A Sampling of CSU California Education Learning Lab (CELL) Awardees

Moderated by:
Dr. Frank A. Gomez
Executive Director, STEM-NET
Office of the Chancellor

https://www2.calstate.edu/impact-of-the-csu/research/stem-net
A Sampling of CSU California Education Learning Lab (CELL) Awardees

Speakers

Lark Park, California Education Learning Lab
Introducing the California Education Learning Lab

Ji Son, Cal State LA
The "Better Book" Approach: Using Student Data to Improve Introductory Statistics Materials

Delmar Larsen, UC Davis
ADAPT is Built for Multi-modal Use – Application

Sonal Singhal, CSU Dominguez Hills
Engaging Students as Scientists Through Authentic Research Inquiry

Earvin Balderama & Bianca Lopez Yendluri, Fresno State
The key to Success in STEM is Empowering all Students to take Ownership of their Learning

Youwen Ouyang & Marisol Clark-Ibáñez, CSU San Marcos
Giving the Ownership of Active Learning to Students in Computer Science (GOALS in CS)
California Education Learning Lab

Lark Park, Director
Program Overview

• Established by Statute in 2018
• Housed in Governor’s Office of Planning and Research
• Partnership with Foundation for CA Community Colleges
• Intersegmental by Design (CSU, UC, CCC)
• Initial Focus on STEM Success
• Innovation + Equity + Community
• 3 Core Areas:
  • Grantmaking
  • Community Building
  • Collecting & Promoting Best Practices
OUR MISSION

Improve learning outcomes and close equity gaps in California’s public higher education institutions.

OUR VALUES

We operate on the premise that all students are capable learners with potential for success given the right conditions, supports, and motivations. We believe that faculty are our greatest resource in helping students meet their goals, and that innovation begins with them.
Program Activities

**INNOVATION**
Award grants to faculty to test and enhance innovative approaches to teaching and learning.

**COMMUNITY**
Foster collaboration across public higher education systems and build a learning network among faculty.

**THEORY & RESEARCH**
Contribute to the science of human learning through funded projects and disseminate findings to faculty and other stakeholders.

**EDUCATIONAL PRACTICE**
Collect and promote data-driven teaching and learning practices.

**EDUCATIONAL POLICY**
Leverage data and findings from Learning Lab projects to influence California educational policy.
Funded Projects

- Seed & Prototype Projects
- Professional Development
- Demonstration Projects
- Institutional Change
- Grand Challenges
Funded Project Building Blocks

- Technology
- Pedagogy
- Equity
- Student-centric
- Faculty-facing
Program Stats

Learning Lab in Action

$42.7M in committed funding
82 funded projects
103 funded higher education institutions
475+ faculty leading funded projects
CSU Stats

• 23 of 23 campuses
• 160+ CSU faculty and other instructors as key personnel in awarded projects
• $12.7 million in funding direct to CSUs
• 55 unique projects
• Math & Data Science dominance
• Advisory Board Members Present & Past
Why Apply?

- CSU Graduation Initiative
- COVID-19 Impacts
- Equity Matters
- Students Have Changed
- Community
- Generative AI

"Support from the Learning Lab was incredibly important to the success of this work. Beyond the fiscal support, the symbolic value of having such an important program provide backing, advice, structure, and connections cannot be overstated." (Increasing Student Flow and Success Along Intersegmental STEM Program Pathways)

"Thank you for this opportunity. The Learning Lab is making a difference!" (Eliminating Equity Gaps in Online Gateway STEM Courses through Humanized Instruction)
Lessons from the Past Five Years

• Change leadership is necessary
• Administrative hurdles can be addressed
• Intersegmental work is rewarding
• Sustainability is inconsistent
• Scalability will require different models
• Difficult, tumultuous times will continue
Next Grant Opportunity

Fill Out Our Survey!

AI Call For Ideas
FROM THE CALIFORNIA EDUCATION LEARNING LAB

- https://calearninglab.org/ai-call-for-ideas/
Next Steps for Learning Lab

- AI CALL FOR IDEAS SURVEY
- PROFESSIONAL LEARNING/PROFESSIONAL DEVELOPMENT
- LEARNING LAB ASSET DATABASE (LLAD)
- CONTINUOUS IMPROVEMENT ON GRANTMAKING
- EXPAND OUTREACH
Our Next Convening

2024 INSPIRE CONVENING
Reimagining the Future of Teaching and Learning
Questions?

California Education Learning Lab

😊 info@calearninglab.org

😊 www.calearninglab.org

lark.park@calearninglab.org
The “Better Book” Approach: Using Data to Improve Statistics Education

Ji Y. Son, PhD, Cal State LA
Teaching Hard Things to All Students

Collaboration Across Segments and Systems of Education
After CA community colleges reduced developmental math courses (AB705), 50% of math enrollment is now in statistics courses. A similar (albeit less widely studied) CSU policy is Chancellor’s Office EO1110.

OPPORTUNITY TO MODERNIZE STATS
OPPORTUNITY TO MODERNIZE STATS

A Modeling Approach

DATA = MODEL + ERROR

Connecting stats to modeling with algebraic functions

Interactive Textbook (R)

In-Class Jupyter Notebooks
OPPORTUNITY TO MODERNIZE HOW WE STUDY STUDENT LEARNING
<table>
<thead>
<tr>
<th>Results</th>
<th>Activities</th>
</tr>
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<tbody>
<tr>
<td><strong>Overview</strong></td>
<td>5.2 The Mean as a Model</td>
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<tr>
<td></td>
<td>5.3 Fitting the Empty Model</td>
</tr>
<tr>
<td></td>
<td>5.4 Generating Predictions from the Empty Model</td>
</tr>
<tr>
<td></td>
<td>5.5 Venturing into the World of Mathematical Notation</td>
</tr>
<tr>
<td></td>
<td>5.6 DATA + MODEL + ERROR: Notation</td>
</tr>
<tr>
<td></td>
<td>5.7 Statistics and Parameters</td>
</tr>
<tr>
<td></td>
<td>5.8 The Power of Aggregation</td>
</tr>
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<td></td>
<td>5.9 Summarizing Where We Are</td>
</tr>
<tr>
<td></td>
<td>5.10 Chapter 5 Review Questions</td>
</tr>
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<td></td>
<td>5.11 Chapter 5 Review Questions 2</td>
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</table>

<table>
<thead>
<tr>
<th>Lessons Learned</th>
<th>Next Steps</th>
</tr>
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<tbody>
<tr>
<td><strong>Chapter 6 - Quantifying Error</strong></td>
<td></td>
</tr>
<tr>
<td>6.0 Quantifying Total Error Around a Model</td>
<td></td>
</tr>
<tr>
<td>6.1 The Beauty of Sum of Squares</td>
<td></td>
</tr>
</tbody>
</table>
The “Better Book” Model

Using student data to *improve* how we teach statistics.

What did we learn?
Example 1: Small Improvements!

Excerpt:

It is important to note that what is equal about the four quartiles is the number of data points included in each...
Example 1: Small Improvements!

The quartiles are equally sized. What is "equal" about the quartiles?

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>They each have the same range on the variable (i.e., 1-10, 11-20, 21-30, 31-40).</td>
<td>28%</td>
</tr>
<tr>
<td>B</td>
<td>They each have the same data points.</td>
<td>1%</td>
</tr>
<tr>
<td>C</td>
<td>They each have the same number of data points.</td>
<td>46%</td>
</tr>
<tr>
<td>D</td>
<td>They each have the same interval.</td>
<td>25%</td>
</tr>
</tbody>
</table>
Example 1: Small Improvements!

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Example 1: Small Improvements!

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<p>| | | | |</p>
<table>
<thead>
<tr>
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<tr>
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<tr>
<td>D</td>
<td>They each have the same interval.</td>
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<td>3%</td>
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</table>
Example 2: COVID x Campus

In-person

Remote

Importance of context!
Example 2: COVID x Campus

In-person

Remote

Importance of context!
Example 2: COVID x Campus

Importance of context!
Example 2: COVID x Campus

Increases in Anxiety in CC and CSU

<table>
<thead>
<tr>
<th>Anxiety</th>
<th>CC</th>
<th>CSU</th>
<th>UC</th>
</tr>
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<tbody>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
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<tr>
<td>3</td>
<td></td>
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<tr>
<td>1</td>
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</tr>
</tbody>
</table>

COVID-19 Declaration

in-person  remote  in-person  remote  in-person  remote

- CC: Red circles indicate increases in anxiety.
- CSU: Yellow circles indicate increases in anxiety.
- UC: Green circles indicate decreases in anxiety.
Example 2: COVID x Campus

Even with more open policies, no changes in beliefs about memorization
Example 2: COVID x Campus

Even with more open policies, no changes in beliefs about memorization.
Example 3: Design for Equity

Utility Value: the relevance and perceived usefulness of content

Concerns and challenges in introductory statistics and correlates with motivation and future interest.
Example 3: Design for Equity

**Utility Value:** the relevance and perceived usefulness of content

**Cost:** perceived time and energy needed to succeed in this chapter

---

Example 3: Design for Equity

**Utility Value:** the relevance and perceived usefulness of content

**Cost:** perceived time and energy needed to succeed in this chapter

---

**NURM** (non-underrepresented)

**URM** (underrepresented racially minoritized: Black, Latine, Indigenous)

---

Example 3: Design for Equity

V4.0:
- Page lengths inconsistent
- Ch7 twice as long as others
- Notation for models introduced before visual representation

V5.0:
- More consistent length of pages
- Split contents of Ch7 into 2 chapters
- Visual introduction to models before notation

Example 3: Design for Equity

V4.0:
- Page lengths inconsistent
- Ch7 twice as long as others
- Notation for models introduced before visual representation

V5.0:
- More consistent length of pages
- Split contents of Ch7 into 2 chapters
- Visual introduction to models before notation

Doing the research and storing innovations *in* the student-facing materials!
CourseKata.org

Statistics curriculum continuously improved by research.
THANK YOU!

@cogscimom
@coursekata
Introducing The ADAPT Open Homework and Assessment Platform

Delmar Larsen
Executive Director, LibreTexts
Professor, Department of Chemistry,
University of California, Davis

• ADAPT
  (https://ADAPT.LibreTexts.org)
• Studio (https://studio.libretexts.org)
ADAPT is brought to you by the California Education Learning Lab
How do you build an online homework system that complements the utility of the LibreTexts Infrastructure and is:

- Flexible,
- Dynamic,
- Comprehensive,
- Integrated,
- LMS agnostic,
- Powerful, &
- and free or nearly free?
Slowly and Efficiently

Don't reinvent the wheel!
ADAPT is Built for Multi-modal Use - Technology

No single technology can handle all use cases. Our solution is to build ADAPT with multiple technologies capable of handling numerous use cases.
<table>
<thead>
<tr>
<th></th>
<th>WebWork</th>
<th>IMathAS</th>
<th>H5P</th>
<th>QTI</th>
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<td>Assessment Delivery</td>
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<td>Assessment Checker</td>
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<td>Gradebook</td>
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<tr>
<td></td>
<td>LMS Interface</td>
<td>LMS Interface</td>
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</tbody>
</table>
ADAPT is Built for Multi-modal Use – Application

Different Instructors have different pedagogies in their use of Homework.
estimated that up to 1 million people have IBD in the United States. Half of these individuals have Crohn’s disease, and the other half have ulcerative colitis. The figure in the link below illustrates the differences between these two conditions.

The exact causes of these two diseases is not known. One hypothesized cause is an overactive immune system (autoimmune response, the immune system attacks tissues/cells rather than pathogens) that results in the chronic inflammation and collateral damage to the cells of the intestine, resulting in formation of lesions.

Crohn’s disease and ulcerative colitis present symptoms similar to other gastrointestinal diseases, such as irritable bowel syndrome and GERD.

Query 5.4.1

Crohn’s disease primarily affects the colon or rectum, while ulcerative colitis primarily affects the ileum. Both these conditions may be a result of the immune system attacking the intestinal cells.

- True
- False

Check
Anywhere and Anytime

User ADAPT as a handheld homework interface for easy access to homework.

Use ADAPT as a **Personal Response Systems**: This enables instructors to pose questions to students and immediately collect and view the responses of the entire class.

Useful for labs and collaborative projects (e.g., easy submission of pictures of collective or individual work)
ADAPT is Built for Multi-modal Use – Delivery

Students interact with problems via traditional Assignment/Question approach or via an adaptive Learning Tree approach that enables individualized assessment and learning.
Workflows

Learning Management Systems

- Realtime (LTI) Delayed Learning Trees

ADAPT

- Summative or Formative Assessment Technologies

Embedded as Modules

Textbook

- Open-ended Assessments

- QTI

- H5P server

- IMathAS

- WebWork

- Open Ended
Learning Analytics – Data at your Fingertips

Snapshot of the homework activity for a class in the learning analytics dashboard showing the activity of all assignments (blue) and of a specific assignment (red).
Ideal question is …

- Autograd (if possible)
- Pedagogical Solution
- Algorithmic
- Significant Figures and precision
- Feedback (Mastering Approach)
ADAPT in Action

Over 190,000 questions in the centralized question bank and **growing rapidly**
### ADAPT in Action

90 Premade Courses available in the Commons – mostly STEM.

250+ Public “Courses” available

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Beginning Chemistry (Ball)</strong></td>
<td>This text introductory chemistry text is aimed for a single semester or quarter beginning experience to the field. The textmaps survey some of the basic topics of chemistry. This survey should give student enough knowledge to appreciate the impact of chemistry in everyday life and, if necessary, prepare student for additional instruction in chemistry.</td>
</tr>
<tr>
<td><strong>Big Ideas in Cosmology</strong></td>
<td>Development of Big Ideas in Cosmology began with extensive research and vigorous peer review, to ensure the quality of the content and the level of instruction. Field testing was conducted at Sonoma State University to evaluate the effectiveness of the publication’s methods and pedagogy, which revealed high levels of engagement and comprehension for science and non-science majors alike.</td>
</tr>
<tr>
<td><strong>University Physics II (OpenStax)</strong></td>
<td>University Physics is a three-volume collection that meets the scope and sequence requirements for two- and three-semester calculus-based physics courses. Volume 2 covers thermodynamics, electricity, and magnetism.</td>
</tr>
<tr>
<td><strong>University Physics I (OpenStax)</strong></td>
<td>University Physics is a three-volume collection that meets the scope and sequence requirements for two- and three-semester calculus-based physics courses. Volume 1 covers mechanics, sound, oscillations, and waves.</td>
</tr>
<tr>
<td><strong>University Physics III (OpenStax)</strong></td>
<td>University Physics is a three-volume collection that meets the scope and sequence requirements for two- and three-semester calculus-based physics courses. Volume 3 covers optics and modern physics.</td>
</tr>
<tr>
<td><strong>General, Organic, and Biological Chemistry (Ball)</strong></td>
<td>The Basics of General, Organic, and Biological Chemistry by David W. Ball, John W. Hill, and Rhonda J. Scott. This textbook is intended for the one-semester GOB course. Although a two-semester GOB sequence is available at many colleges and universities, one-semester GOB offerings are increasing in popularity. This textbook is divided into approximately one-half general chemistry topics, one-fourth organic chemistry topics, and one-fourth biochemistry topics.</td>
</tr>
<tr>
<td><strong>Microbiology (OpenStax)</strong></td>
<td>Microbiology covers the scope and sequence requirements for a single-semester microbiology course for non-majors. The book presents the core concepts of microbiology with a focus on applications for careers in allied health. The pedagogical features of the text make the material interesting and accessible while maintaining the career-application focus and scientific rigor inherent in the subject matter. Microbiology’s art program enhances students’ understanding of concepts through clear and effective illustrations, diagrams, and photographs.</td>
</tr>
<tr>
<td><strong>General Biology (OpenStax)</strong></td>
<td>Biology is a natural science concerned with the study of life and living organisms, including their structure, function, growth, evolution, distribution, and taxonomy. Modern biology is a vast and eclectic field, composed of many branches and subdisciplines. However, despite the broad scope of biology, there are certain general and unifying concepts within it that govern all study and research, consolidating it into single, coherent fields. Subdisciplines of biology are defined by the scale at which organisms are studied, the kinds of organisms studied, and the methods used to study them.</td>
</tr>
</tbody>
</table>

[https://adapt.libretexts.org/open-courses/commons](https://adapt.libretexts.org/open-courses/commons)
<table>
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<tr>
<th>ID</th>
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<tr>
<td>8</td>
<td>Gravitational Energy Question</td>
<td>Delmar Larsen</td>
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<tr>
<td>13</td>
<td>Identifying Significant Figures</td>
<td>Andreas Beyersdorff</td>
</tr>
<tr>
<td>22</td>
<td>Rounding Significant Figures</td>
<td>Andreas Beyersdorff</td>
</tr>
<tr>
<td>23</td>
<td>Significant Figures Calculations (Addition/Subtraction)</td>
<td>Andreas Beyersdorff</td>
</tr>
<tr>
<td>24</td>
<td>Significant Figures Calculations (Multiplication/Division)</td>
<td>Andreas Beyersdorff</td>
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<tr>
<td>25</td>
<td>Metric Conversion Basics</td>
<td>Andreas Beyersdorff</td>
</tr>
<tr>
<td>29</td>
<td>Molarity</td>
<td>Larry Mink</td>
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<tr>
<td>30</td>
<td>Dilution (154)</td>
<td>Larry Mink</td>
</tr>
<tr>
<td>31</td>
<td>Stoichiometry grams to grams (196)</td>
<td>Larry Mink</td>
</tr>
<tr>
<td>32</td>
<td>Stoichiometry and Limiting Reagent (197)</td>
<td>Larry Mink</td>
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<tr>
<td>33</td>
<td>Determination of molarity by titration (198)</td>
<td>Larry Mink</td>
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<td>34</td>
<td>Combustion Analysis and Empirical Formula (273)</td>
<td>Larry Mink</td>
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<tr>
<td>35</td>
<td>Reaction stoichiometry (192)</td>
<td>Larry Mink</td>
</tr>
</tbody>
</table>
The Future of ADAPT

Development Goal: Building Quantity and Quality

Expanding Scope into other STEM fields:
- Physics,
- Engineering,
- Biology,
- Applied Health
- Mathematics,
- Statistics

Expand technology
- Jupyter Tech for statistic and data sciences
- Greater Analytics
- Field specific Technology (e.g., organic chemistry, spreadsheets for statistics, virtual dissection)
Engaging Students as Scientists Through Authentic Research Inquiry

Sonal Singhal

on behalf of our CSU Dominguez Hills, El Camino College & UC Irvine team

Associate Professor // CSU Dominguez Hills
Who are we: CSU Dominguez Hills, El Camino College, UC Irvine

CSU Dominguez Hills
Carson, CA
- Regional comprehensive university
- Predominantly undergraduate institution
- 77% underrepresented minority
- 48% first-generation

El Camino College
Torrance, CA
- California Community College
- Offers Associate degrees as terminal degree
- 72% underrepresented minority
- 51% first-generation

UC Irvine
Irvine, CA
- Part of University of California system
- R1 university
- 33% underrepresented minority
- 50% first-generation
Our team at CSU Dominguez Hills, El Camino College, UC Irvine

Brynn Heckel
CSUDH

Sam Leigh
CSUDH

Karin Kram
CSUDH

Charlie McCord
CSUDH

Sonal Singhal
CSUDH

Kathryn Theiss
CSUDH

Justin Valliere
CSUDH

Fang Wang
CSUDH

Darcie McClelland
El Camino

Polly Parks
El Camino

Karla Villatoro
El Camino

Rachael Barry
UC Irvine

Suzanne Bohlson
UC Irvine

Brian Sato
UC Irvine

Lauren Snow
UC Irvine

not pictured: Bryan Carey (El Camino College), Nancy Roback (CSUDH), Carolyn Yarnall (CSUDH)
Our project goal was to provide inquiry-based experiences for biology students across our 3 campuses.
What was our approach?
Our starting point was cookbook labs

sunday PASTA

The time it takes your son to make her Sunday pasta varies in admirable. But let's face it, she's going to love that recipe too. The sauce is her favorite, and it's easy to make. So why not throw together all of the best elements of the Italian combo sauce, and let them go. The fact that you can't read her recipe into your son's face. Well, don't do that. your son is a amazing and lovely adult (but she's still young).
How do we go from here to there?
Collaborative design of learning objectives
Our final learning objectives

• Engage with the tenets of the scientific method
• Communicate effectively
• Work effectively in a team of their peers.
• Recognize the diversity of participants within the scientific community.
• Effectively use quantitative skills to address scientific questions.
Curriculum structure provided natural scaffolding
<table>
<thead>
<tr>
<th>Course</th>
<th>Scientific Citation</th>
<th>Scientific Literature</th>
<th>Lab Reports</th>
<th>Figure/Table Generation</th>
<th>Lab Presentation</th>
<th>Teamwork</th>
<th>Statistics</th>
<th>Hypothesis Generation</th>
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<tbody>
<tr>
<td>Bio 121</td>
<td>Parts of a citation</td>
<td>Primary v secondary and trustworthiness</td>
<td>Writing figure legend</td>
<td>Identify dependent &amp; independent variable</td>
<td>What should a presentation contain?</td>
<td>Simple t-test</td>
<td>Difference between question and hypothesis</td>
<td>Hypothesis should have a direction</td>
</tr>
<tr>
<td>Bio 123</td>
<td>Create a literature-cited page in proper CSE format</td>
<td>Finding scholarly sources, reading scientific literature, and evaluating the quality of various types of literature</td>
<td>What is plagiarism and how to avoid it</td>
<td>Paraphrasing</td>
<td>Make a histogram, understand why/how bar graphs can be misleading, be able to explain relationships among variables</td>
<td>Presentation skills; focus on the skeleton of solid presentations and press into how to make the science presenting better</td>
<td>Goal setting for individual and group norms, expectations, etc. at start of term; end of term reflection of teamwork</td>
<td>Descriptive stats; t-test; chi-square</td>
</tr>
<tr>
<td>Bio 125</td>
<td>How to use a citation manager (Zotero)</td>
<td>How to break down figures</td>
<td>Writing introduction</td>
<td>Making histogram</td>
<td>What does an effective slide look like?</td>
<td>How to use collaborative tools to help facilitate group work</td>
<td>ANOVAs? Or correlations?</td>
<td>Null vs. alternate hypotheses</td>
</tr>
<tr>
<td>Bio 221</td>
<td>Find a relevant paper and cite it</td>
<td>Describe a figure from a paper to the class</td>
<td>Create a report with embedded figures and reference them.</td>
<td>Create graph from spreadsheet with axes labeled and a sound legend.</td>
<td>Describe a figure from a paper to the class</td>
<td>Lab groups.</td>
<td>Question vs. hypothesis vs. prediction. Was the hypothesis supported by the data?</td>
<td></td>
</tr>
<tr>
<td>Upper div bio courses</td>
<td>Use multiple primary sources for a report and cite them</td>
<td>Describe multiple figures from a paper to the class</td>
<td>Deeper focus on scientific language</td>
<td>Multi-panel figure</td>
<td>Full-story presentation</td>
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</table>
This project touched a lot of students.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Number of courses</th>
<th>Students per course (per semester)</th>
<th>Total students across courses (per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSU Dominguez Hills</td>
<td>10</td>
<td>~40</td>
<td>~500</td>
</tr>
<tr>
<td>El Camino College</td>
<td>4</td>
<td>~40</td>
<td>~300</td>
</tr>
<tr>
<td>UC Irvine</td>
<td>2</td>
<td>~1500</td>
<td>~3000</td>
</tr>
</tbody>
</table>
Our learning objectives were implemented across a diversity of inquiry-based experiences.
An example of a guided inquiry: Bio Sci 93 @ UC Irvine
Maria, Metastasis, and Methotrexate

- A case-study centered on cancer biology
- This case study was designed to have students:
  - Apply their knowledge re: the cell cycle
  - Interpret data and figures from primary scientific literature
  - Explore the contributions of scientists from marginalized backgrounds

Jewel Plummer Cobb
MTX in treatment of childhood cancers

Jane Cooke Wright
MTX in treatment of solid tumors

https://www.nsta.org/ncss-case-study/maria-metastasis-and-methotrexate
• Students develop a research question on the role of soils in plant growth
• This project is designed to have students
  • Develop research questions, hypotheses, and methods
  • Implement experiment with colleagues
  • Use R to analyze and graph data
  • Share results in standard scientific formats
So did it work?
How did we assess?

- Informal
  - Group discussions

- Formal
  - Student survey
  - Faculty survey
  - Retention in major (ongoing)
Our anecdata & faculty survey show many positives and some challenges

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Students were more engaged</td>
<td>• Needed more examples of authentic inquiry labs</td>
</tr>
<tr>
<td>• More fun for students &amp; faculty</td>
<td>• More time-consuming</td>
</tr>
<tr>
<td>• Easier to engage with students</td>
<td>• Required more on-your-feet thinking</td>
</tr>
<tr>
<td>• Lab staff liked the changes</td>
<td>• Can be challenging to implement curriculum across sections</td>
</tr>
<tr>
<td>• Labs were cheaper</td>
<td>(logistics, instructor buy-in)</td>
</tr>
<tr>
<td></td>
<td>• Did not work online</td>
</tr>
<tr>
<td></td>
<td>• Logistics non-trivial</td>
</tr>
</tbody>
</table>
How are we measuring success?

- Increasing student retention in the major
- Increasing student efficacy in their scientific abilities
  - Engage with the tenets of the scientific method
  - Communicate effectively
  - Effectively use quantitative skills to address scientific questions
- Increasing student sense of belonging in the major
  - Work effectively in a team of their peers
  - Recognize the diversity of participants within the scientific community
Student outcomes improved!
Engage with the tenets of the scientific method:
Level of experience with an independent research project
Communicate effectively:
Level of experience with writing a research proposal
Work effectively in a group of your peers:
The people near me have learned from me
Recognize the diversity of scientists in our community:
I know of one or more scientists with whom I can personally relate
Effectively use quantitative skills to address scientific questions.

Level of experience with analyzing data:

- Before (pre): None, Some, Extensive
- After (post): None, Some, Extensive
Where to next?
Acknowledgements

- Our grant participants
- Our faculty and staff at each institution
- Our funders, CA Learning Lab

For questions, please contact:
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ssinghal@csudh.edu

Questions ???
On-ramp to STEM

The key to success in STEM is empowering all students to take ownership of their learning.

project website: bit.ly/onramptostem

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byendluri@mail.fresnostate.edu
Motivation

For many students, **College Algebra** and **Precalculus** are a roadblock to a STEM degree.

- Low passing rates
- Lack of conceptual understanding
- Lack of confidence and negative mindsets
- Unprepared for subsequent math courses
- Large learning/achievement gap for URM students
On-Ramp to STEM project

- **Goal #1**: *Transform the culture of learning* in math classrooms
- **Goal #2**: Develop and utilize suitable *Adaptive Learning Technology* and appropriate pedagogy to assist students of all backgrounds.
- **Goal #3**: Improve the learning outcomes and *close the achievement gaps* among student populations
Impacted courses (~1000 students)

Fall 2022
- 11 Precalculus classes at Fresno State
- 2 Precalculus classes at Clovis Community College
- 4 College Algebra classes at Fresno City College
- 1 Advanced math class at University High School

Spring 2023
- 8 Precalculus classes at Fresno State
- 3 classes (2 Precalculus/1 College Algebra) at Clovis Community College
- 2 College Algebra classes at Fresno City College
- 1 Advanced math class at University High School

Summer 2023
- 1 Precalculus class at Fresno State

Fall 2023
- 10 Precalculus classes at Fresno State
- 1 College Algebra class at Clovis Community College
- 3 College Algebra classes at Fresno City College
Engage instructors in Culturally Responsive Teaching

- Summer Workshops
  - Invited experts in Culturally Responsive Teaching (CRT) pedagogies
- Check-in meetings with instructors during the year
- Peer observations/feedback
- Shared resources - CRT implementation journal
New Classroom for PreCalc at Fresno State

- Dedicated classroom for precalculus courses at Fresno State.
- Whiteboards around the room and tables and chairs to promote active learning, collaborations and discourse.
**SCALE** (Student-Centered Adaptive Learning Environment)

- “A platform for delivering adaptive instruction online, and provides a framework that guides the learner through the instructional content based on proven theories about how people learn effectively.”
  - Dr. Bill Ferster, University of Virginia.
**SCOOL** (Student-Centered Open Online Learning)

- Developed by **Dr. Cecotti and students** of Fresno State Computer Science.

- To guide students through the learning process
  - **Formative** and **summative** assessments
  - Homework or extra credit assignments
  - Independent and autonomous learning

- Integrated through CANVAS LMS API
Knowledge map

- Knowledge map: A hierarchical concept map of learning outcomes.
  - Created by team of expert Math instructors.
  - Learning outcomes derived from OpenStax textbook.
  - Connected ~220 learning outcomes from College Algebra and Precalculus.

- Feedback to the user
  - If you master a learning outcome, what is next?
  - If you have problems with activities related to a given learning outcome, what prerequisite learning outcomes were not met?

- Empower students to build and improve on prerequisite skills.

- Enable instructors to identify roadblocks in learning pathways.
## Chapter 1 Learning Outcomes

<table>
<thead>
<tr>
<th>Section</th>
<th>LO #</th>
<th>Section Title</th>
<th>Learning Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>1.1.1</td>
<td>Functions and Function Notation</td>
<td>Determining Whether a Relation Represents a Function</td>
</tr>
<tr>
<td>1.1</td>
<td>1.1.2</td>
<td>Functions and Function Notation</td>
<td>Finding Input and Output Values of a Function</td>
</tr>
<tr>
<td>1.1</td>
<td>1.1.3</td>
<td>Functions and Function Notation</td>
<td>Determining Whether a Function is One-to-One</td>
</tr>
<tr>
<td>1.1</td>
<td>1.1.4</td>
<td>Functions and Function Notation</td>
<td>Using the Vertical Line Test</td>
</tr>
<tr>
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<td>1.1.5</td>
<td>Functions and Function Notation</td>
<td>Using the Horizontal Line Test</td>
</tr>
<tr>
<td>1.1</td>
<td>1.1.6</td>
<td>Functions and Function Notation</td>
<td>Identifying Basic Toolkit Functions</td>
</tr>
<tr>
<td>1.2</td>
<td>1.2.1</td>
<td>Domain and Range</td>
<td>Finding the Domain of a Function Defined by an Equation</td>
</tr>
<tr>
<td>1.2</td>
<td>1.2.2</td>
<td>Domain and Range</td>
<td>Using Notations to Specify Domain and Range</td>
</tr>
<tr>
<td>1.2</td>
<td>1.2.3</td>
<td>Domain and Range</td>
<td>Finding Domain and Range from Graphs</td>
</tr>
<tr>
<td>1.2</td>
<td>1.2.4</td>
<td>Domain and Range</td>
<td>Finding Domains and Ranges of the Toolkit Functions</td>
</tr>
<tr>
<td>1.2</td>
<td>1.2.5</td>
<td>Domain and Range</td>
<td>Graphing Piecewise-Defined Functions</td>
</tr>
<tr>
<td>1.3</td>
<td>1.3.1</td>
<td>Rates of Change and Behavior of Graphs</td>
<td>Finding the Average Rate of Change of a Function</td>
</tr>
<tr>
<td>1.3</td>
<td>1.3.2</td>
<td>Rates of Change and Behavior of Graphs</td>
<td>Using a Graph to Determine Where a Function is Inc, Dec, or Const</td>
</tr>
<tr>
<td>1.3</td>
<td>1.3.3</td>
<td>Rates of Change and Behavior of Graphs</td>
<td>Analyze the Toolkit Functions for Increasing or Decreasing Intervals</td>
</tr>
<tr>
<td>1.3</td>
<td>1.3.4</td>
<td>Rates of Change and Behavior of Graphs</td>
<td>Use A Graph to Locate the Absolute Maximum and Absolute Minimum</td>
</tr>
<tr>
<td>1.4</td>
<td>1.4.1</td>
<td>Composition of Functions</td>
<td>Combining Functions Using Algebraic Operations</td>
</tr>
<tr>
<td>1.4</td>
<td>1.4.2</td>
<td>Composition of Functions</td>
<td>Create a Function by Composition of Functions</td>
</tr>
<tr>
<td>1.4</td>
<td>1.4.3</td>
<td>Composition of Functions</td>
<td>Evaluating Composite Functions</td>
</tr>
<tr>
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<td>1.4.4</td>
<td>Composition of Functions</td>
<td>Finding the Domain of a Composite Function</td>
</tr>
<tr>
<td>1.4</td>
<td>1.4.5</td>
<td>Composition of Functions</td>
<td>Decomposing a Composite Function into its Component Functions</td>
</tr>
<tr>
<td>1.5</td>
<td>1.5.1</td>
<td>Transformation of Functions</td>
<td>Graphing Functions Using Vertical and Horizontal Shifts</td>
</tr>
<tr>
<td>1.5</td>
<td>1.5.2</td>
<td>Transformation of Functions</td>
<td>Graphing Functions Using Reflections about the Axes</td>
</tr>
<tr>
<td>1.5</td>
<td>1.5.3</td>
<td>Transformation of Functions</td>
<td>Decomposing Even and Odd Functions</td>
</tr>
<tr>
<td>1.5</td>
<td>1.5.4</td>
<td>Transformation of Functions</td>
<td>Graphing Functions Using Stretches and Compressions</td>
</tr>
<tr>
<td>1.5</td>
<td>1.5.5</td>
<td>Transformation of Functions</td>
<td>Performing a Sequence of Transformations</td>
</tr>
<tr>
<td>1.6</td>
<td>1.6.1</td>
<td>Absolute Value Functions</td>
<td>Understanding Absolute Value</td>
</tr>
<tr>
<td>1.6</td>
<td>1.6.2</td>
<td>Absolute Value Functions</td>
<td>Graphing an Absolute Value Function</td>
</tr>
<tr>
<td>1.6</td>
<td>1.6.3</td>
<td>Absolute Value Functions</td>
<td>Solving an Absolute Value Equation</td>
</tr>
<tr>
<td>1.6</td>
<td>1.6.4</td>
<td>Absolute Value Functions</td>
<td>Solving an Absolute Value Inequality</td>
</tr>
<tr>
<td>1.7</td>
<td>1.7.1</td>
<td>Inverse Functions</td>
<td>Verifying That Two Functions Are Inverse Functions</td>
</tr>
<tr>
<td>1.7</td>
<td>1.7.2</td>
<td>Inverse Functions</td>
<td>Finding Domain and Range of Inverse Functions</td>
</tr>
<tr>
<td>1.7</td>
<td>1.7.3</td>
<td>Inverse Functions</td>
<td>Finding and Evaluating Inverse Functions</td>
</tr>
<tr>
<td>1.7</td>
<td>1.7.4</td>
<td>Inverse Functions</td>
<td>Finding Inverse Functions and Their Graphs</td>
</tr>
</tbody>
</table>
Chapter 1 Knowledge map
MATH 6 (03) - Precalculus
4dcc18e235b9b40a79d81691e155694fe6784683
Browse Practice Questions

Please select a Chapter, a Section, and a Learning Outcome.

Chapter

Select a Chapter

Section

Select a Section

Learning Outcome

Select a Learning Outcome

Go
1.1.1. Determining Whether a Relation Represents a Function

**Question (1/5): 1.1.1**

Determine whether the relation represents a function: \( \{(a, b), (b, c), (c, c)\} \).

- Not a function
- Function

Submit Answer

<table>
<thead>
<tr>
<th>Attempts</th>
<th>Correct</th>
<th>Correct Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
1.1.1. Determining Whether a Relation Represents a Function

Chapter 1 Introduction

Toward the end of the twentieth century, the values of stocks of internet and technology companies rose dramatically. As a result, the Standard and Poors stock market average rose as well. Figure 1 tracks the value of that initial investment of just under $100 over the 40 years. It shows that an investment that was worth less than $500 until about 1995 skyrocketed up to about $1,100 by the beginning of 2000. That five-year period became known as the dot-com bubble because so many internet startups were formed. As bubbles tend to do, though, the dot-com bubble eventually burst. Many companies grew too fast and then suddenly went out of business. The result caused the sharp decline represented on the graph beginning at the end of 2000. Notice, as we consider this example, that there is a definite relationship between the year and stock market average. For any year we choose, we can determine the corresponding value of the stock market average. In this chapter, we will explore these kinds of relationships and their properties.

Learning Outcome Information

Learning Outcome Tag: 1.1.1
Number of questions for this learning outcome: 5

By mastering this learning outcome, we suggest you to visit:

1.1.2- Learning Outcome: Finding Input and Output Values of a Function of Section: Functions and Function of Chapter: Functions
1.1.3- Learning Outcome: Determining Whether a Function is One-to-One of Section: Functions and Function of Chapter: Functions
1.1.5- Learning Outcome: Using the Horizontal Line Test of Section: Functions and Function of Chapter: Functions
1.1.6- Learning Outcome: Identifying Basic Toolkit Functions of Section: Functions and Function of Chapter: Functions
Percentage Correct by Chapter

- Chapter 1: 75% Correct
- Chapter 2: 75% Correct
- Chapter 3: 50% Correct
- Chapter 4: 75% Correct
- Chapter 5: 50% Correct
- Chapter 6: 25% Correct
- Chapter 7: 50% Correct

Legend:
- Correct
  - No
  - Yes
20-question Rolling % Correct over time

Percentage

0%
25%
50%
75%
100%

Time
Jun 15
Jul 01
Jul 15

Student
1
2
3
4
5
6
7
Lessons Learned

● No simple set of ingredients that makes a “Culturally Responsive” classroom.
  ○ Ambiguity of what CRT “looks like”
  ○ Instructors were unsure if they were actually doing CRT – wanted a list of boxes to check off.
  ○ CRT is more like an “environment”

● Very difficult and time-consuming to create new software.
  ○ Obtaining buy-in from instructors very challenging.
Early instructor feedback

“Even if something seems really obvious from our perspective, a student could easily be lost”

“When there’s a lot of clicking to get to things, it’s very annoying.”

“By making it optional, . . . they just chose not to do those things.”
Next Steps

- Source code in github, available as an OER.
- Data analyses: compare pre-post surveys and student performance data.
- Continued implementation of SCOOL beyond grant period.
Recent instructor feedback

- “I've had compliments from the students saying that this is **how a math class should be**.”

- “I was very heavy in lecturing earlier. Now, then, I was **lecturing very less**.”

- “It's been a fun process to develop activities that have the students work together in groups and not just on like canned examples from a textbook… using an actual building in Fresno, or something rather than just like a canned textbook problem. So it's that sort of thing to just make all of the applications **meaningful for students from the valley**.”
Thank you for your attention!

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- Department of Computer Science
  - Hubert Cecotti, hcecotti@mail.fresnostate.edu

Website:

On-ramp to STEM

The key to success in STEM is empowering all students to take ownership of their learning.

project website: bit.ly/onramptostem
Giving the Ownership of Active Learning to Students in Computer Science (GOALD in CS)

Youwen Ouyang, Computer Science
Marisol Clark-Ibáñez, Sociology
California State University San Marcos
Project Overview

- Partnership between CSU and CC
- Focus on introductory sequence
- Interactive online course content via Open Learning Initiative (OLI) and Canvas
- Flipped classroom format

GOALS in CS by the numbers
- 37 sections
- 35 instructors
- 1548 students

Continued implementation after grant has ended.
Culturally relevant: Accept and affirm the culture and identities of students of color. ACCEPTING

Culturally responsive: Use familiar cultural information and processes to scaffold learning. Emphasis on community and relationships (pedagogy). CONNECTING

Culturally sustaining: Schools are places where the cultural ways of being in communities of color are sustained and not erased or seen as deficit. TRANSFORMING

Students Feel Validated When They Believe:

“I matter.”

“Someone cares about me.”

“I am a capable person.”
Interactive textbook via Open Learning Initiative (OLI)

In-lecture group projects

In-lab individual projects with breakout room support

Individual programming homework
Methodology

Surveys

- **Data collection sites**: Introductory CS redesigned & non-redesigned courses at 2 HSIs
- **Collection period**: end-of-semester surveys from Fall 2019 - Fall 2022
- **Survey measures**: career interests, student efficacy, active participation, student validation, and cultural relevance in computer science.
- **N= 396** college students

Data analysis

- **IBM SPSS** program (version 26)
- **Pearson’s chi-square**: categorical survey responses & identify significant patterns between GOALS & Non-GOALS students in CS.
Results

Student Validation

<table>
<thead>
<tr>
<th>Statement</th>
<th>Redesigned CS Courses</th>
<th>Non-Redesigned CS Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felt comfortable asking CS instructors' questions on mis/uncovered content</td>
<td>81%</td>
<td>67%</td>
</tr>
<tr>
<td>CS instructors understood my strengths</td>
<td>60%</td>
<td>38%</td>
</tr>
<tr>
<td>CS instructor helped me improve my performance in classes</td>
<td>82%</td>
<td>56%</td>
</tr>
<tr>
<td>Felt I mattered to CS instructor</td>
<td>79%</td>
<td>62%</td>
</tr>
</tbody>
</table>

Active Participation

<table>
<thead>
<tr>
<th>Statement</th>
<th>Every week/once in a while:</th>
<th>Every week/once in a while:</th>
<th>Every week/once in a while:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asked professor questions in class</td>
<td>83%</td>
<td>73%</td>
<td>78%</td>
</tr>
<tr>
<td>Asked TAs questions in class</td>
<td>67%</td>
<td>59%</td>
<td>73%</td>
</tr>
<tr>
<td>Asked peers questions in class</td>
<td>67%</td>
<td>59%</td>
<td>73%</td>
</tr>
</tbody>
</table>
Results

**Cultural Relevance**

“I feel that I was able to share my culture/interests through projects when we were allowed to include this things in projects.”

“This course certainly provided exceptional cultural sensitive subject matter while simultaneously providing comprehensive course content.”
Lessons Learned

- One size does not fit all
- Active, adaptive learning demands more responsive feedback
- Learning analytics provoke reflection and refinement
- Essential elements also must include:
  - Intentional conversations
  - Center student voices
  - Interdisciplinary collaborations

- Self-reflection can lead to culturally responsive teachers (CS faculty)
- Continued professional development needed (e.g., difficult to change)
- Classroom development: try things out, research & improve
- Share strengths: building like-minded faculty and/or department (e.g., hiring priorities)
Summary

The highly iterative and collaborative redesign featured:

- **Skill Mapping**: students & CS faculty contributed to the development
- **Flipped Classroom**: interactive, online material
- **Classroom Community**: active learning with students as near-peer mentors in class
- **Culturally Sustaining**: content and pedagogies
- **Continuous Data Collection**: focus on student voice on progress, successes, and challenges
- **Training**: Support and coaching provided for CS faculty
Thank you!

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Next Steps/Closing Remarks

Dr. Frank A. Gomez
Executive Director, STEM-NET
Office of the Chancellor

https://www2.calstate.edu/impact-of-the-csu/research/stem-net
Webcast Feedback Survey

Please take a few moments to tell us about your webcast experience.

Use the QR Scan Code to download it
STEM-NET February Webcast
Topic: Department of Education Awardees
Date: Feb. 7, 2024
Time: 10:00 AM - 12:00 PM

Register Here
Join our CSU STEM-NET Community listserv
 csustemnet@lists.calstate.edu

Begin a Conversation with Colleagues and Join our Private CSU STEM-NET Facebook Group
 https://www.facebook.com/groups/2629611737269292
For more information about STEM-NET visit our website:

THANK YOU FOR JOINING US TODAY!