



Collectively Improving Our Teaching

*Department-wide Efforts in Scientific Teaching
that Produced Classroom Transformations,
Unanticipated Discoveries, and Scholarly
Publications*

Kimberly D. Tanner, Ph.D.

Professor, Department of Biology

San Francisco State University

Director, SEPAL



The Science Education
Partnership & Assessment Lab
San Francisco State University



SAN FRANCISCO
STATE UNIVERSITY



Who are we?

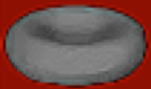
Please share in the chat window

- **name**
- **discipline and institution**
- **two important things to know about you and what you value**

Kimberly Tanner

Biology, San Francisco State University

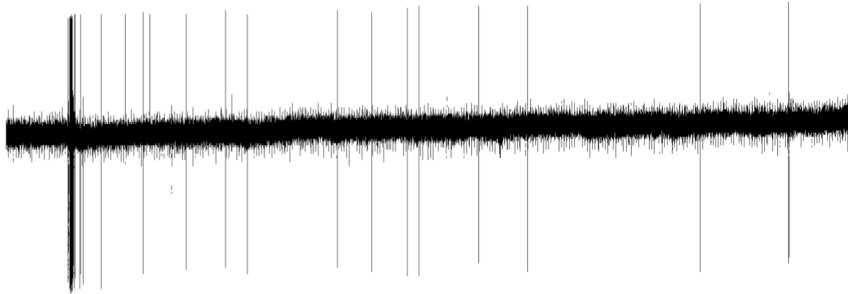
FirstGenCollegeGoing, Neuro-lens



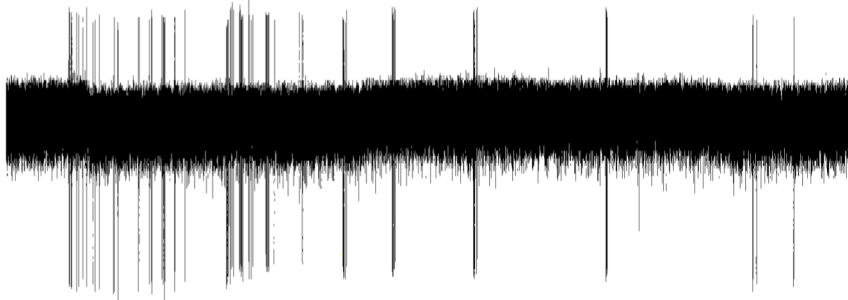
From First-generation College-going... To Neuroscience Research... To K-12 Science Education... To Discipline-Based Biology Education Research...

**Neurophysiology:
Single Unit Recording in Peripheral Nerve**

**Control
condition**

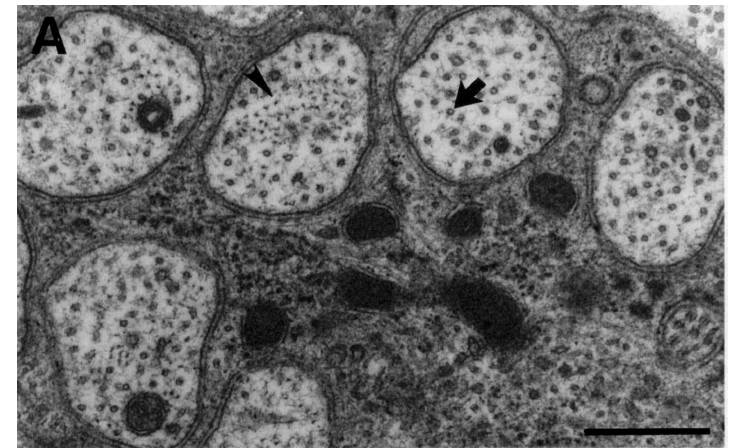


**Neuropathic
condition**



Journal of Neuroscience, 1998
Neuroscience, 2002

**Anatomy:
Electron Microscopy**



Journal of Comparative Neurology, 1998
Journal of Comparative Neurology, 2000

SFES: Science Faculty with Education Specialties

EDUCATIONFORUM

THE PIPELINE

Science Faculty with Education Specialties

2008

Career dynamics for science faculty with interests in education point the way for developing this nascent career specialty.

S. D. Bush,^{1*} N. J. Pelaez,^{2*} J. A. Rudd,^{3*†} M. T. Stevens,^{4*} K. D. Tanner,^{5*} K. S. Williams^{6*}

Globally, efforts to improve science education continue (1, 2). In the United States, primary and secondary (K–12) science education lags on international assessments and struggles to sustain qualified K–12 science teachers and to prepare

gated SFES numbers, characteristics, training, professional activities, and persistence.

We identified, with the aid of deans, 156 CSU faculty as SFES and invited all 156 to complete a 111-question survey (7), which we

tenure-track faculty ranks (28% assistant, 31% associate, and 41% full professors), and trained extensively as researchers in basic science. We completed Pearson's chi-square and McNemar's tests to compare subpopulations of SFES and to make inferences ($P < 0.05$).

SFES include tenure-track

Widespread distribution and unexpected variation among science faculty with education specialties

PLOS ONE

2016

RESEARCH ARTICLE

Fostering Change from Within: Influencing Teaching Practices of Departmental Colleagues by Science Faculty with Education Specialties

Seth D. Bush^{1☯†*}, James A. Rudd, II^{2☯†}, Michael T. Stevens^{3☯†}, Kimberly D. Tanner^{4☯†}, Kathy S. Williams^{5☯†}

2013

of Biological Sciences, Purdue University, West Lafayette, IN 47907-1332; ^aDepartment of Biology, Purdue University, West Lafayette, IN 47907-1332; ^bDepartment of Biology, Purdue University, West Lafayette, IN 47907-1332; ^cDepartment of Biology, Purdue University, West Lafayette, IN 47907-1332; ^dDepartment of Biology, Purdue University, West Lafayette, IN 47907-1332; ^eDepartment of Biology, Purdue University, West Lafayette, IN 47907-1332; ^fDepartment of Biology, Purdue University, West Lafayette, IN 47907-1332

SEPAL: The Science Education Partnership and Assessment Laboratory



SEPAL

The Science Education
Partnership & Assessment Lab
San Francisco State University

(≈ The Tanner
Laboratory)

*Funded by National Science Foundation (NSF) GK-12 Award,
National Institutes of Health (NIH) Science Education Partnership Award,
NSF Transforming Undergraduate Education in STEM (TUES) Award,
NSF CAREER Award, and HHMI Undergraduate Science Education Award.*

Founded in 2004...

- **Programs**
- **Coursework**
- **Research**





Ideas that Drive SEPAL Research Efforts...

- Twice as many undergraduates leave the sciences as the humanities in the U.S.
- Women and scientists of color continue to be underrepresented in the sciences
- Few scientists have formal training in effective teaching
- Wisdom from James Fairweather

Report: National Academies National Research Council Board of Science Education

“The largest gain in learning productivity in STEM will come from convincing the large majority of STEM faculty that currently teaches by lecturing to use any form of active or collaborative instruction...”



A Plan for Our Time Together...

- **Introductions**
- **Context, Theory of Change, and Key Ideas**
- **Evidence from Faculty and Students about Change**
- **Unanticipated Discovery: DART–Decibel Analysis for Research in Teaching**
- **Another Unanticipated Discovery: Instructor Talk**

**Questions, Insights, Resources to
Share, and Comments are
WELCOME THROUGHOUT!!**

Engaging Biology Faculty in Explorations of Scientific Teaching...

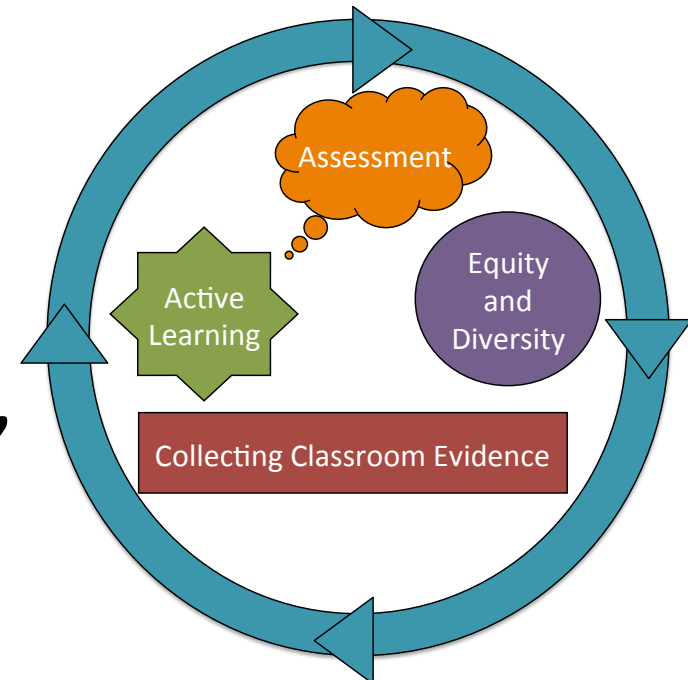


CCB FEST:
Community College Biology
Faculty Enhancement through
Scientific Teaching, 2010-present

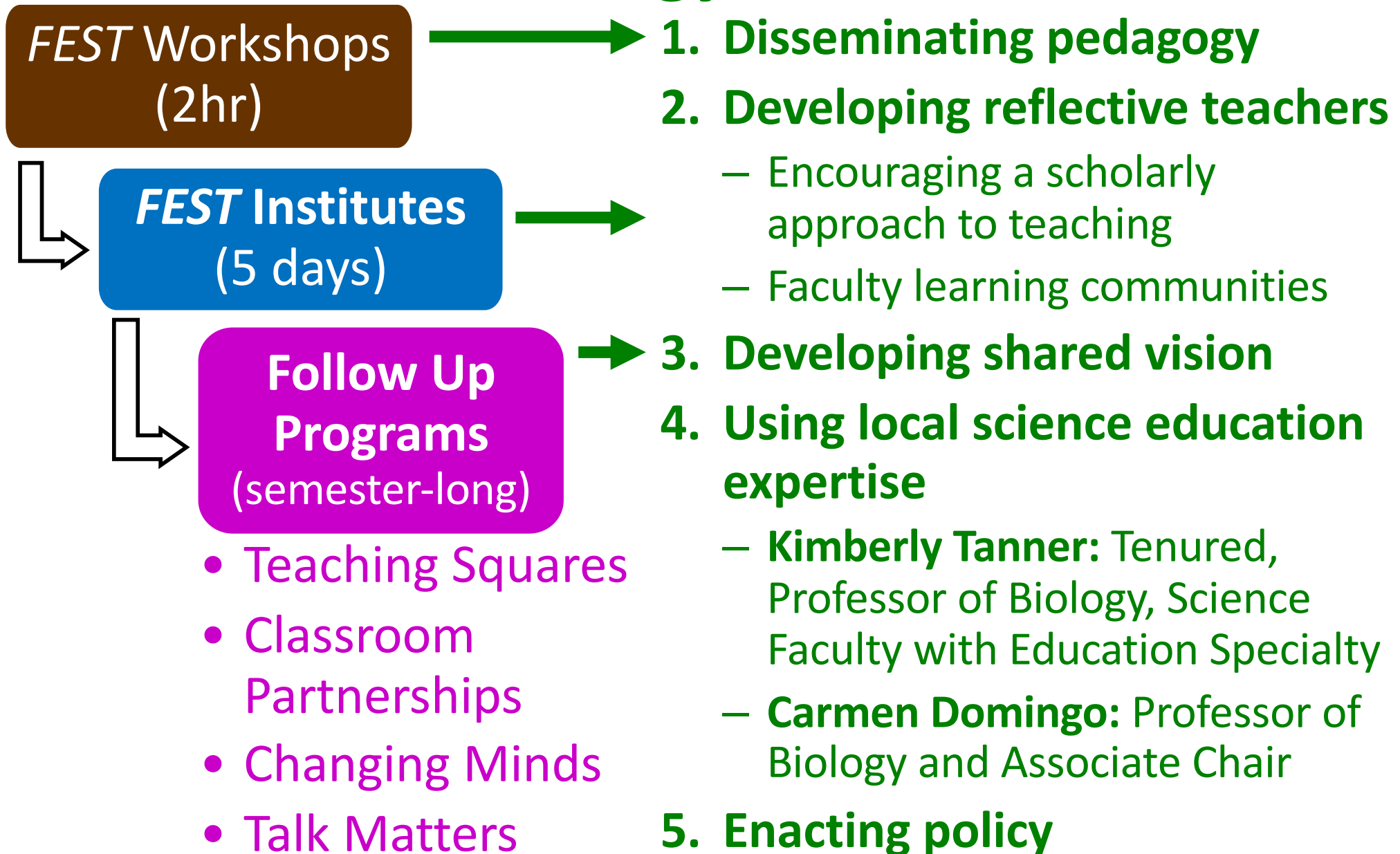
Engaged ~30% of the CC Biology Faculty in the San Francisco Bay Area, 24 institutions



Biology FEST:
Biology Faculty
Explorations of
Scientific Teaching,
2012-2016



What was our Theory of Change for the *Biology FEST* effort?





Key ideas that guided our work...

Moving Away From

- Faculty deficit model
- STEM-wide efforts engaging small numbers of faculty per discipline
- Pre-determined professional development activities
- Faculty as research subjects/participants
- Low alignment with professional identity

Moving Towards

- Faculty asset model
- Discipline-specific efforts engaging large numbers of faculty per discipline
- Assessment-driven, responsive professional development activities
- Faculty as collaborators/co-investigators
- High(er) alignment with professional identity

But how many faculty would really participate?

Make a prediction!

Context:

SFSU Biology department

~60 instructors total

~40 tenured/tenure-track

~20 long-term lecturers

*What proportion of
biology faculty in a single
department would
participate in ~100 hours
of professional
development in scientific
teaching over 2 years?*

- A. 0%, or just you and a couple of friends, Kimberly
- B. ~30%, just the Lecturers
- C. ~50%
- D. ~85%
- E. 100%

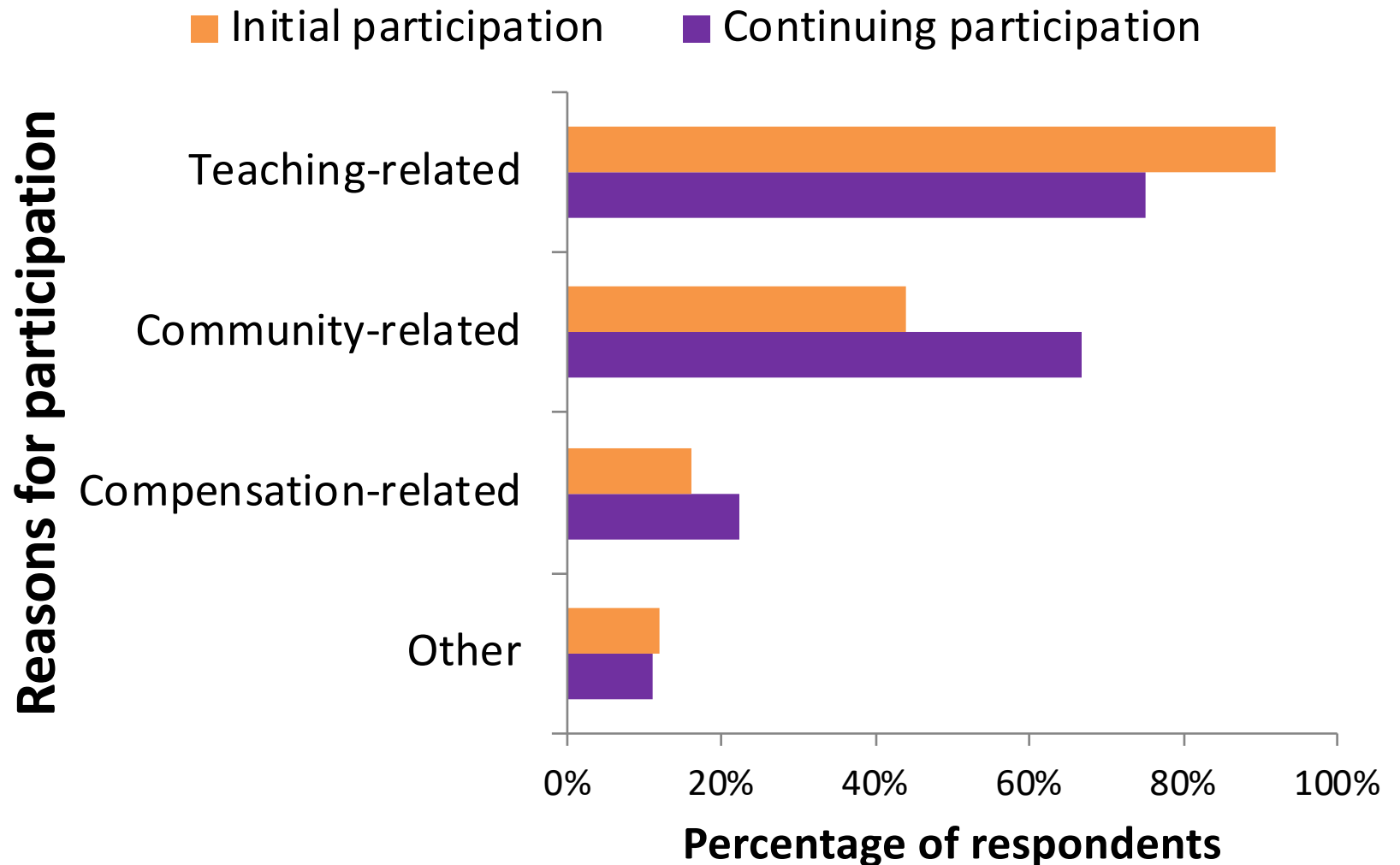
Engaging Science Faculty in Pedagogical Change is Possible

Biology Faculty	Total (n)	Scientific Teaching Institute Participation % (Participants/Eligible)	Follow Up Program 2013-2014 Participation % (Participants/Eligible)	Follow Up Program 2014-2015 Participation % (Participants/Eligible)
Total	62	89% (55/62)	84% (36/43)	81% (39/48)
Tenured/ Tenure-Track	39	90% (35/39)	85% (22/26)	89% (25/28)
Lecturer	23	87% (20/23)	82% (14/17)	70% (14/20)

- >80% biology faculty participated in ~100 hours scientific teaching professional development
- Moving away from a faculty deficit model
- Moving away from small numbers of departmental heroes
- Moving towards engaging ALL faculty as change agents

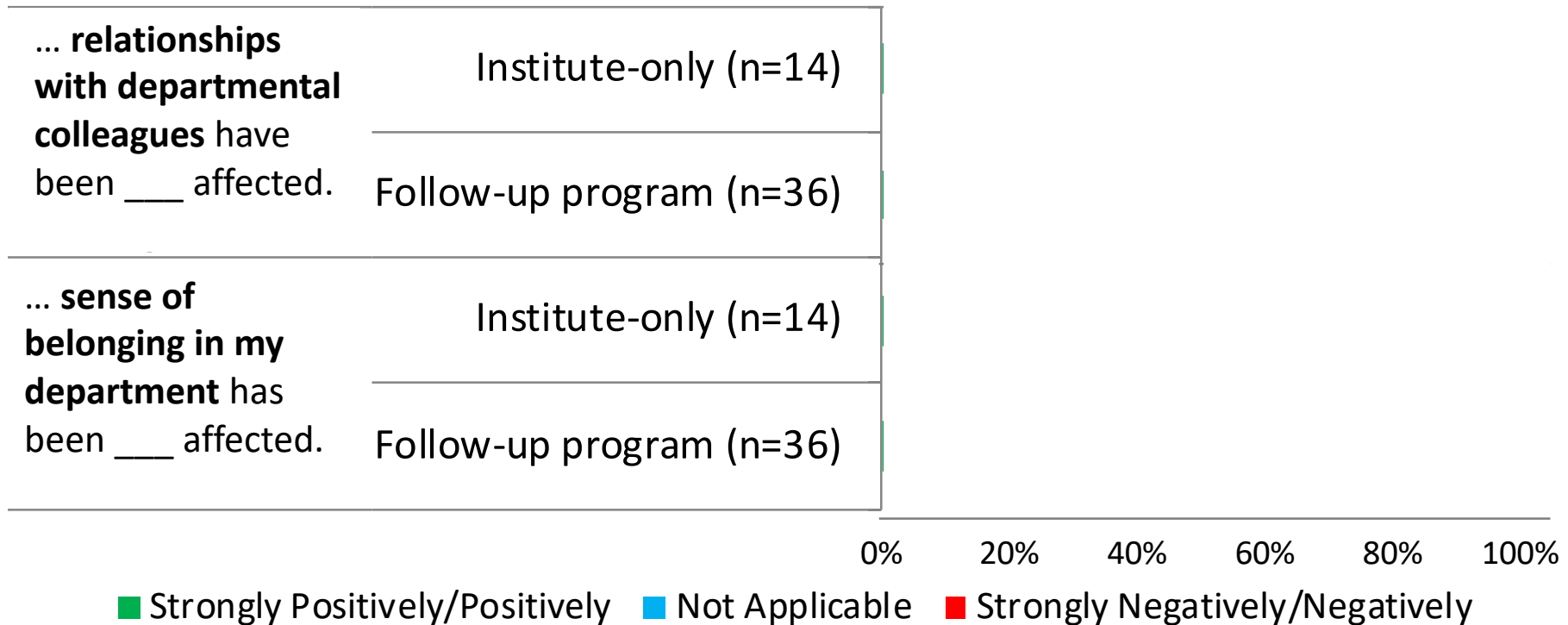
To what extent is this happening in other contexts?
What would enable this in other contexts?

What motivated *Biology FEST* instructors to participate?



How would *Biology FEST* impact perceptions of departmental community?

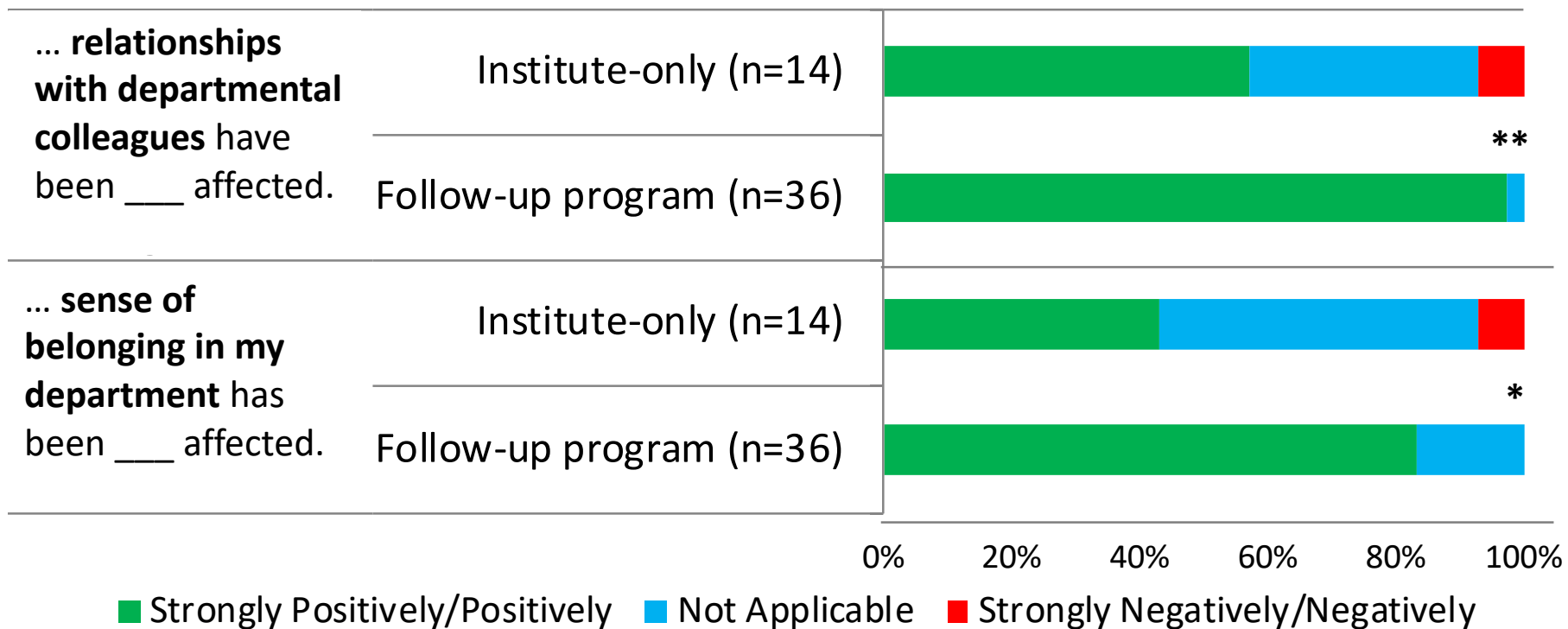
Percentage of faculty responses to, “As part of my participation in Biology FEST, I feel that my...”



**p=0.001, *p=0.010

How would *Biology FEST* impact perceptions of departmental community?

Percentage of faculty responses to, “As part of my participation in Biology FEST, I feel that my...”



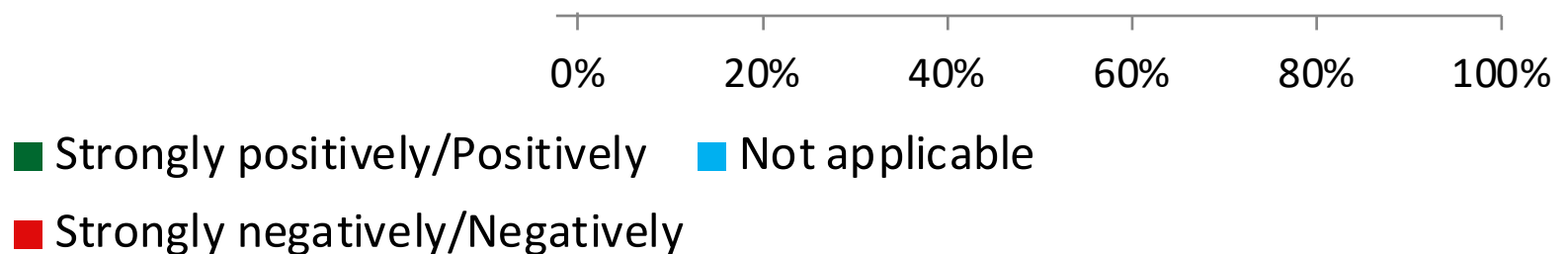
**p=0.001, *p=0.010



How would faculty perceive the impact of *Biology FEST* on research?

Percentage of faculty responses to, “As part of my participation in *Biology FEST*, I feel that my...”

... research has been _____
affected. (n=48)

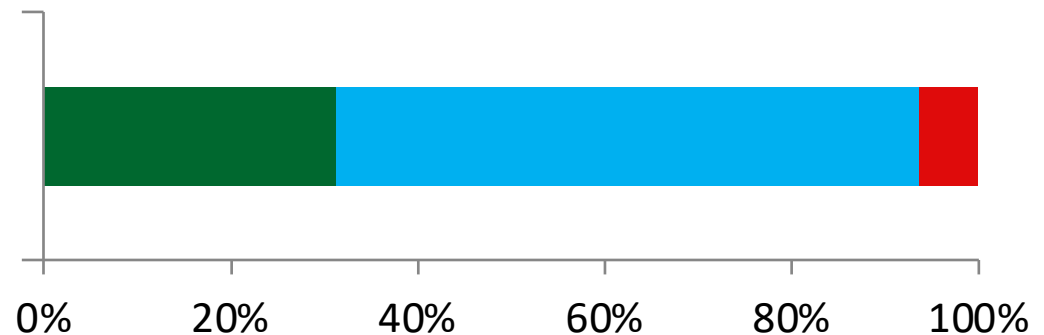


Only 6% of faculty thought that participation in *Biology FEST* negatively affected their research.

How would faculty perceive the impact of *Biology FEST* on research?

Percentage of faculty responses to, “As part of my participation in *Biology FEST*, I feel that my...”

... research has been affected. (n=48)



■ Strongly positively/Positively ■ Not applicable
■ Strongly negatively/Negatively

Only 6% of faculty thought that participation in *Biology FEST* negatively affected their research.

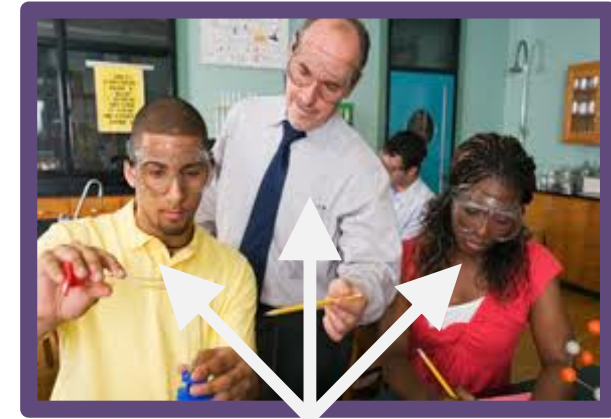
To what extent are instructors moving beyond traditional lecture?



Instructor Perspective



Student Perspective




Direct Classroom Observation

Collectively Improving Our Teaching: Attempting Biology Department-wide Professional Development in Scientific Teaching, *LSE: Life Sci Education*, January, 2018.

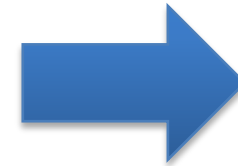
Owens, MT, Trujillo, G, Seidel, SB, Harrison, CD, Blair, JR, Boyer, KE, Breckler, J, Burrus, LW, Byrd, DT, Caporale, N, Carpenter, EJ, Chan, YHM, Chen, L, Chu, DS, Cochlan, WP, Crow, KD, de la Torre, JR, Denetclaw, WF, Dowdy, L, Fuse, M, Goldman, MA, Govindan, B, Green, M, Harris, HE, He, ZH, Ingalls, S, Ingmire, PD, Knight, JS, LeBuhn, G, Leasure, C, LE, Light, TL, Lowe, C, Lund, L, Márquez-Magaña, LM, Miller-Sims, VC, Moffatt, CA, Murdock, H, Nusse, GL, Parker, VT, Pasion, SG, Patterson, R, Pennings, PS, Ramirez, R, Ramirez, J, Riggs, BE, Rohlf, R, Romeo, J, Rothman, B, Roy, SW, Russo-Tait, T, Sehgal, R, Simonin, K, Spicer, GS, Stillman, JH, Sweig, A, L, Vredenberg, V, Weinstein, SL, Zink, A, Kelley, LA, Domingo, CD, Tanner, KD.

Discovering Classrooms:

Observations, Emerging Questions, and Novel Measures

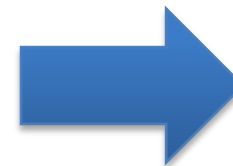


To what extent are
instructors doing
anything but lecture?



DART:
Decibel
Analysis for
Research in
Teaching

What are instructors
saying during class that
may influence
students' experiences?



Instructor
Talk

To what extent are instructors moving beyond traditional lecture?

Example Tools:

Student Perspective:

National Survey of Student Engagement
Student Evaluations

Instructor Perspective:

Cutting Edge Survey: Macdonald, *et al. J of Geosci Ed.* 2004.

Self-report Survey: Ebert-May, *et al. Biosciences*, 2011.

Direct Classroom Measure or Observation:

RTOP: Sawada, *et al. Sci Sci M* 2002.

ALIT: Van Aartsen, *et al. J of Geosci Ed.* 2007.

COPC

TE

POF

**Beyond our capacity...
time, people, money**



Unanticipated Discoveries and Scholarly Publications



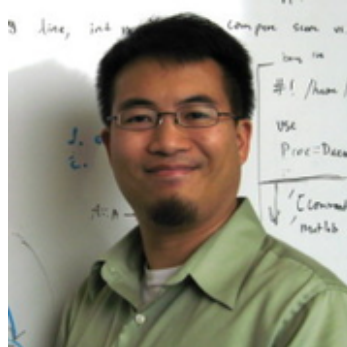
Jeff Schinske, MS
Foothill-De Anza
Community Colleges



Shannon Seidel, PhD
Pacific Lutheran U.



Melinda Owens, PhD
San Francisco State U



Mike Wong, PhD
San Francisco State U

To what extent
are instructors
doing anything
but lecture?



DART:
Decibel
Analysis for
Research in
Teaching

What can we learn about classrooms just from the noise?

Make a prediction!

Class Session A

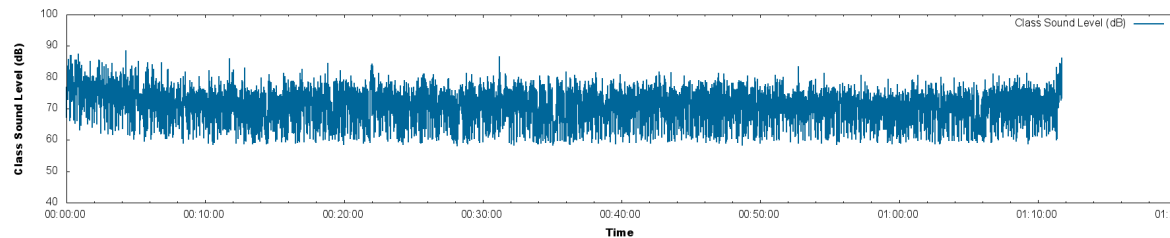
What do you predict is happening in the audio recordings of these two lecture class sessions?

NOTE:

X-axis is TIME

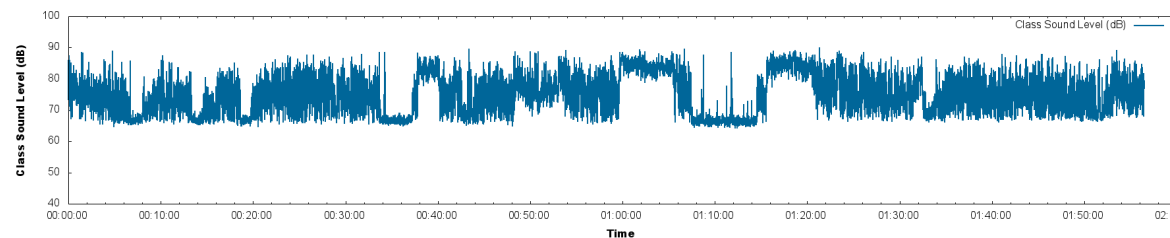
Y-axis is DECIBELS


Class Waveform
INST9012 0303 2015 CCB FEST



Class Session B

Class Waveform
INST1966 0218 2015 HHMI BIO FEST



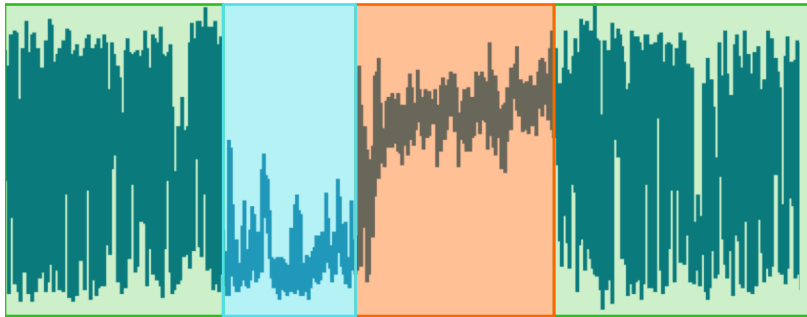


Would classroom noise levels indicate the presence of active learning?

DART (Decibel Analysis for Research in Teaching):

- **Automated machine-learning based algorithm**
- Analyzes the **volume and variance of classroom audio recordings**
- Estimates **which types of activities** are occurring during that class session

DART: the Decibel Analysis for Research in Teaching Tool



- **~90% accuracy rate overall**
- Easy to analyze **every class session** of an entire course

DART Mode	Human Annotation
Single Voice (Average Volume, High Variance)	Lecture with Question/Answer Video
Multiple Voice (High Volume, Low Variance)	Discussion** Transition
No Voice (Low Volume, Low Variance)	Silent** (writing or thinking)

** probable active learning

Community-Based Research Publication

PNAS, March 2017



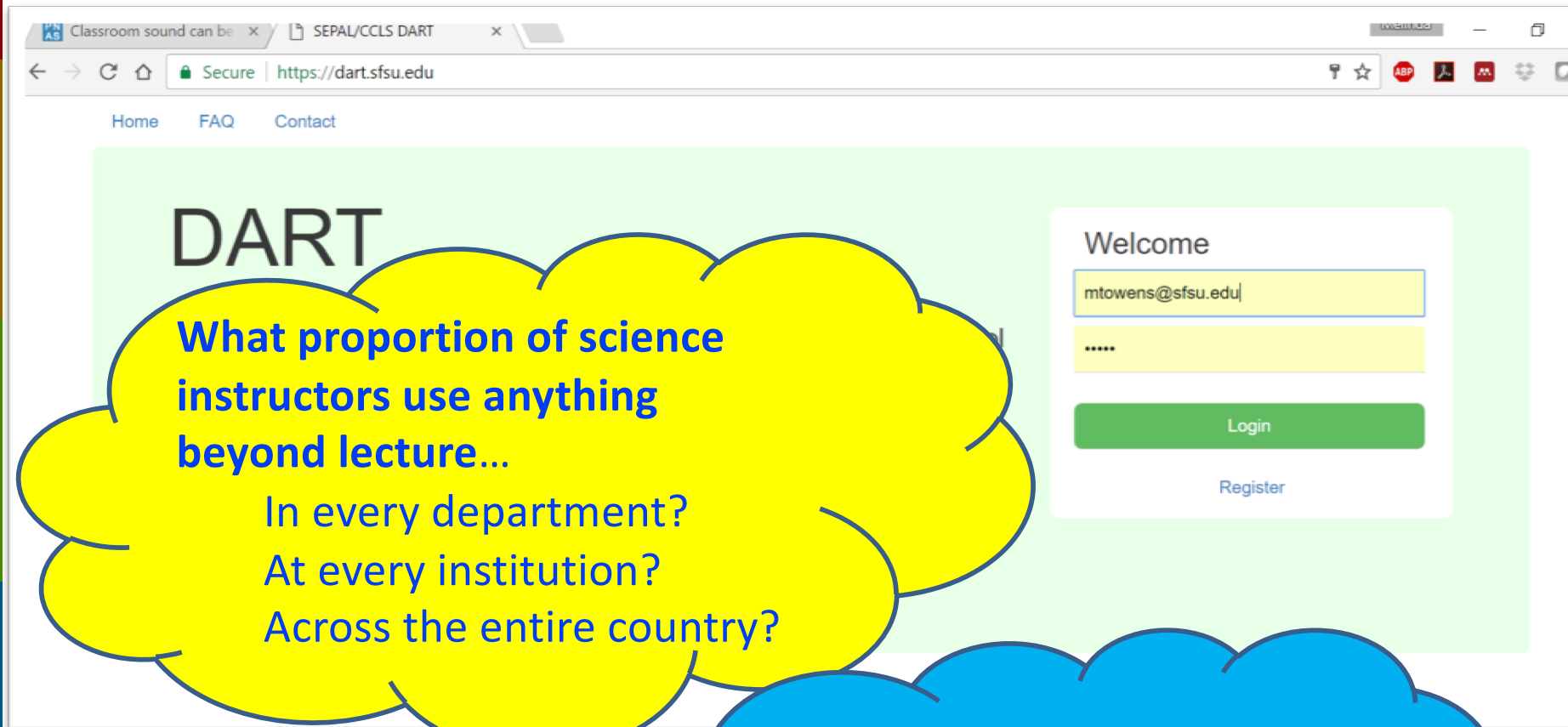
Classroom sound can be used to classify teaching practices in college science courses

Melinda T. Owens^{a,1}, Shannon B. Seidel^{b,1}, Mike Wong^{c,1}, Travis E. Bejines^b, Susanne Lietz^a, Joseph R. Perez^b, Shangheng Sit^a, Zahur-Saleh Subedar^a, Gigi N. Acker^{d,e}, Susan F. Akana^f, Brad Balukjian^g, Hilary P. Benton^{a,h}, J. R. Blair^a, Segal M. Boazⁱ, Katharyn E. Boyer^{a,j}, Jason B. Bram^d, Laura W. Burrus^a, Dana T. Byrd^a, Natalia Caporale^k, Edward J. Carpenter^{a,j}, Yee-Hung Mark Chan^a, Lily Chen^a, Amy Chovnickⁱ, Diana S. Chu^a, Bryan K. Clarkson^l, Sara E. Cooper^h, Catherine Creech^m, Karen D. Crow^a, José R. de la Torre^a, Wilfred F. Denetclaw^a, Kathleen E. Duncan^h, Amy S. Edwards^h, Karen L. Erickson^h, Megumi Fuse^a, Joseph J. Gorgaⁿ, Brinda Govindan^a, L. Jeanette Green^o, Paul Z. Hankamp^p, Holly E. Harris^a, Zheng-Hui He^a, Stephen Ingalls^a, Peter D. Ingmire^{a,q}, J. Rebecca Jacobs^h, Mark Kamakea^r, Rhea R. Kimpo^{a,s}, Jonathan D. Knight^a, Sara K. Krause^t, Lori E. Krueger^{u,v}, Terrye L. Light^a, Lance Lund^a, Leticia M. Márquez-Magaña^a, Briana K. McCarthy^w, Linda J. McPheron^x, Vanessa C. Miller-Sims^a, Christopher A. Moffatt^a, Pamela C. Muick^{u,y}, Paul H. Nagami^{a,g,z}, Gloria L. Nusse^a, Kristine M. Okimura^{aa}, Sally G. Pasion^a, Robert Patterson^a, Pleuni S. Pennings^a, Blake Riggs^a, Joseph Romeo^a, Scott W. Roy^a, Tatiane Russo-Tait^{bb}, Lisa M. Schultheis^h, Lakshmikanta Sengupta^p, Rachel Small^{cc}, Greg S. Spicer^a, Jonathon H. Stillman^{aj}, Andrea Swei^a, Jennifer M. Wade^{dd}, Steven B. Waters^{ww}, Steven L. Weinstein^a, Julia K. Willsie^l, Diana W. Wright^{ee,ee}, Colin D. Harrison^{ff}, Loretta A. Kelley^{gg}, Gloriana Trujillo^{hh}, Carmen R. Domingo^a, Jeffrey N. Schinske^{d,h}, and Kimberly D. Tanner^{a,2}

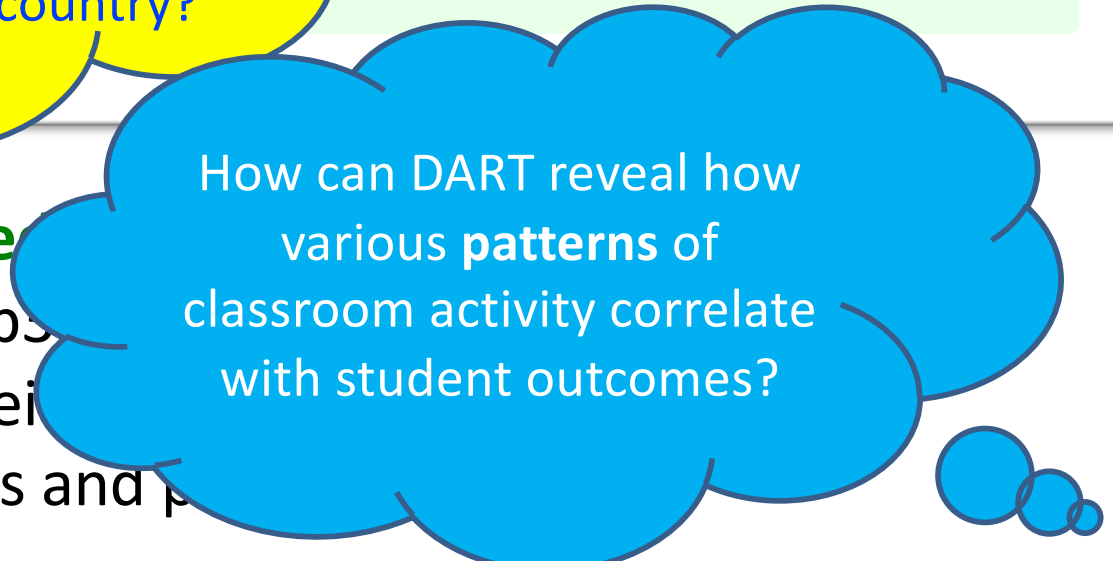
^aDepartment of Biology, San Francisco State University, San Francisco, CA 94132; ^bD
^cCenter for Computing for Life Sciences, San Francisco State University, San Francisco, CA 94132; ^dDepartment of Biology, San Francisco State University, San Francisco, CA 95014; ^eNutrition, Food Science, and Packaging Department, San Jose State University, San Jose, CA 95128; ^fDepartment of Biology, San Francisco State University, San Francisco, CA 94132; ^gBiology Department, Laney College, Oakland, CA 94602; ^hBiology Department, Las Positas College, Livermore, CA 94551; ⁱRomberg Tiburon Center, Tiburon, CA 94920; ^jDepartment of Neurobiology, Physiology, and Behavior, University of California, Davis, CA 95616; ^kDepartment of Biology, Portland Community College, Portland, OR 97208; ^lDepartment of Biology, Portland Community College, San Ramon, CA 94582; ^mScience and Technology Division, Cañada College, San Mateo, CA 94402; ⁿDivision of Undergraduate Education and Academic Advising, San Francisco State University, San Francisco, CA 94132; ^oScience Department, Chabot College, Hayward, CA 94545; ^pScience/Mathematics/Technology Department, Palomar College, San Marcos, CA 92069; ^qBiology Department, Solano Community College, Sacramento, CA 95819; ^rBiology Department, City College, Berkeley, CA 94704; ^sBiological Sciences Department, Contra Costa College, Contra Costa College, CA 94515; ^tDepartment of Earth and Climate Sciences, San Francisco State University, Oakland, CA 94619; ^uDepartment of Earth and Climate Sciences, San Francisco State University, Oakland, CA 94619; ^vCurriculum and Instruction, STEM Education, University of Texas at Austin, Austin, TX 78712; ^wDepartment of Biology, University of San Francisco, San Francisco, CA 94132; ^xDepartment of Biology, University of San Francisco, San Francisco, CA 94132; ^yDepartment of Biology, University of San Francisco, San Francisco, CA 94132; ^zDepartment of Biology, University of San Francisco, San Francisco, CA 94132; ^{aa}Department of Biology, University of San Francisco, San Francisco, CA 94132; ^{bb}Department of Biology, University of San Francisco, San Francisco, CA 94132; ^{cc}Department of Biology, University of San Francisco, San Francisco, CA 94132; ^{dd}Department of Biology, University of San Francisco, San Francisco, CA 94132; ^{ee}Department of Biology, University of San Francisco, San Francisco, CA 94132; ^{ff}Department of Biology, University of San Francisco, San Francisco, CA 94132; ^{gg}Department of Biology, University of San Francisco, San Francisco, CA 94132; ^{hh}Office of the Vice Provost for Teaching and Learning, University of San Francisco, San Francisco, CA 94132.

- 81 co-authors
- >24 institutions
- patent filed
- potentially a game changing tool for higher education...

Introducing DART for your use...



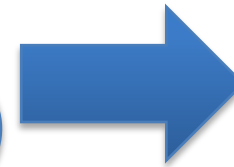
- **dart.sfsu.edu**
- Upload mp3 audio, receive predictions and p...



Discovering Classrooms:

Observations, Emerging Questions, and Novel Measures

What are instructors
saying during class that
may influence
students' experiences?



**Instructor
Talk**



Shannon Seidel, PhD
Pacific Lutheran U.



Colin Harrison, PhD
Georgia Tech



Tiffy Nguyen, MS
Foothill College





What is *Instructor Talk*?

- Said by instructor(s)
- During class time
- Excludes course content (e.g. biology concepts)
- Excludes agenda items (e.g. format of class, date assignments are due, etc.)

CBE—Life Sciences Education
Vol. 14, 1–14, Winter 2015

Article

Beyond the Biology: A Systematic Investigation of Noncontent Instructor Talk in an Introductory Biology Course

Shannon B. Seidel,^{*,†} Amanda L. Reggi,^{*} Jeffrey N. Schinske,[†] and Kimberly D. Tanner^{*}

Over 650
instances of
Instructor Talk
were identified in
first course
analyzed.

But what can take away and apply now?

Feature

Approaches to Biology Teaching and Learning

Structure Matters: Twenty-one Teaching Strategies to Promote Student Engagement and Equity

Kimberly D. Tanner

- When is the last time most instructors listened to a recording of themselves teaching?
- What non-content things do they say? And why?
- How could we engage instructors in being more purposeful in using *Instructor Talk*?

CBE—Life Sciences Education
Vol. 6, 251–258, Winter 2006

Feature

Approaches to Biology Teaching and Learning


Cultural Considerations in the College Classroom

Kimberly D. Tanner

Language Matters: Considering Microaggressions in Science

Colin Harrison[†] and Kimberly D. Tanner^{**}

[†]School of Biological Sciences, Georgia Institute of Technology, Atlanta, GA 30332; ^{**}Department of Biology, San Francisco State University, San Francisco, CA 94132



Is changing classrooms enough?

How do we go beyond classrooms and change the culture of science?

Scientific Presenting: Using Evidence-Based Classroom Practices to Deliver Effective Conference Presentations

Lisa A. Corwin,[†] Amy Prunuske,[‡] and Shannon B. Seidel^{§*}

[†]Department of Ecology & Evolutionary Biology, University of Colorado, Boulder, CO 80309; [‡]Department of Microbiology and Immunology, Medical College of Wisconsin, Central Wisconsin, Wausau, WI 54401; [§]Biology Department, Pacific Lutheran University, Tacoma, WA 98447

IN
PRESS

When will effective
teaching/communication
strategies become
commonplace in all scientific
learning environment?

- Lab meetings
- Conferences
- Faculty meetings
- Grant meetings
- Everywhere...



Acknowledgements...

CCB FEST and Biology FEST Instructor Collaborators!

Georgia Acker, Susan F. Akana, Bradley J. Balukjian, Hilary Benton, J. R. Blair, Segal Boaz, Katharyn E. Boyer, Jason Bram, Laura W. Burrus, Dana T. Byrd, Natalia Caporale, Edward J. Carpenter, Y.-H. Mark Chan, Lily Chen, Amy Chovnick, Diana S. Chu, Bryan K. Clarkson, Sara Cooper, Catherine Creech, Karen D. Crow, José R. de la Torre, Wilfred F. Denetclaw, Kathleen Duncan, Amy Edwards, Karen Erickson, Megumi Fuse, Joseph Gorga, Brinda Govindan, L. Jeanette Green, Paul Hankamp, Holly E. Harris, Zheng-Hui He, Stephen Ingalls, Peter Ingmire, J. Rebecca Jacobs, Mark Kamakea, Rhea R. Kimpo, Jonathan Knight, Sara K. Krause, Lori Krueger, Terrye Light, Lance Lund, Leticia M. Márquez-Magaña, Briana McCarthy, Linda McPheron, Vanessa C. Miller-Sims, Christopher Moffatt, Pamela C. Muick, Paul H. Nagami, Gloria L. Nusse, Kristine Okimura, Sally G. Pasion, Robert Patterson, Pleuni S. Pennings, Blake Riggs, Joseph Romeo, Scott W. Roy, Tatiane Russo-Tait, Lisa Schultheis, Lakshmikanta Sengupta, Rachel Small, Greg S. Spicer, Jonathon H. Stillman, Andrea Swei, Jennifer M. Wade, Steven B. Waters, Steven L. Weinstein, Julia Willsie, Diana Wright

Postdoctoral and Visiting Scholars


Melinda Owens
Gloriana Trujillo
Shannon Seidel
Colin Harrison
Katherine Farrar

Undergraduate Researchers and Annotators!

Susanne Lietz
Shangheng Sit
Zahur-Saleh Subedar Travis
Bejines
Joseph Perez
Amanda Reggi
Katie Lam
Kristin Liang
Alycia Escobedo

hhmi
Howard Hughes
Medical Institute





Thank you for choosing to spend your time with me today...

Kimberly D. Tanner, Ph.D.
Professor, Department of Biology
San Francisco State University
Director, SEPAL



The Science Education
Partnership & Assessment Lab
San Francisco State University