ACKNOWLEDGMENTS

• Phoenix is in the Salt River Valley, the ancestral (and current) home of many of the indigenous Akimel O’Odham & Pee Posh
• It is *still* a global pandemic and we’re all going through a lot
• The pandemic has exacerbated existing inequalities, inequities, and double standards
• I will do my best to be informative and entertaining!
• I will also do my best to respect our respective capacity
OUTLINE

• Instructional practices (RBIS project)
  • Calculus @ TYC
  • Factors impacting RBIS use
• Strategizing for cultural change
• [In progress] DEI beliefs

This will be broken up with a few activity sessions!

(Grab something to write with / write on)

Whova app
(polls and Q&A?)
RBIS Project - Personnel

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Sites.google.com/view/rbisproject
RBIS Project - Background

• Investigation of factors impacting instructors’ decisions to (not) use research-based instructional practices (RBIS)
• Comparison of factors known to impact RBIS usage in certain contexts
• Focus on three disciplines: Chemistry, Mathematics, Physics
• Focus on gateway courses: Calculus, Gen Chem, Intro Phys.
• Goals:
  • Map instructional practice trends in these courses
  • Identify influential factors which could be used for change

(Apkarian et al., 2021)
RBIS Project - Survey Methods

- Survey instrument informed by:
  - Prior large-scale survey instruments of instructors
  - Smaller-scale research identifying factors that impact instruction and change
  - Change theories
- Incorporated validated items/instruments as possible
- Web-based survey constructed and distributed by AIP
- Distributed to 18,000+ instructors at TYC, PUI, Uni
### RBIS Project - Participant Summary

<table>
<thead>
<tr>
<th></th>
<th>TYC</th>
<th>PUI</th>
<th>Uni.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calc.</td>
<td>422</td>
<td>377</td>
<td>556</td>
</tr>
<tr>
<td>Phys.</td>
<td>261</td>
<td>373</td>
<td>542</td>
</tr>
<tr>
<td>Chem.</td>
<td>422</td>
<td>379</td>
<td>443</td>
</tr>
</tbody>
</table>
422 calculus instructors from
240 TYC in 42 states
Satisfaction with Students’ Learning

Generally speaking, how satisfied are you with your students’ learning in your course?

☐ Very dissatisfied
☐ Dissatisfied
☐ Neither dissatisfied nor satisfied
☐ Satisfied
☐ Very satisfied
65% of TYC single-variable calculus instructors report being satisfied with their students’ learning.
In terms of satisfaction, not much difference across disciplines at TYCs
In terms of satisfaction, calculus instructors at universities are the least satisfied, compared to TYC and PUI.
Lecture vs. Non-Lecture

- Didactic lecture is very common in postsecondary STEM courses in the USA (e.g., Stains et al., 2018) and echoes a view of learning as a passive practice of transmission.
- Various non-lecture practices have been
During a typical week, what proportion of regular class time (i.e., lecture sections) do students spend doing the following?

___% Working individually
___% Working in small groups
___% Participating in whole-class discussions
___% Listening to the instructor lecture or solve problems
During a typical week, what proportion of regular class time (i.e., lecture sections) do students spend doing the following?

- **13.3%** Working individually
- **17.4%** Working in small groups
- **17.6%** Participating in whole-class discussions
- **51.6%** Listening to the instructor lecture or solve problems
GENERAL INSTRUCTIONAL PRACTICE

TYC
- Indiv.: 13%
- SmGp: 17%
- Disc.: 18%
- Lecture: 52%

PUI
- Indiv.: 10%
- SmGp: 21%
- Disc.: 15%
- Lecture: 54%

UNI
- Indiv.: 11%
- SmGp: 15%
- Disc.: 13%
- Lecture: 61%
During a typical week, what proportion of regular class time (i.e., lecture sections) do students spend doing the following?

- **13.3%** Working individually
- **17.4%** Working in small groups
- **17.6%** Participating in whole-class discussions
- **51.6%** Listening to the instructor lecture or solve problems

*“Active Learning”*
During a typical week, what proportion of regular class time (i.e., lecture sections) do students spend doing the following?

- **48.4%** Active learning strategies
- **51.6%** Listening to the instructor lecture or solve problems
**General Instructional Practice**

- **TYC**
  - Active: 48%
  - Lecture: 52%

- **PUI**
  - Active: 46%
  - Lecture: 54%

- **UNI**
  - Active: 39%
  - Lecture: 61%
**WHY? TCSR**

Teacher-Centered Systemic Reform model for understanding individuals’ decisions about implementing reform practices

(Woodbury & Gess-Newsom, 2002)
**Contextual Factors**

- **Department characteristics**
  - Discipline
  - Highest degree awarded

- **Department appointment expectations**
  - Teaching load
  - Tenure status
  - Role of student evaluations
  - Assessment of teaching performance

- **Classroom**
  - Class size
  - Classroom setup
  - Decision making authority

**Personal Factors**

- Research-based instructional practices as a student
- Scholarship of teaching and learning or discipline-based educational research
- Teaching-focused coursework
- Teaching-related workshops
- Teaching-related new faculty experiences

**Teacher Thinking Factors**

- Growth mindset
- Satisfaction with student learning
Analysis Method

- Nested multilevel regression model
- 2,382 Instructors ⊂ 1,405 departments ⊂ 749 institutions
- 17 factors included in the model
  - 10 context; 5 personal; 2 beliefs
- Checked for interactions and multicollinearity
- Reference group: math instructor at TYC with median score on other factors
  - Intercept: 83% class time spent in lecture

(Yik et al., in review)
DEPARTMENT CHARACTERISTICS

PHYSICS < CHEM & MATH

NO MEASURABLE DIFFERENCE BY INST. TYPE
PERSONAL FACTORS

PERSONAL EXPERIENCE, SOTL, AND PD RELATE TO LESS TIME IN LECTURE
**Teacher Thinking**

SATISFACTION (NS)  
GROWTH MINDSET -> LESS LECTURE
CLASSROOM CONTEXT

CLASSROOM SETUP MATTERS

COORDINATION SUPPORTS NON-LECTURE
APPOINTMENT EXPECTATIONS

- Tenure-track instructors
- Tenured instructors
- Teaching load (# of sections)
- Assessment of teaching performance
  - Influence in review, tenure, promotion
- Student evaluations of teaching
  - Weight in comparison to other measures of teaching evaluation

NO MEASURABLE IMPACT
WHY? AND... WHAT DO WE DO NOW?

**Contextual Factors**
- **Department characteristics**
  - Discipline
  - Highest degree awarded
- **Department appointment expectations**
  - Teaching load
  - Tenure status
  - Role of student evaluations
  - Assessment of teaching performance

**Personal Factors**
- Research-based instructional practices as a student
- Scholarship of teaching and learning or discipline-based educational research
- Teaching-focused coursework
- Teaching-related workshops
- Teaching-related new faculty experiences

**Teacher Thinking Factors**
- Growth mindset
- Satisfaction with student learning
Malleable factors (within math):

- Experiences as student
- Class size & context
- Professional development
- Instructional teams
- Personal interest / mindset
Culture is a historical and evolving set of *structures* and *symbols* and the resulting *power* relationships between *people*.
FOUR FRAMES

STRUCTURES
- Roles, responsibilities, practices, and incentives that organize how people interact
- Committee structures; opt-in course coordination; promotion

SYMBOLS
- Cultural artifacts, language, values, attitudes, beliefs that guide people’s reasoning
- Calculus as a weed-out service course; teaching is private business

PEOPLE
- Individuals’ goals, agency, needs and identities which affect individual actions
- Caregivers; job security; teaching and mentoring focus

POWER
- Interactions between people are mediated by power, status, position, and political coalitions
- Chair decides raises; status differential between ranks

(Bolman & Deal, 2008; Reinhoz & Apkarian, 2018)
FOUR FRAMES

STRUCTURES

CLASS SIZE & CONTEXT

INSTRUCTIONAL TEAMS

PROFESSIONAL DEVELOPMENT

SYMBOLS

PERSONAL INTEREST / MINDSET

PEOPLE

WHO’S INVOLVED

POWER

MESSAGING

SHARED ATTITUDES/ BELIEFS

CHANGING STRUCTURES

RESOURCE ALLOCATION

INSTRUCTION & CHANGE - AMATYC 2021
**Theory of Change**

- 4F model is a Change Theory which has principles to inform an actual change initiative, but is only one piece.
- Theory of change includes context, waypoints, indicators, interventions, assumptions.
- These can be informed by different theories, models, case studies, etc. but are often underspecified when people try to make sweeping changes.
- But we know a few things!

(Reinholz & Andrews, 2020; Reinholz & Apkarian, 2018)
WHAT DO WE KNOW?

- Remove barriers and create drivers
- Communication is critical between change agents and stakeholders at all levels
- Keep the top brass on board (or at least not trying to sink you)
- Afford individuals agency to participate, take ownership, and accommodate their individual needs and goals
- For sustainability, you need to establish a culture that perpetuates the things you want and inhibits things you don’t
- Use a mix of multiple theories, tactics, strategies, etc. to address multiple interrelated aspects of the system(s)
LOOkIng forWArd

• Most of the existing undergraduate-level RBIS are developed to support mathematical understanding and thinking

• Few have purposefully targeted issues of equity, inclusion, and supporting whole students

• As we develop those ideas and test new strategies, we expect some overlap in impactful/predictive patterns:
  • Individual beliefs and attitudes
  • Professional development
  • Demographic diversity of context
  • Prior experiences in diverse settings
WHERE ARE WE NOW?

- As per the general change theories, where we are matters when strategizing how to get where we want to be.
- Follow-up to RBIS study surveyed instructors about their beliefs, attitudes, and experience in relation to DEI issues and initiatives in STEM (undergraduate & professional).
- Roughly 1000 responses to this follow-up survey.
- Analysis in progress! Sneak peek at some emerging results related to race-gender.
**Race-gender intersectionality**

- Race-gender diversity of STEM ≠ race-gender diversity of USA
- Stereotypes abound:
  - Racial hierarchy of mathematics (e.g., Shah, Martin)
  - STEM* as technical and “for men”
- Race and gender identities don’t “add up” but they interact:
  - How people are perceived
  - How people experience the world
  - How people perceive themselves in the world

(Crenshaw, 1991)
# Net Advantage / Disadvantage in Math

<table>
<thead>
<tr>
<th></th>
<th>Asian</th>
<th>Black</th>
<th>Hispanic/Latinx</th>
<th>White</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>32.2</td>
<td>-64.1</td>
<td>-57.6</td>
<td>65.1</td>
</tr>
<tr>
<td>Women</td>
<td>-18.5</td>
<td>-67.3</td>
<td>-65.0</td>
<td>-12.5</td>
</tr>
</tbody>
</table>
Patterns in Responses

- About 78% of respondents provided answers which are similar to the over/underrepresentation patterns in STEM and racial hierarchy in American society
- 16% perceive no net advantage/disadvantage among groups
- 6% perceive an advantage for members of underrepresented groups, akin to “reverse discrimination”
Demographic Mismatches

White men are ~30% of the US population, but represent more than 50% of those receiving advanced degrees in mathematics. Do you see this phenomena as related to:

- WM having more opportunity than (some?) other race-gender groups to do mathematics?
- WM having more interest than (some?) other race-gender groups in doing mathematics?
- WM having more aptitude than (some?) other race-gender groups for doing mathematics?
- Other things?
MORE RESPONSE PATTERNS

- ~80% pointed to variation with some groups having fewer opportunities than white men
- ~50% perceive no difference in interest in STEM
- ~90% perceive no difference in aptitude for STEM

Among those who perceive no advantage/disadvantage:
- 60% perceive equal opportunity
- 49% perceive equal interest
- 90% perceive equal aptitude

ONGOING WORK: WHO IS IN THESE GROUPS, WHAT DO THESE ANSWERS MEAN, HOW MIGHT WE ADDRESS THEM... AND WHAT INSTRUCTIONAL PRACTICES *SHOULD* WE BE TRYING TO IMPLEMENT?
FINALE!

- Instructors’ instructional practices are impacted by many factors, including:
  - Local context and culture
  - Personal factors and beliefs
  - Classroom resources
  - Collegial support
- Changing, and sustaining, practice at scale requires shifts in all these factors, and careful planning
- It also requires investigating and accounting for existing culture and beliefs as we continue learning how to support mathematics students in an evolving world
Thank You!

Questions (and compliments) welcome
References & Resources

Resources & Tools

Accelerating Systemic Change Network (STEM Higher Education)

Change Dashboard: Blog Post & Details & Interactive Dashboard

Special Issues & Curated Collections from PRIMUS

References


PCAST. (2012). Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. President’s Council of Advisors on Science and Technology; Office of Science and Technology Policy.


Saxe, K., & Braddy, L. (2015). A common vision for undergraduate mathematical sciences programs in 2025. MAA.


