Strategies from Biology to Transform Undergraduate STEM Teaching and Learning

Krystle Cobian, Sylvia Hurtado, Kevin Eagan, Liz Roth-Johnson

University of California, Los Angeles

SABER West

January 2018

HERI HIGHER EDUCATION RESEARCH INSTITUTE AT UCLA
HOME OF THE COOPERATIVE INSTITUTIONAL RESEARCH PROGRAM

Who we are, why we're here

Topics we will cover today:

National college trends in Biology
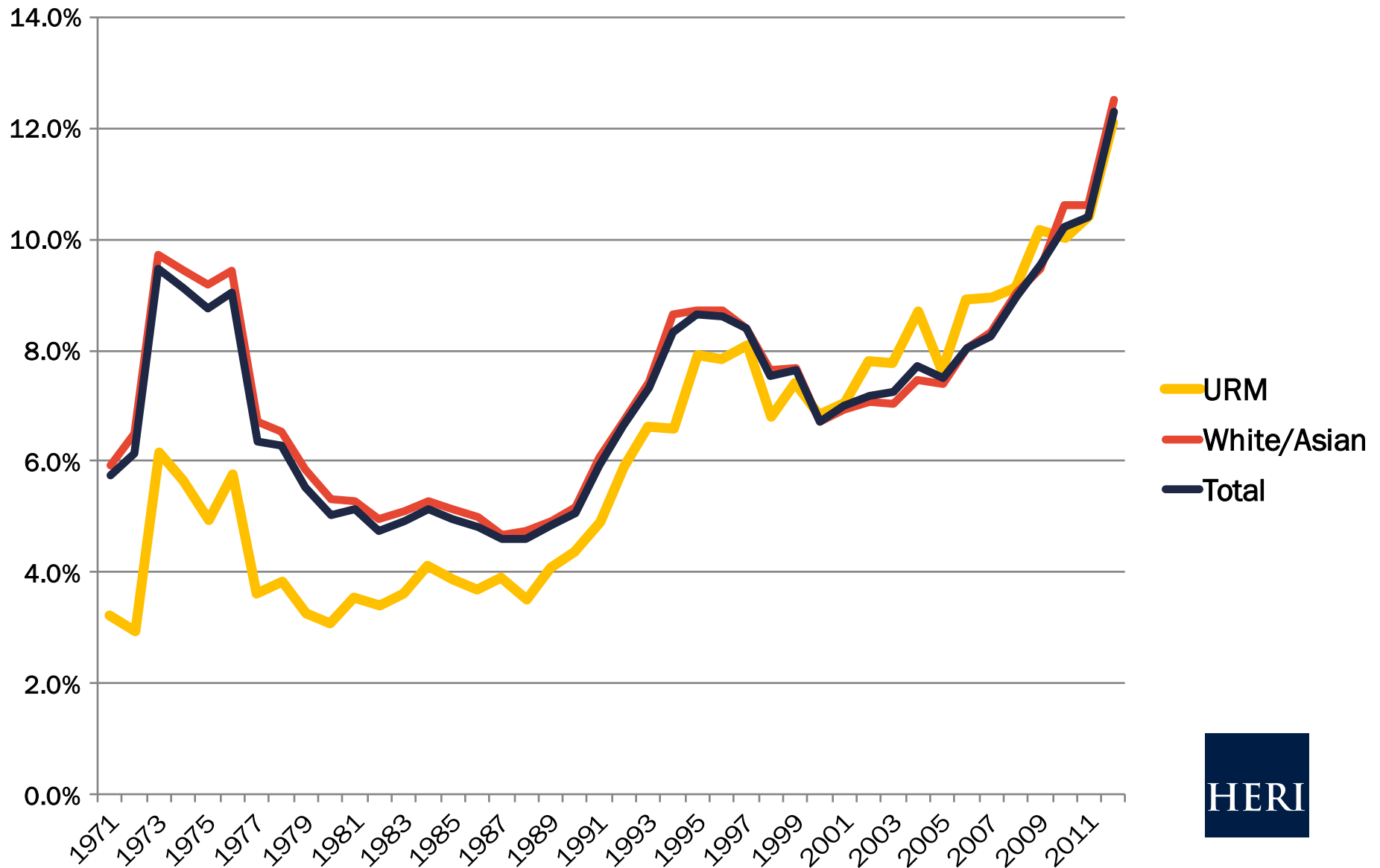
Institutional transformation

What you can do (strategies)

A Look at National Data: Trends in Biological Sciences

Trends in student interest in the Biological Sciences reported at the beginning of their freshman year

Of students who aspired to major in the biological sciences in the beginning of their freshman year, what is their final major?

- Other major, 11.8
- Education, 2.5
- Health Pre-professional, 4.4
- Other STEM , 5.0
- Business, 5.5
- Agriculture, 6.0
- Social Sciences, 6.8
- Psychology, 7.3
- Arts & Humanities, 8.0
- Biological Science, 42.7

HERI
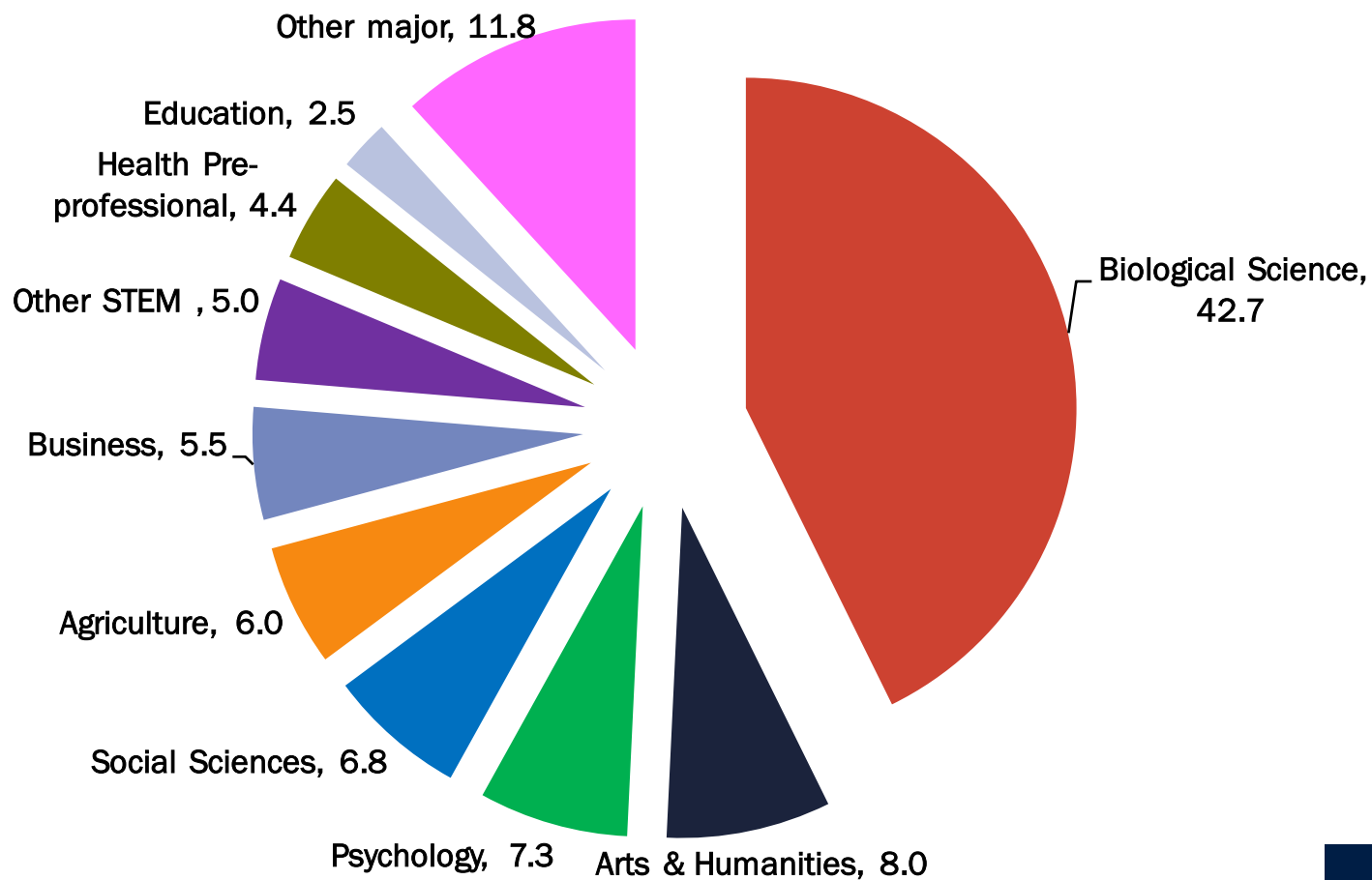
Biomedical Science Completion versus Completion in Another Field of Study 6th year (30, 614 biology aspirants, 296 colleges)

Prior Preparation	
Average high school GPA	+
Student-centered pedagogy factor	+
SAT composite score (100)	+
Years of HS study: Mathematics or Biological science	+
Entering Aspirations and Expectations	
Communicate regularly with professors	+
TFS Academic Self-Concept	+
Ph.D./Ed.D. degree aspiration	+
Medical degree aspiration	+
Grading on a curve	-

Figueroa, T., Hurtado, S., Eagan, K. (2013). Making it!...or Not: Institutional Contexts and Biomedical Degree Attainment

HERI

How Talent is Cultivated

Some faculty actively thought about how their teaching practices contribute to the academic success of students

The first and most important lesson I've learned is to **appreciate the difficulty that some students have with the material and to make sure that they don't feel judged for the difficulty** that they're having, to express the idea that some of this material is challenging, it is different from anything that they've had before. Some of it is not intuitive, and that's okay. It's okay to struggle with it, and many people do. They won't be judged harshly for not getting it right away. — *Professor in Ecology and Evolutionary Biology, Introductory Classroom Data*

Figueroa, T., & Hurtado, S., Cobian, K., Wilkins, A., & White-Lewis, D. (2016). **Cultivating STEM talent: Lessons from STEM pioneers and exemplar institutions.** Paper presented at the annual meeting for the Association for the Study of Higher Education, Columbus, OH.

HERI

Institutional Resources or Policies that Support Faculty in Cultivating Talent

Change efforts must be multi-level and multi-strategy

One of the things that I pushed throughout [my career] was that we have to get this from many different levels. We have to train junior faculty. We have to try to implicate senior faculty. We have to train the next generation of post-docs and graduate students. We have to provide grant incentives. We have to provide awards. We have to provide negative reinforcement for the other ways [that reduce STEM success]. Just in every angle, I see different ways of either rewarding or discouraging the behaviors we either want or don't want respectively. – Biology Professor, *Pioneer Data*

Figueroa, T., & Hurtado, S., Cobian, K., Wilkins, A., & White-Lewis, D. (2016). **Cultivating STEM talent: Lessons from STEM pioneers and exemplar institutions.** Paper presented at the annual meeting for the Association for the Study of Higher Education, Columbus, OH.

HERI

Structure in Place: Still Requires Change in Leadership

There was a lot of opposition from other units who thought that these active learning classrooms were a fad, a waste of time, and didn't believe the data that showed that it was very effective for student learning. That's how the building got to be [with key champions], and as with anything new, there were bumps in the road, and there was student resistance at the beginning....It's not what most universities were doing, and so that was a little, "What's going on here?" Frankly, some of the things we said to them didn't help. The first one or two semesters, basically, we told them it was an experiment, so they're guinea pigs. Well, that—that did not go over well, so we soon learned to say, "No, this isn't an experiment. We know this works well. We've seen the grades of students who came through this university before and after this, and there's a big difference. Students are grasping material better. We have many fewer DFW grades. C students tend to get bumped up into the lower B range, and, no, A students, you're not suffering.

Associate Dean, Public Research University- Exemplar Case Studies Data

HERI

Institutional Transformation: A New Framework Informed by Strategies Utilized at Highly Productive Institutions

Methods

Sample

- Case studies from 11 diverse institutions
    - Institutions had 'exemplary success' in producing STEM degrees overall, or among a particular underrepresented racial group of interest
    - Efficiency scores generated by stochastic frontier analysis identified 'exemplar' campuses (See Eagan paper)
    - Roughly 20-30 STEM faculty, program directors, and upper level administrators were interviewed at each institution

- We investigated evidence-based practices and the overall context for STEM education

Coding and Analysis

- Constant Comparative Approach used to code
    - Transcripts open coded for salient larger themes followed by axial coding to determine how themes were interconnected.

- Analysis involved visually displaying the data within each code in spreadsheets by institution.
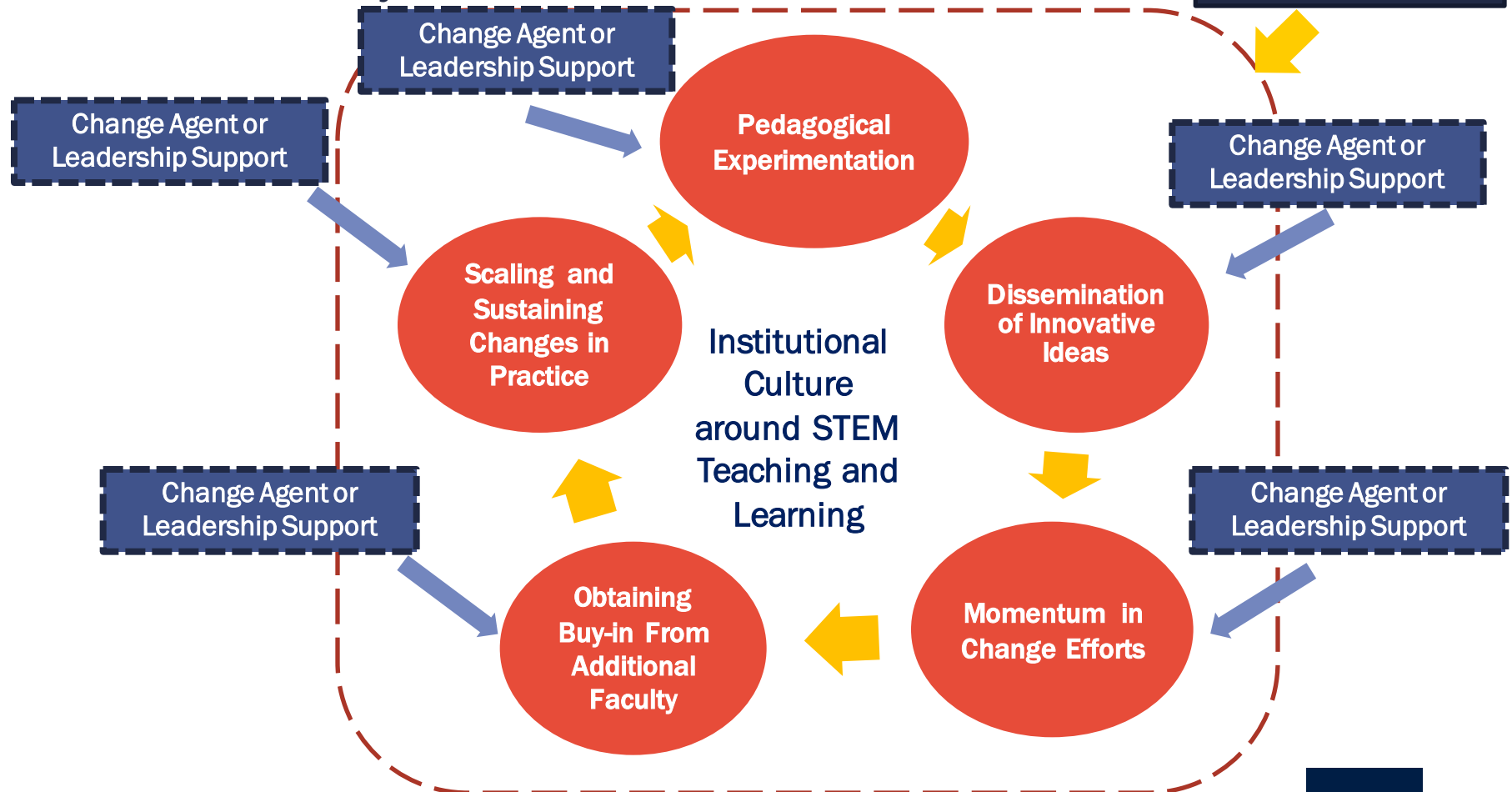   - Easily allows for comparisons between institutions.

Eagan, M.K. (2010). *Moving beyond Frontiers: How Institutional Context Affects Degree Production and Student Aspirations in STEM*. (Ph.D. Dissertation), University of California, Los Angeles, CA. ProQuest database.

Organizational Perspective for Changing Norms in STEM Teaching and Learning

Attention to Diversity within Institutional Culture

External Pressures

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Pedagogical Experimentation

Scaling and Sustaining Changes in Practice

Institutional Culture around STEM Teaching and Learning

Dissemination of Innovative Ideas

Change Agent or Leadership Support

Change Agent or Leadership Support

Obtaining Buy-in From Additional Faculty
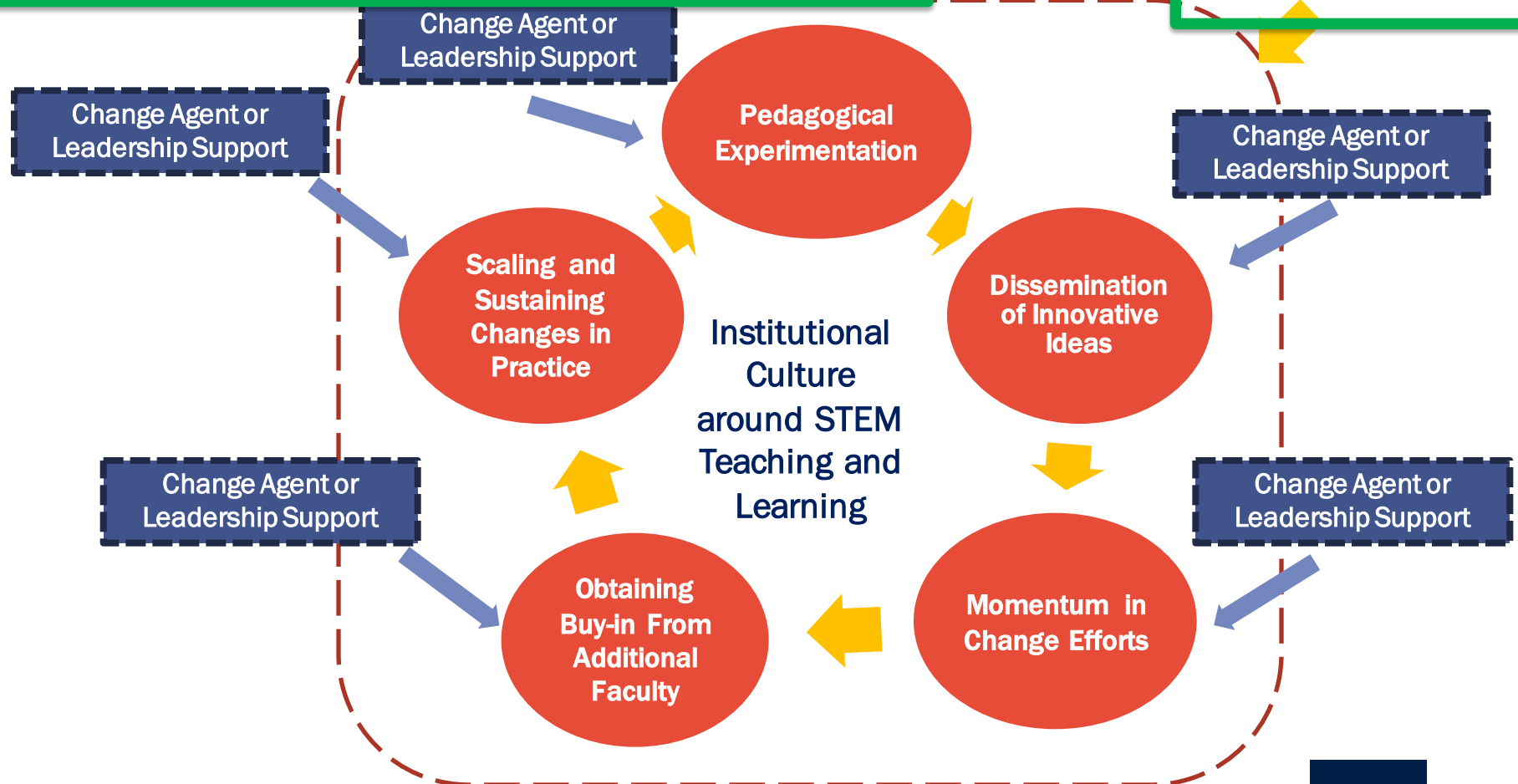
Momentum in Change Efforts

HERI

Organizational Perspective for Changing Norms in STEM Teaching and Learning

Attention to Diversity within Institutional Culture

External Pressures

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Pedagogical Experimentation

Scaling and Sustaining Changes in Practice

Institutional Culture around STEM Teaching and Learning

Dissemination of Innovative Ideas

Obtaining Buy-in From Additional Faculty

Momentum in Change Efforts

HERI

Attention to Diversity within Institutional Culture

- Institutions embraced increasingly diverse student body

- Leadership vocal about the importance of diversity
    - Hiring of diverse faculty & faculty who value teaching/doing research with diverse students

- Collaborations with nearby Native American communities

- Institution recognizes that effectively teaching diverse students requires attention to additional challenges that URMs face

- Services may need to be tailored so that they can target diverse students

When we hire faculty… we are looking for somebody who really loves being with students, who likes teaching students, who's not afraid to work with people from different diverse backgrounds.

~ Professor Emeritus in Biology, Master's Comprehensive HSI

HERI

Organizational Perspective for Changing Norms in STEM Teaching and Learning

Attention to Diversity within Institutional Culture
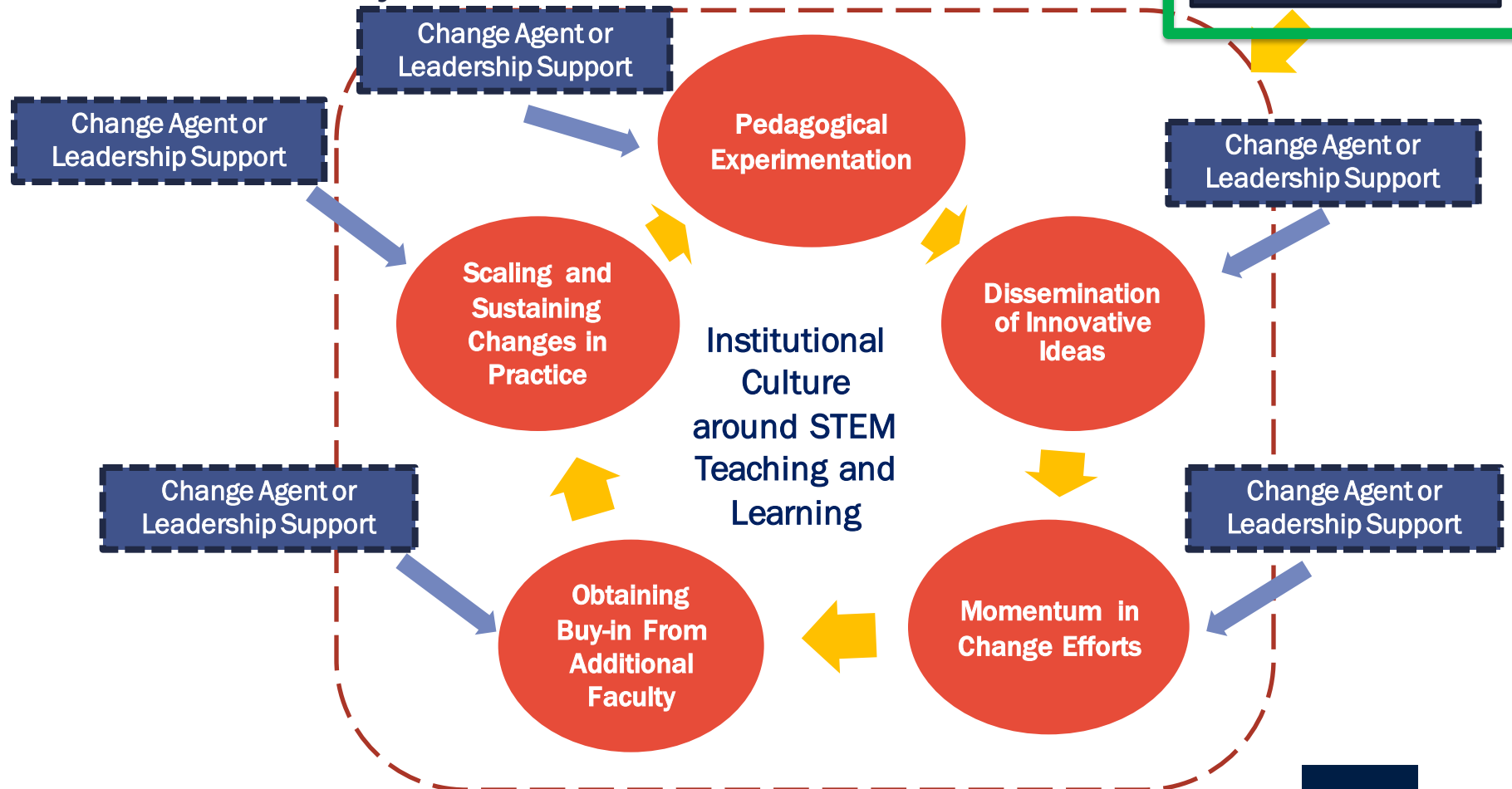
External Pressures

...the [external funding] director for our program was here in January, and he said that there is a good probability that this particular program will sunset. And so, he said, "You know, if you write a renewal, think about language too. How can you take the last round of funding, and try and scale these things at the institutional level?"

So, to address that – I don't know how common these things are at other institutions, but the recitation sections and supplemental instruction is something that started out as a boutique, and was scaled up. Institutional resources were brought to bear on that, and it does seem to help reduce the drop, withdrawal, and fail rates for all students in the earlier stages.
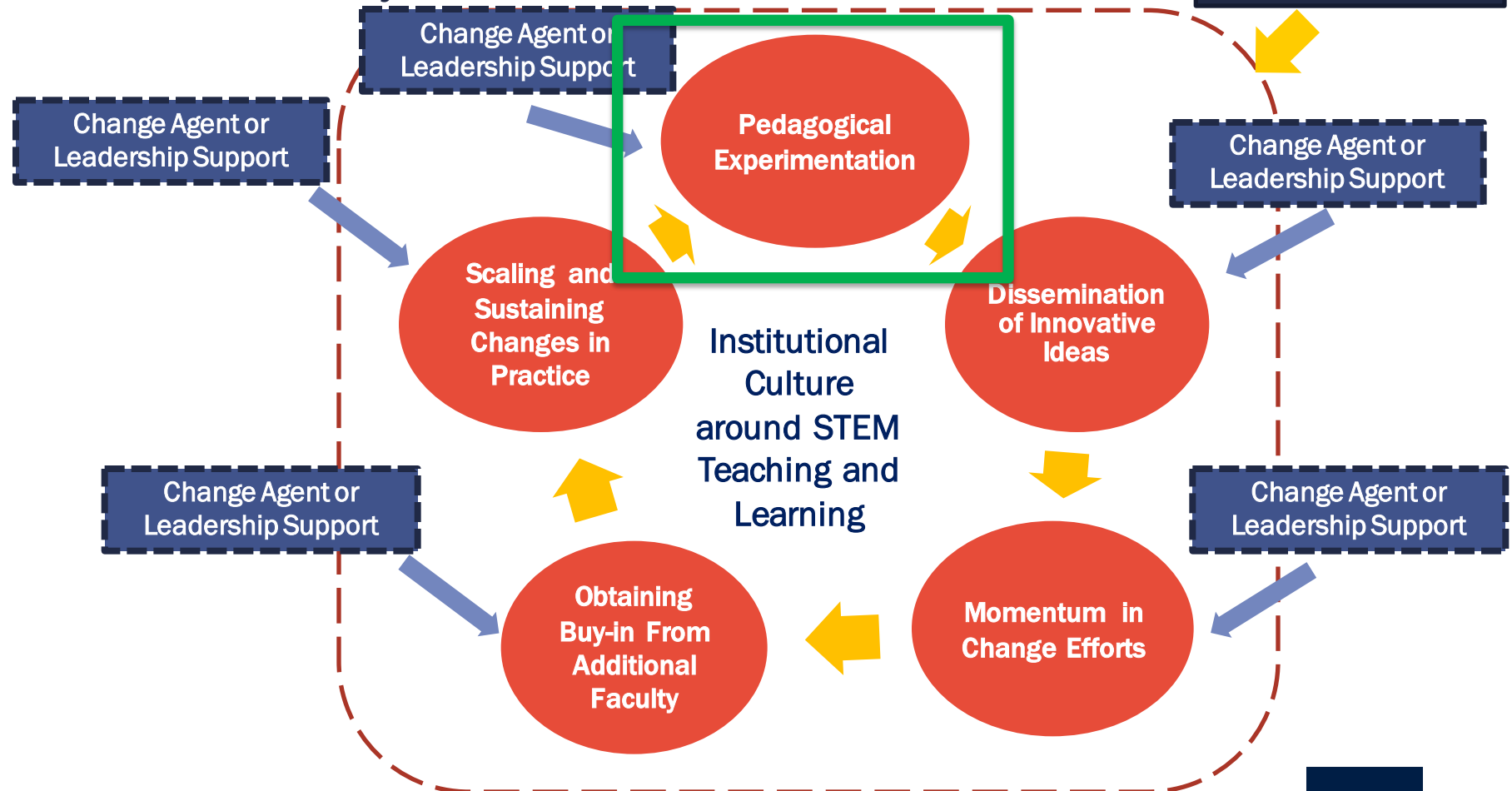
~ Associate Professor in Biology, Private Liberal Arts University

Organizational Perspective for Changing Norms in STEM Teaching and Learning

Attention to Diversity within Institutional Culture

External Pressures

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Pedagogical Experimentation

Scaling and Sustaining Changes in Practice

Institutional Culture around STEM Teaching and Learning

Dissemination of Innovative Ideas

Change Agent or Leadership Support

Change Agent or Leadership Support

Obtaining Buy-in From Additional Faculty

Momentum in Change Efforts

Change Agent or Leadership Support

HERI

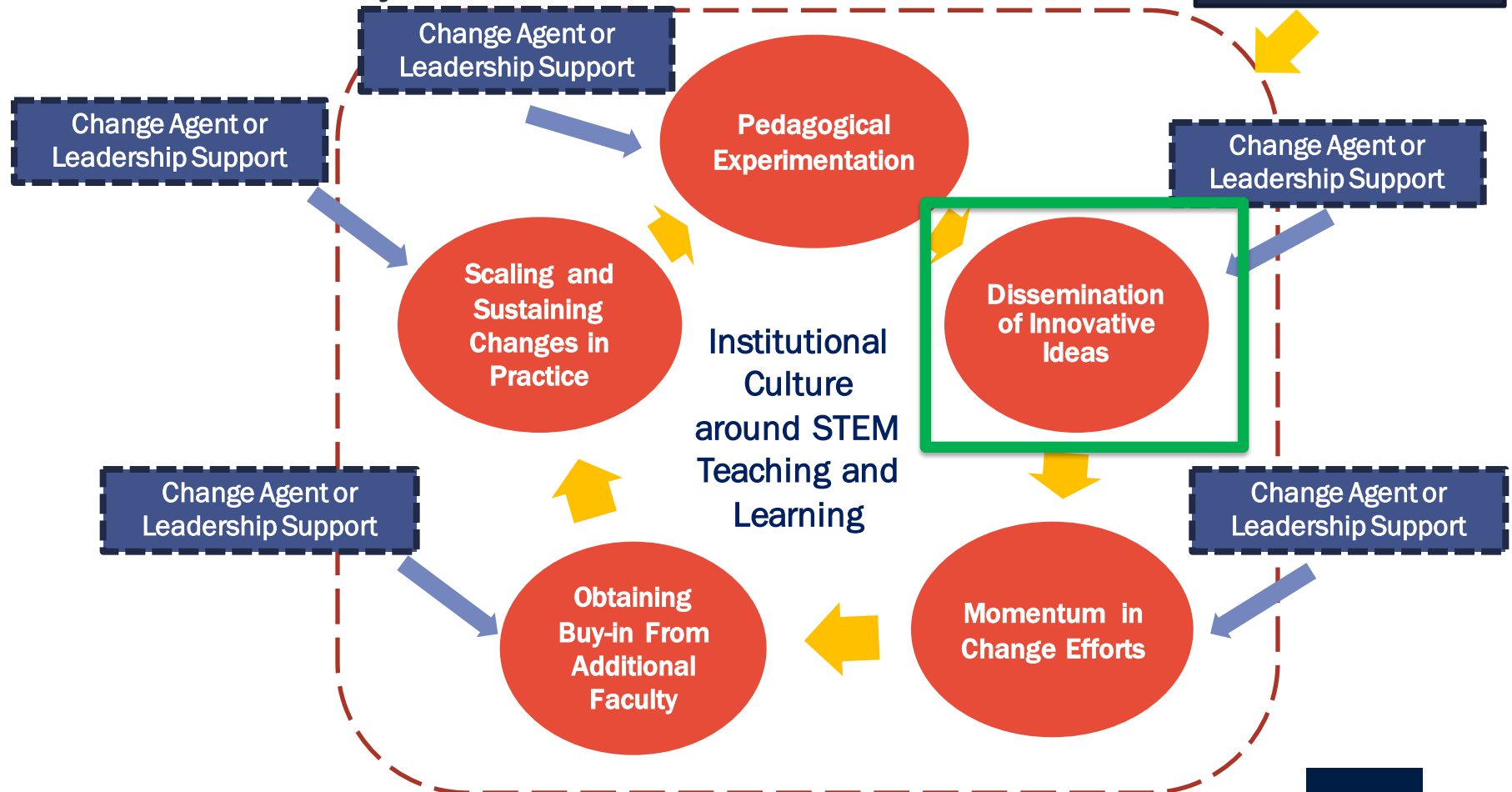# Pedagogical Experimentation Begins

We have four classes in Biology ...So we talk about a total of about nine sections each semester, times 250 students. The students basically are struggling with [aspects] in general. So what we did was establish a program that is based on professor nominations....I will email all the students you know from all the sections and invite them to participate as peer tutors, It's voluntary, you don't get paid. ... And these were tutors that took the classes again with those same professors...So they not only know Physiology really well, the tutors, they also know my teaching styles, they all know the way I write exams and that's very helpful.

~Professor, Biology, Large Public R1 PWI

HERI

Organizational Perspective for Changing Norms in STEM Teaching and Learning

Attention to Diversity within Institutional Culture

External Pressures

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Pedagogical Experimentation

Scaling and Sustaining Changes in Practice

Institutional Culture around STEM Teaching and Learning

Dissemination of Innovative Ideas

Obtaining Buy-in From Additional Faculty

Momentum in Change Efforts

HERI

I had a statistician from the [Center for Teaching and Learning] working on it and it was clear that something good was going on. The Center wrote up a one page report and so I have to credit [an instructional consultant] in the Center, who...sent it up the chain of command. He sent it to the Provost right away. And they noticed, the chancellor, the Provost, the Deans they all noticed. And it got a lot of attention, but I kept feeling nervous like 'This isn't even published yet.'
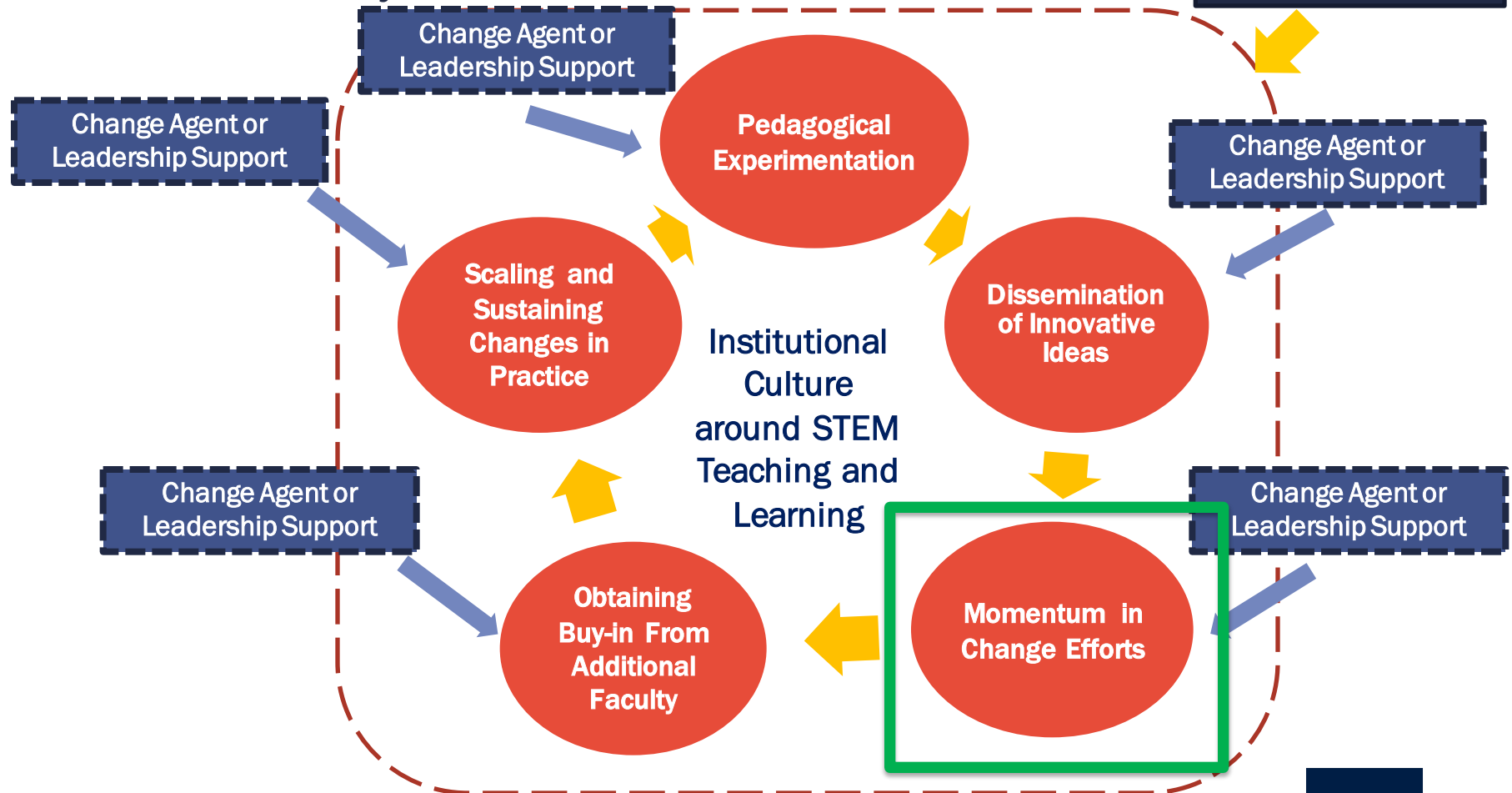
Dissemination of Innovative Ideas

Director of Instructional Innovation for the College of Arts and Sciences, Large Selective Public University

HERI

Organizational Perspective for Changing Norms in STEM Teaching and Learning

Attention to Diversity within Institutional Culture

External Pressures

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Pedagogical Experimentation

Scaling and Sustaining Changes in Practice

Institutional Culture around STEM Teaching and Learning

Dissemination of Innovative Ideas

Obtaining Buy-in From Additional Faculty

Momentum in Change Efforts
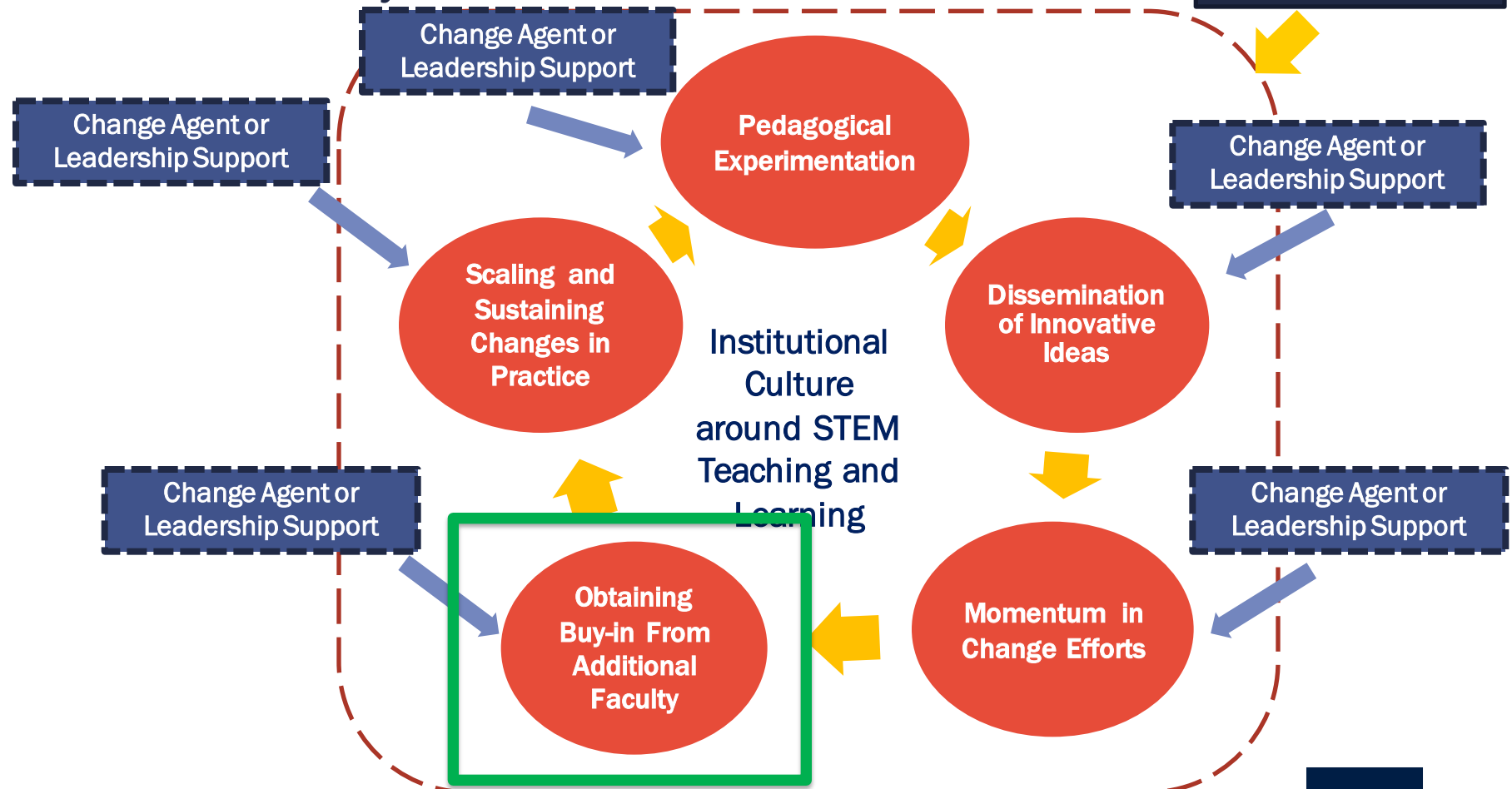
HERI

Momentum in Change Efforts

"The data look really great, after comparing semesters...And we published a paper on that. We had halved the achievement gap for our black students, closed it entirely for first generation college students, which I didn't even know there was a gap there.... So all of those things *led the college to really take a look when they saw the numbers changing and said, "how do we replicate this in other classes?"* So I co-chaired the large taskforce committee...And as some of those taskforce committee reports can go, we were like really worried it was just going to get buried somewhere. *And so the dean really made some changes based on that and one of them was to create my [new administrative] position."*

~Teaching Associate Professor in Biology and Administrator, Large Public R1 PWI

Organizational Perspective for Changing Norms in STEM Teaching and Learning

Attention to Diversity within Institutional Culture

External Pressures

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Pedagogical Experimentation

Scaling and Sustaining Changes in Practice

Institutional Culture around STEM Teaching and Learning

Dissemination of Innovative Ideas

Obtaining Buy-in From Additional Faculty

Momentum in Change Efforts

HERI

We had some initial discussions, and [faculty] weren't terribly receptive to the idea. It falls on the one person, the Director of Undergrad Studies for the Biochem, Biophysics, Molecular Biology Department, since both chemistry and physics impinge on this. *With backing of the rest of the Educational Policy Committee, we're asking him and maybe his department head or someone else from this department to initiate those discussions again to see if we can get a little more buy-in from them...* *We don't wanna threaten them, but we do wanna make it clear that, if they aren't offering a course that suits our students, that there's something wrong there.*
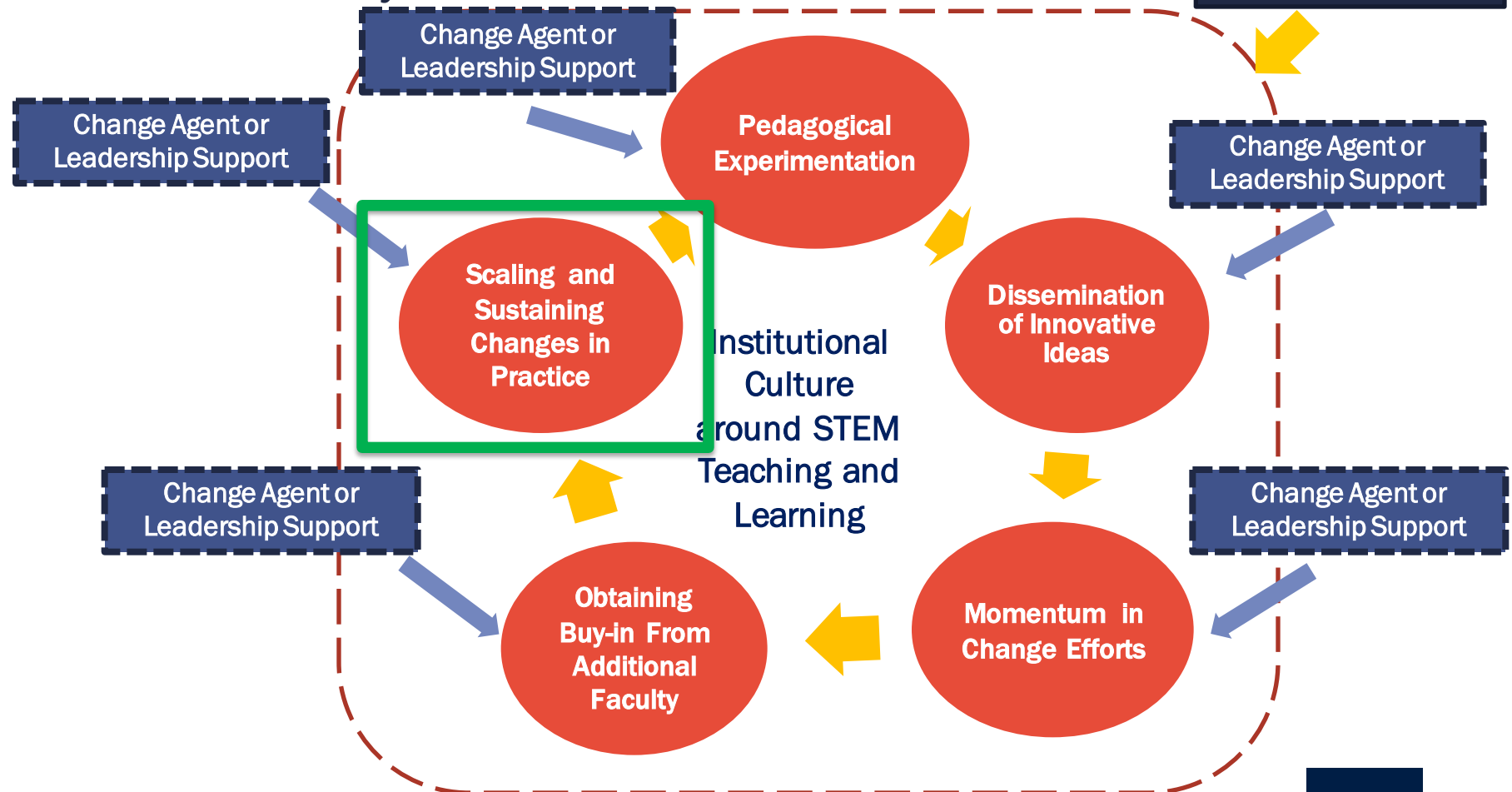
Obtaining Buy-in From Additional Faculty

~ Professor in Biology and Director of Undergraduate Studies, Large Public R1 PWI

HERI

Organizational Perspective for Changing Norms in STEM Teaching and Learning

Attention to Diversity within Institutional Culture

External Pressures

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Pedagogical Experimentation

Scaling and Sustaining Changes in Practice

Dissemination of Innovative Ideas

Institutional Culture around STEM Teaching and Learning

Obtaining Buy-in From Additional Faculty

Momentum in Change Efforts

HERI

Scaling and Sustaining Changes in Practice

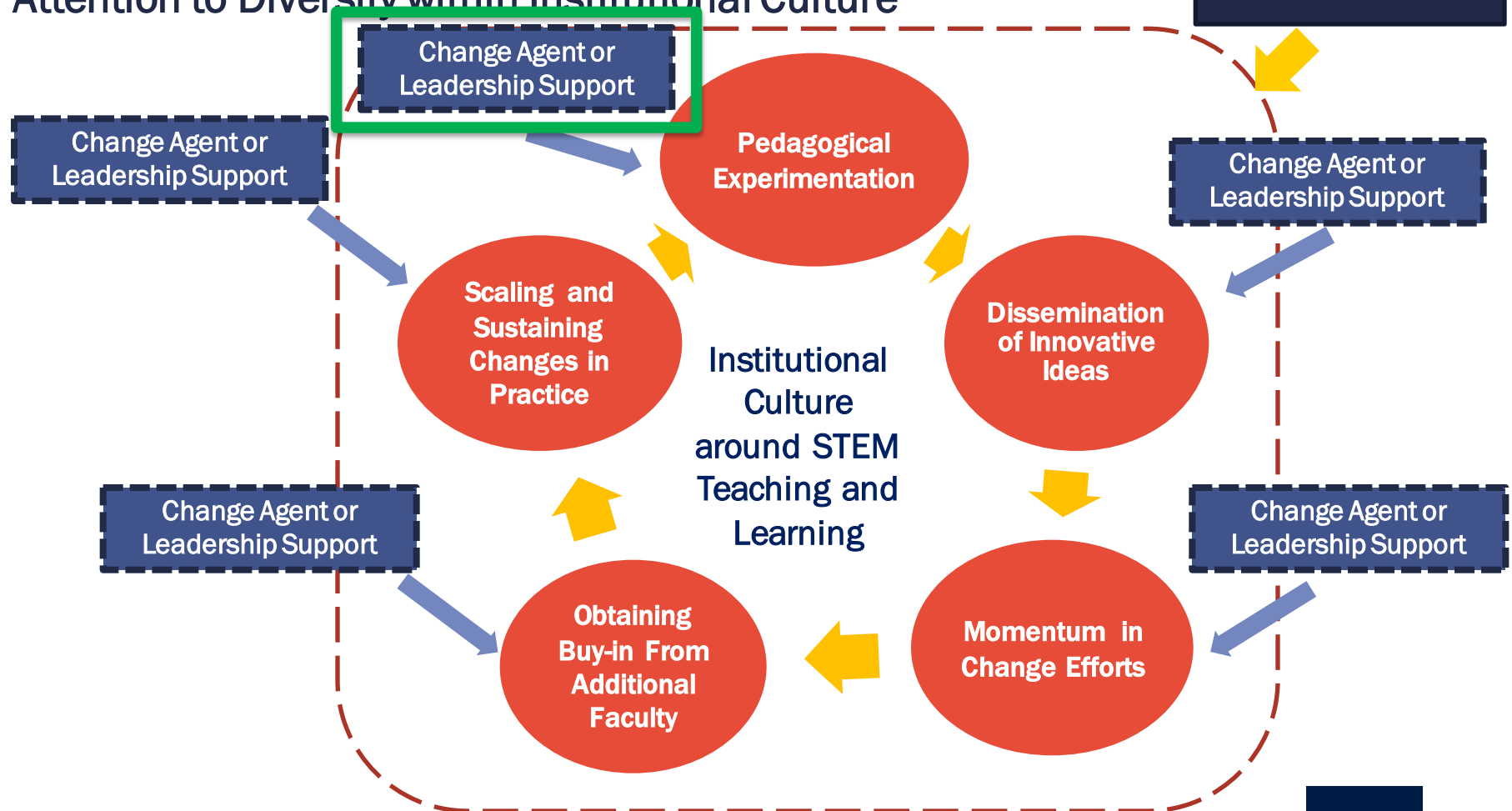*We are in our third year now. We have an apprentice mentor model where we are intentionally looking at which classes we want to work on, and what we settled on was all of our introductory chem, physics and biology courses...what we do with the money we have been given, we incentivize a course release for the faculty member who says, "I want to learn how to do this but I don't have time and I don't know how." They get a mentor and they get a semester to not teach that course but to be part of someone else's course and learn from that person. And then we can efficiently transfer some of the information, the same slides and technology can all be passed down.*

~ Associate Professor in Biology, Public Research University

Organizational Perspective for Changing Norms in STEM Teaching and Learning

Attention to Diversity within Institutional Culture

External Pressures

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Change Agent or Leadership Support

Pedagogical Experimentation

Scaling and Sustaining Changes in Practice

Institutional Culture around STEM Teaching and Learning

Dissemination of Innovative Ideas

Obtaining Buy-in From Additional Faculty

Momentum in Change Efforts

HERI

Change Agents/Leadership Support

You have to be in [the change process] for the long run. They take a while, but it isn't something that just happens with one person, but **it does require both commitment from the top down and excited ideas from the bottom up. The bottom up being faculty...** *the people that are doing it... And at big public universities, people don't have a lot of extra time [to do new innovative things to change their teaching]...* **So finding ways that you can do little things like extra support when they put a grant and you make those matching funds...That kind of recognition I think has a huge impact.** *And then I think if you're going to get new faculty hires to actually care about it, allowing them to care about it and have that not be considered something that goes against them in tenure.*

~ Chancellor of University, Large Selective PWI

HERI

Strategies from Faculty Change Agents

- Share active learning resources/tools on Dropbox or Google Drive and sending link to colleagues

- Finding allies in positions of leadership (Chair, Dean, Provost)

- Use data to show evidence of improved outcomes

- Point out barriers/roadblocks to leaders who will listen

- Organize informal events to share teaching practices (brown-bag lunches)

- Use external pressures as opportunities to create changes

- Apply for small, medium, or large grants

- Talk about/introduce practices and resources from professional conferences and networks (e.g. SABER West)

- Create informal networks among all STEM departments

- Ask for small things (conference funding, new lab equipment)
  - If the answer is no, keep asking for $ for various things until you get a "yes"

- Advocate for diversity & inclusion + teaching & learning (culture)

HERI

Conclusion & Implications

- Substantial student interest in biological sciences

- Retention in a biology or biomedical career is a national priority

- What you do as individuals makes a difference (grassroots leadership)

- What you do *collectively* makes an even bigger difference

HERI

Discussion Questions

To what extent does this model affirm your own experience with institutional transformation in STEM?

What's missing from this process of transformation that we observed on campuses?

If we are to reach someone with these data based in quantitative and qualitative research on STEM transformation, who do you think should also see these data?

HERI

Contact Us

Comments/Questions: krystlecobian@gmail.com

Faculty/Co-PIs:
Sylvia Hurtado
Kevin Eagan

Administrative Staff:
Dominique Harrison

Graduate Research Assistants:
Hector Ramos
Ana Gomez

Damani White-Lewis
Krystle Cobian

Papers and reports are available for download from project website:
http://heri.ucla.edu/nih (presentations)