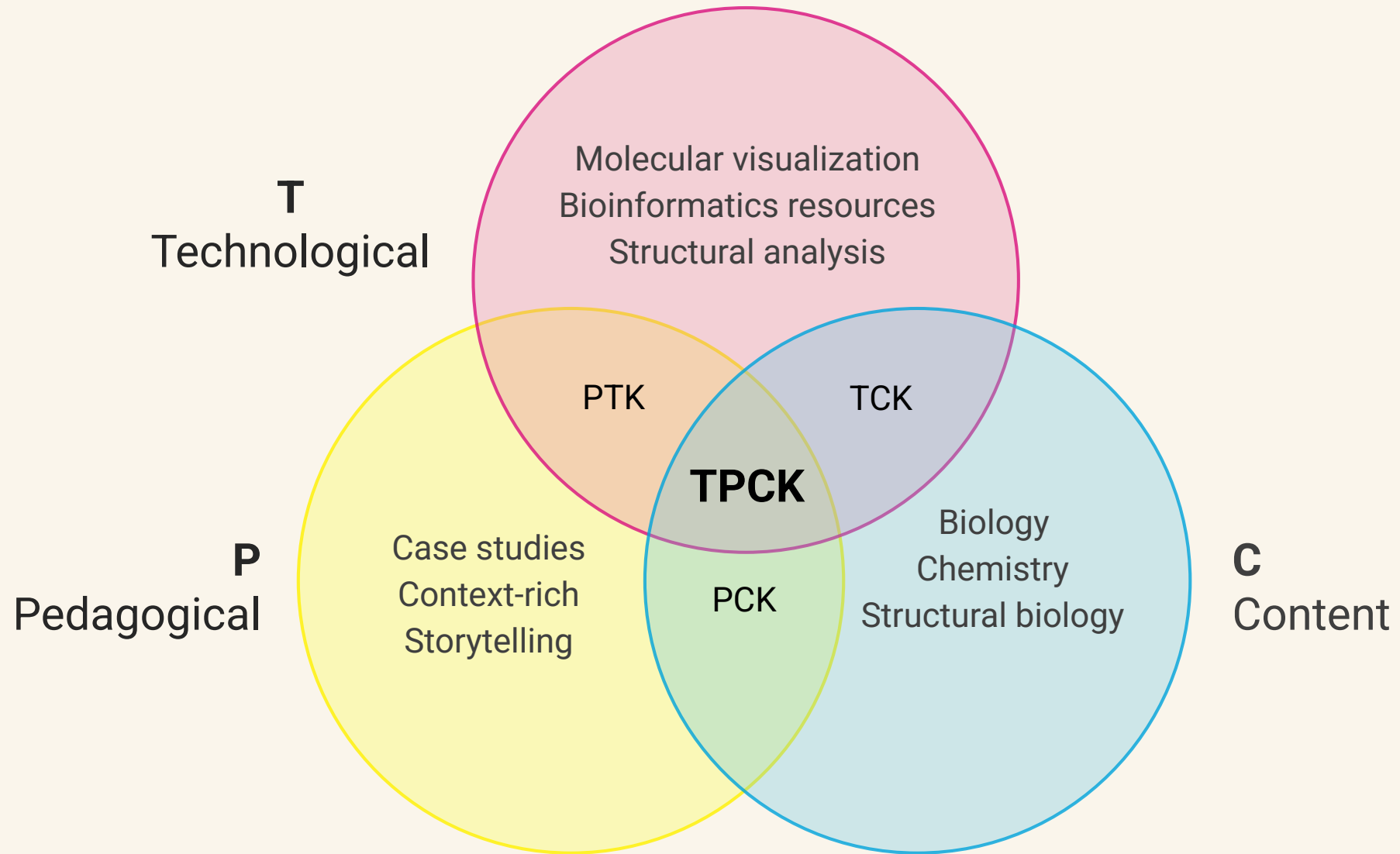
CONNECTED WORLD

MACROSCOPIC WORLD



MOLECULAR WORLD



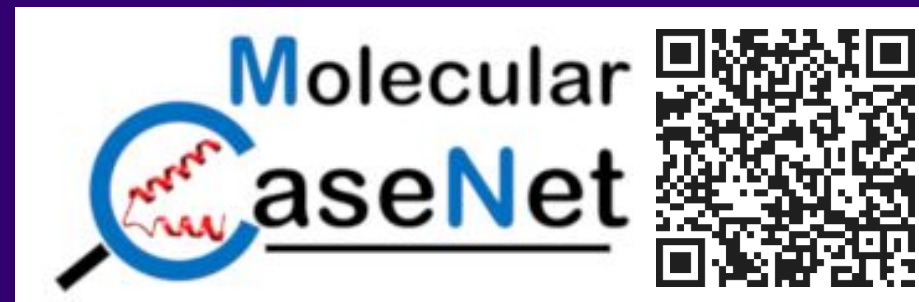


TPCK with overlapping areas as a combination.



Research Aims

1. Measure TPACK development
2. Explore integration of technology with pedagogy and content knowledge
3. Explain faculty experiences in Molecular CaseNet activities

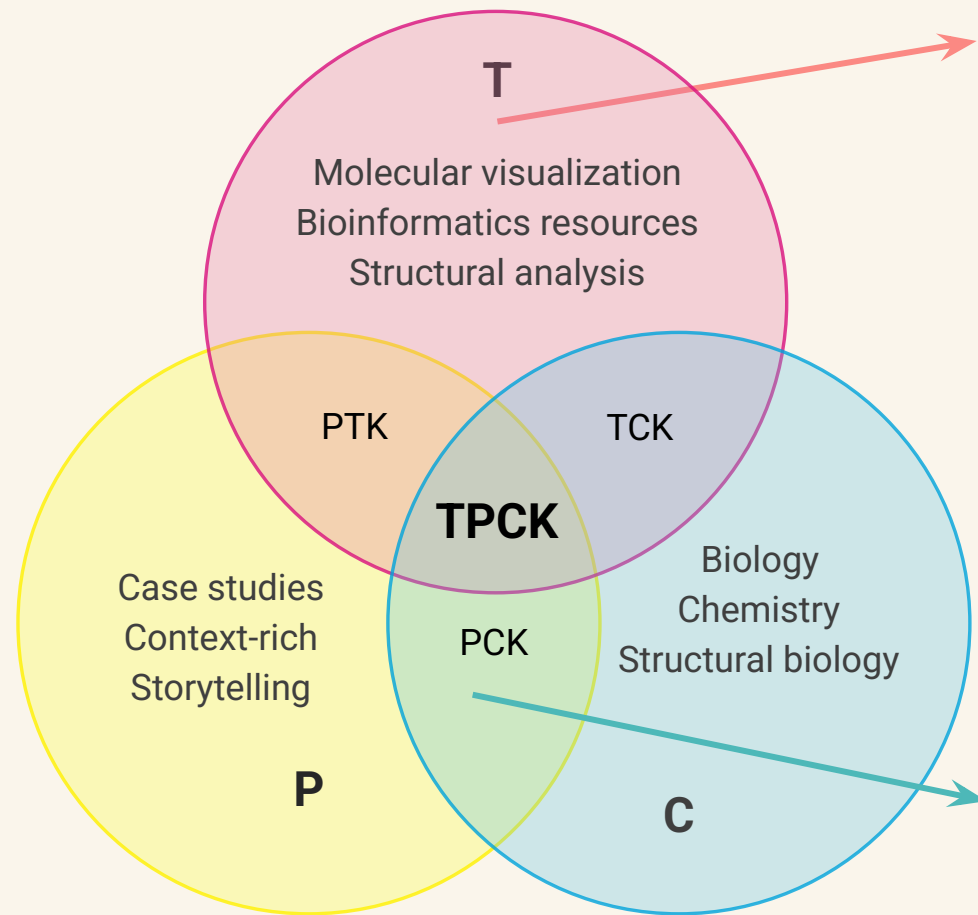


Methods

- > **Mixed-method design**
- > **MCN Participants: 60+ faculty**
 - **Surveys: Paired responses of 35-instructor**
 - **Interviews: 11 interviews**
 - **Artifacts: Authored cases, reviews, resources**



“Please select your current level of knowledge, experience, and confidence regarding...”

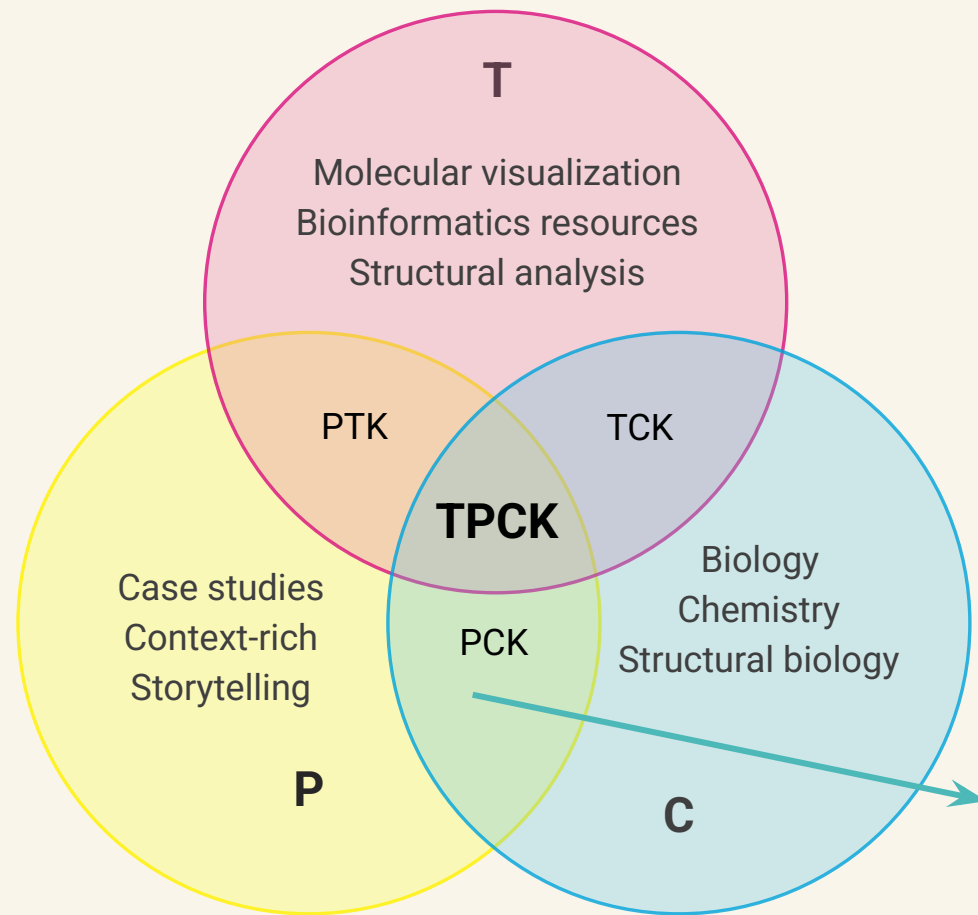


TPCK Venn diagram

T <i>Technology</i>
Using visualization tools (e.g., JSmol, iCn3D, UCSF Chimera, PyMOL, Mol*).

PC <i>Pedagogy and Content</i>
Teaching students structure-function relationships with case studies.

“Please select your current level of knowledge, experience, and confidence regarding...”



TPCK Venn diagram

TPC

Technology, Pedagogy and Content

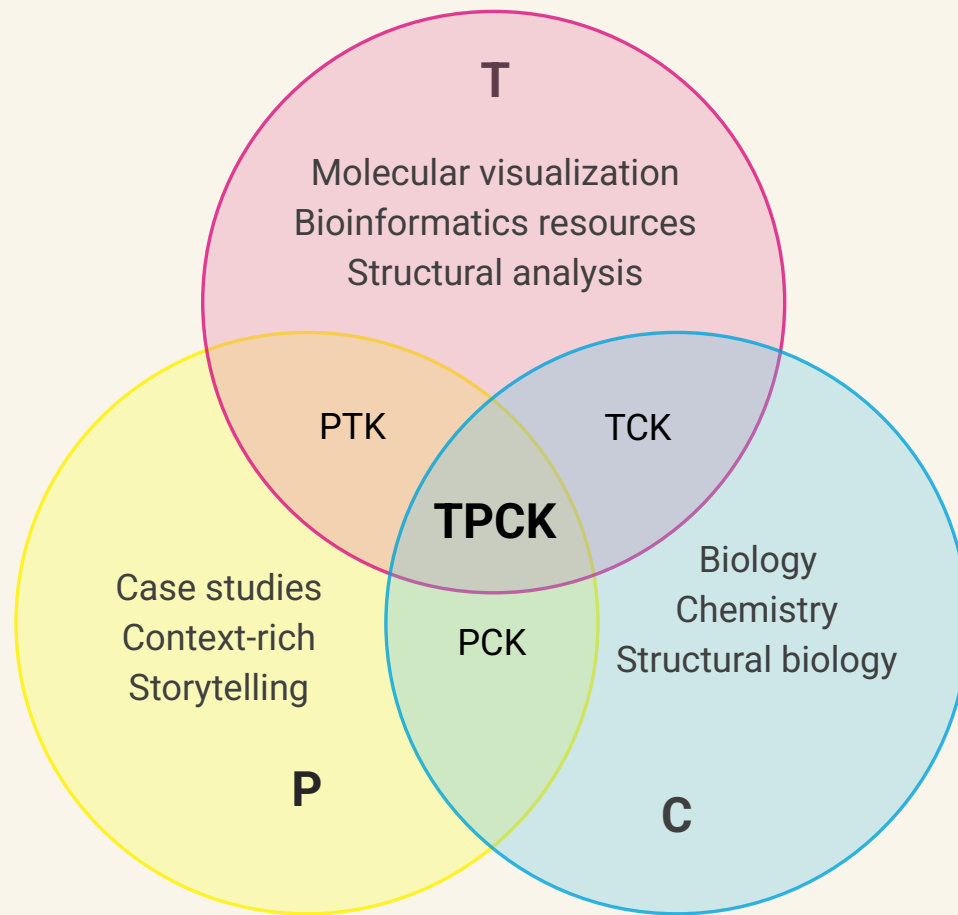
Teaching students to use structural data and a visualization tool, e.g., JSmol, iCn3D, UCSF Chimera, PyMol, Mol* for explaining how the interactions between specific parts of a protein, a nucleic acid, or a small molecule (e.g., ions drugs) facilitate its biological function.

PC

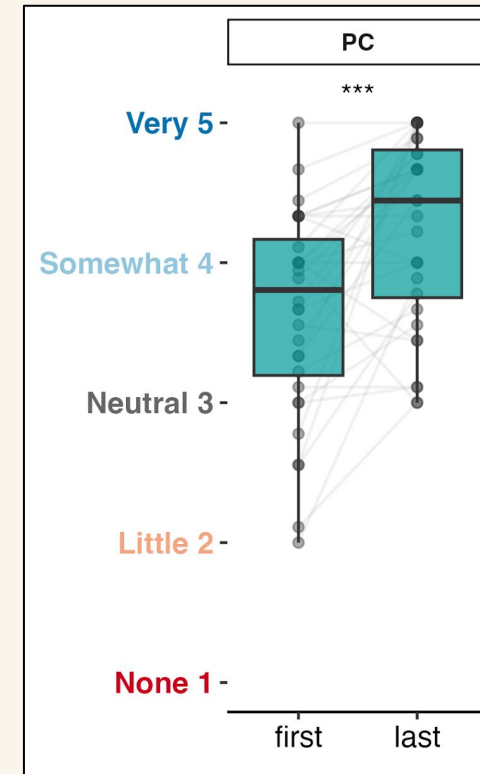
Pedagogy and Content

Teaching students structure-function relationships with case studies.

“Please select your current level of knowledge, experience, and confidence regarding...”



TPCK Venn diagram



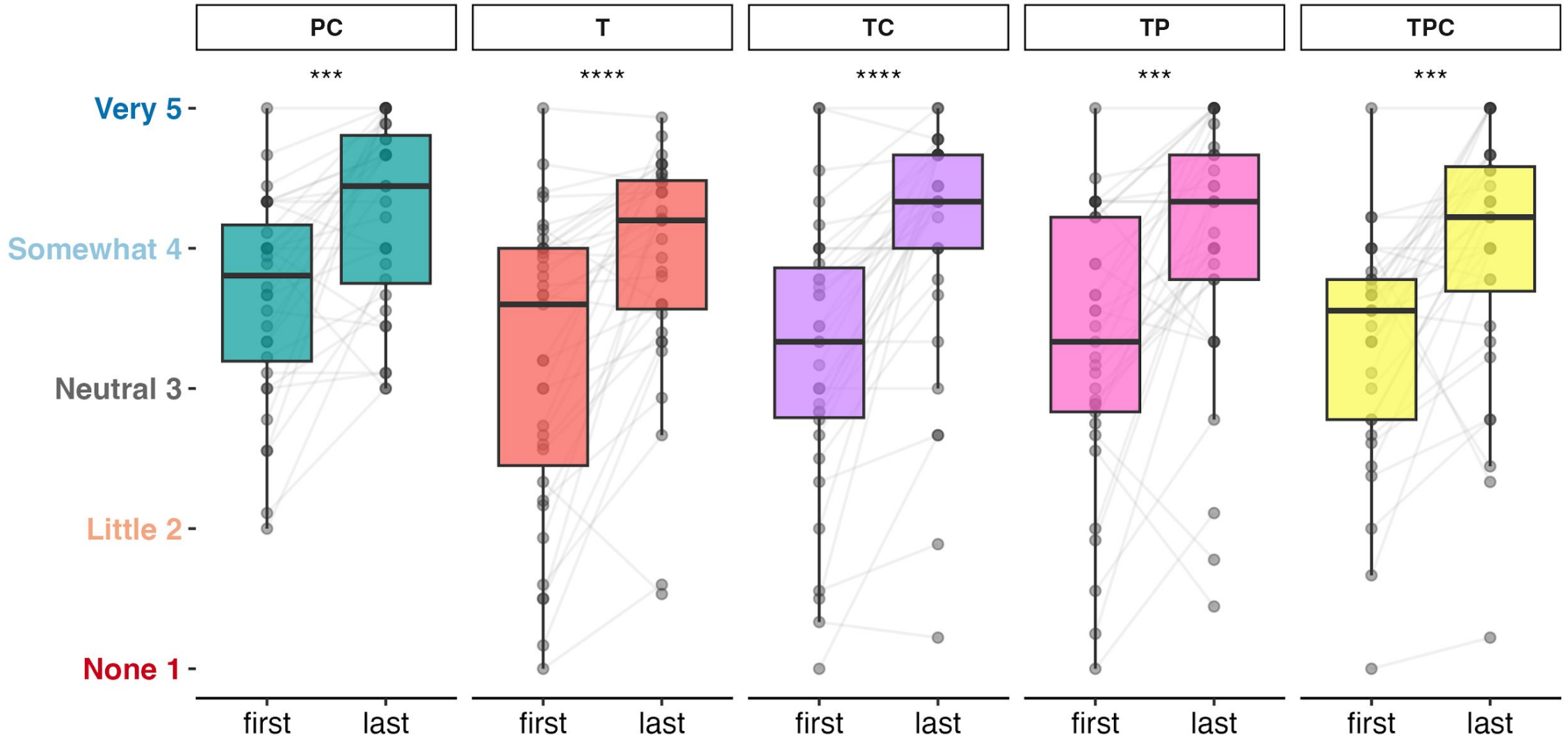
PC

Pedagogy and Content

Teaching students structure-function relationships with case studies.

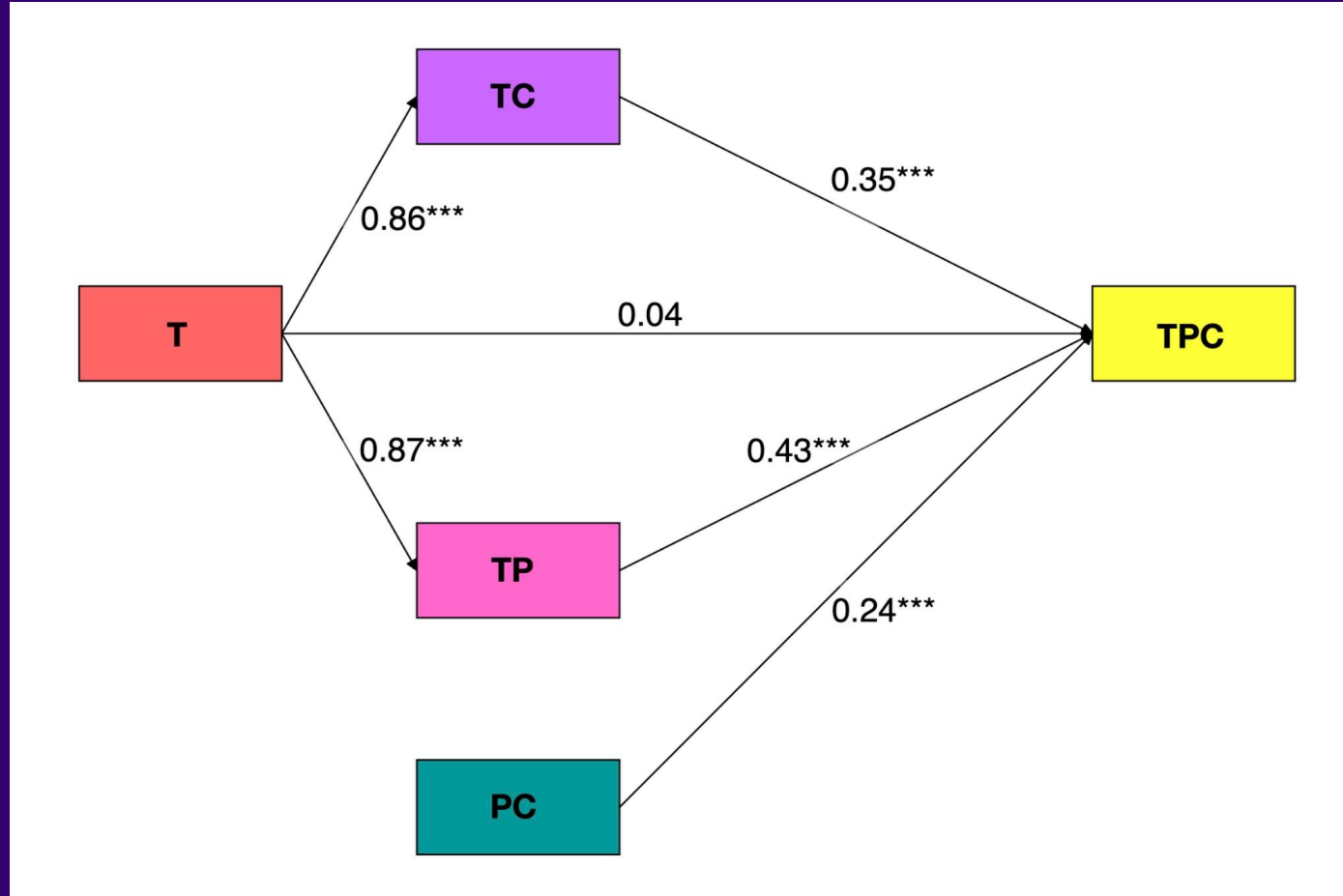
MCN participants Increased and Integrated TPCK

Average self-ratings of knowledge, confidence and experience by first-last measures.



Participants 2020-2025, n = 35.
Adjusted Wilcoxon paired tests shown.
Kruskal-Wallis: $p = 5.9e-15$ ****

Integration Matters



A structured equation model of the TPC measures across all timepoints. Regression analysis optimized by ML with NLMINB, including 94 of 119 observations.

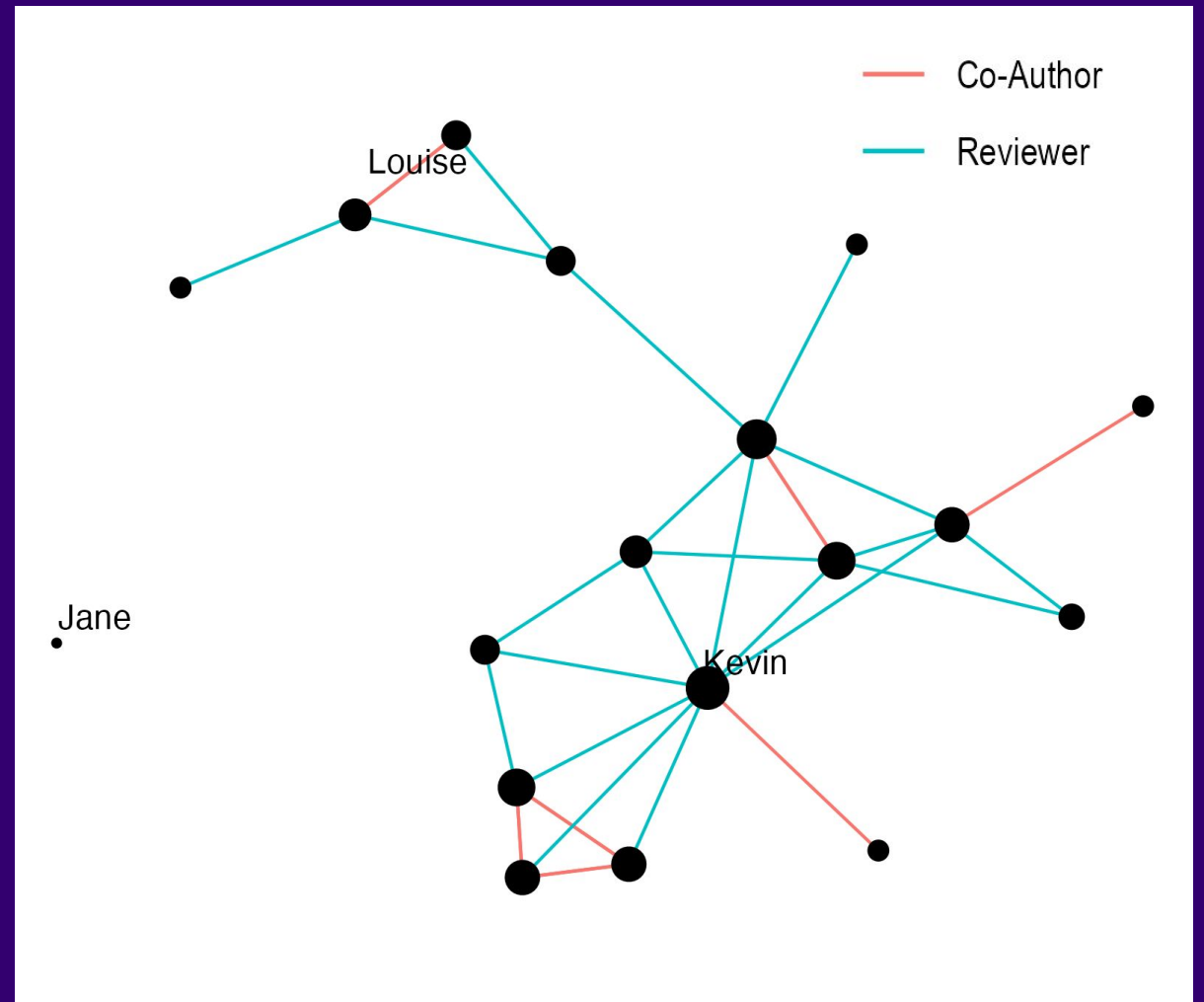
Episodic Narrative Interviews

- > **11 faculty - MCN participants (2023-2024 cohort)**
- > **Semi-structured questions focused on...**
 - **Defining molecular storytelling**
 - **Sharing an experience in the MCN**
 - **Unpacking how the experience related to their molecular storytelling**



Faculty Narratives

- *Louise: Collaboration boosted tech skills and integration*
- *Jane: Overcame tech challenges alone*
- *Kevin: Long-term engagement led to multiple collaborations*



Themes

- > Learning technology requires integration
- > Faculty value storytelling + authentic tools
- > Long-term engagement through collaboration sustains growth



Why it matters

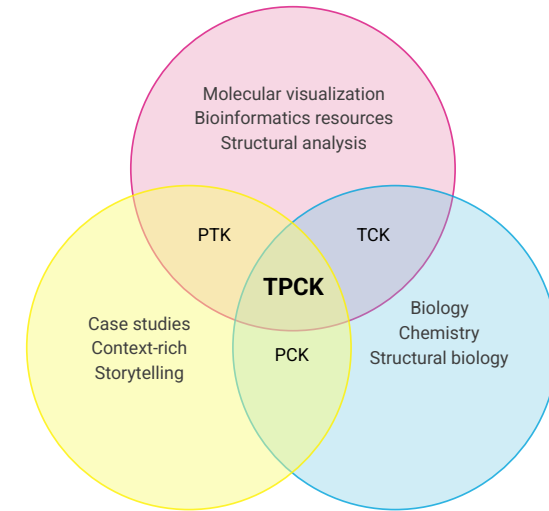
- > Collaborative networks are a “Lever of Change”
- > Foster long-term professional development
- > Supports interdisciplinary STEM coordination
- > Scaling-transformation:
 - Adoption for educational tech
 - Open-Educational Resources
 - Evidence-based Pedagogy



Implications & Future Directions

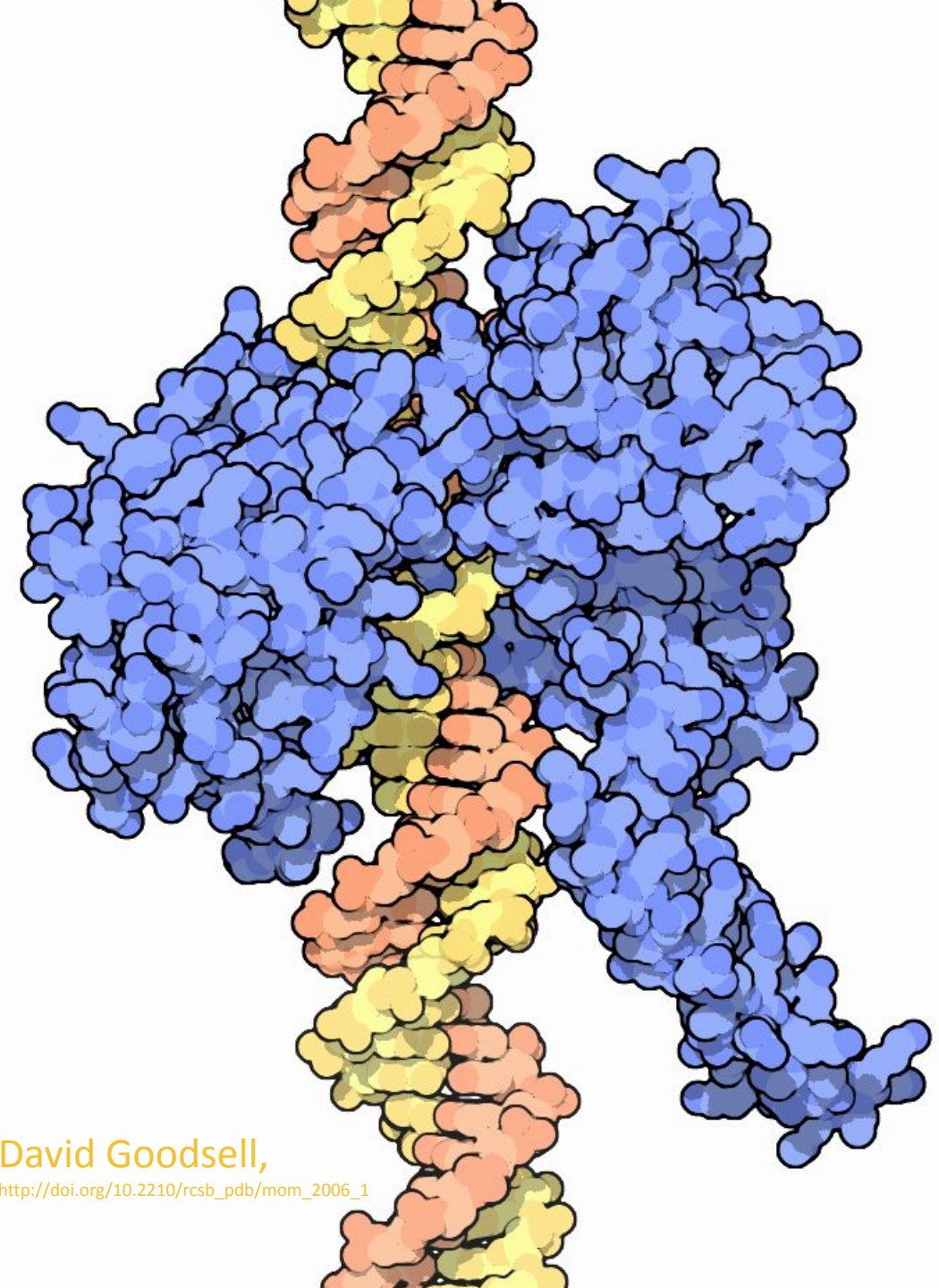
Usefulness of TPCK framework

- > Measurement method
- > Value for collaborative networks
- > Lessons for AI-TPCK
- > Long-term Community of Practice



Conclusion

- > **TPCK gains**
 - Through integration
 - not tech alone
- > **Collaboration is critical**



David Goodsell,

http://doi.org/10.2210/rcsb_pdb/mom_2006_1

Questions?
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HUGE thank you to

- > **participants,**
- > **collaborators, and**
- > **students!**



"We'd now like to open the floor to shorter speeches disguised as questions."

References see: Trujillo and Dutta (2024)
<https://doi.org/10.3389/feduc.2024.1379515>



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Listings

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Assistant Teaching Professor in Data Visualization

Posted: Jan 12, 2026

School of Interdisciplinary Arts and Sciences,
UW Bothell - Bothell, Washington

Application Deadline:
Feb 13, 2026

👤 Full-time



Assistant/Associate Professor of Exercise Science

Posted: Jan 9, 2026

Southern Wesleyan University - Central,

Salary: Monthly