



# NARST 2017

## GLOCALization and Sustainability of Science Education Research and Practice

NARST 90th Annual International Conference — Grand Hyatt San Antonio — San Antonio, TX, USA — April 22-25, 2017





# NARST 2017

## GLOCALization and Sustainability of Science Education Research and Practice

NARST 90th Annual International Conference — Grand Hyatt San Antonio — San Antonio, TX, USA — April 22-25, 2017



**NARST**  
A worldwide organization for improving  
science teaching and learning through research

# NARST 2017

90th Annual International Conference  
Grand Hyatt San Antonio | San Antonio, TX, USA  
April 22-25, 2017  
Glocalization and Sustainability of  
Science Education Research and Practice

## **ACKNOWLEDGMENTS**

The following members of the Program Committee helped in preparing and editing the 2017 NARST Annual International Conference Program Book.

Mei-Hung Chiu, President and Program  
Committee Co-Chair

Barbara Crawford, President-Elect and Program  
Committee Co-Chair

William C. Kyle, Jr., Executive Director

Toni A. Sondergeld, NARST Scheduling Coordinator

# Program Proposal Reviewers

Abi-El-Mona, Issam  
Abubakar, Salisu  
Adibelli-Sahin, Elif  
Aghasaleh, Rouhollah  
Aguirre-Mendez, Claudia  
Akerson, Valarie  
Akindoju, Olugbenga  
Aktan, Mustafa  
Alameh, Sahar  
Al-Balushi, Sulaiman  
Alkahr, Iris  
Allen, Carrie  
Alonzo, Alicia  
Ammons, James  
Anderson, Janice  
Annetta, Len  
Antink-Meyer, Allison  
Anwar, Tasneem  
Arias, Anna Maria  
Arslan, Harika Ozge  
Avargil, Shirly  
Avraamidou, Lucy  
Avsar Erumit, Banu  
Aydin, Ganime  
Azam, Saiqa  
Baek, Jongho  
Balgopal, Meena  
Bancroft, Senetta  
Barak, Miri  
Barnes, Elizabeth  
Bartels, Selina  
Bartus, Greg  
Bencze, John  
Benus, Matthew  
Bernardo, Cyntra  
Bhattacharya, Devarati  
Bianchini, Julie  
Bielik, Tom  
Bills, Patricia  
Birren, Jill  
Bismack, Amber  
Blanchard, Margaret  
Boda, Phillip  
Bogar, Yurdagul  
Bokor, Julie  
Borgerding, Lisa  
Borland, Jennifer  
Bressler, Denise  
Brunner, Jeanne  
Bryan, Lynn  
Bucklin, Carrie  
Buell, Jason  
Burcks, Shannon  
Burkett, Erin  
Buxner, Sanlyn  
Cakir, Birgul  
Canipe, Martha  
Cao, Carol  
Capps, Daniel  
Carlson, Janet  
Carpenter, Yuen-ying  
Carrier, Sarah  
Carter, Ingrid  
Casper, Anne Marie  
Castro-Faix, Moraima  
Cavallo, Ann  
Cavera, Veronica  
Cavlazoglu, Baki  
Cebesoy, Umran Betul  
Cengiz, Canan  
Chakraverty, Devasmita  
Chan, Kennedy  
Chapman, Angela  
Chasen, Ariel  
Chen, Ying-Chih  
Choi, Sanghee  
Christodoulou, Andri  
Chu, Hye-Eun  
Cian, Heidi  
Cigdemoglu, Ceyhan  
Cigdemoglu, Ceyhan  
Cisterna, Dante  
Clark, Ted  
Clough, Michael  
Cole, Merryn  
Cone, Neporcha  
Corin, Elysa  
Craig, Cheryl  
Crawford, Barbara  
Cunningham, Kellie  
Dagher, Zoubeida  
Dalvi, Tejaswini  
Dare, Emily  
Darner Gougis, Rebekka  
Davis, Jeni  
De Los Santos, Elizabeth  
Decoito, Isha  
Delen, Ibrahim  
Delgado, Cesar  
Delos Santos, Julieta  
Deniz, Hasan  
Deshmukh, Narendra  
Dewitt, Jennifer  
Diken, Emine  
Dogan, Nihal  
Dou, Remy  
Drewes, Andrea  
Dutta, Deborah  
Ellis, Joshua  
El-Moslimany, Hebbah  
Emerson Leak, Anne  
Enderle, Patrick  
Enfield, Mark  
Faber, Courtney  
Fadigan, Kathleen  
Ferguson, Nicole  
Fick, Sarah  
Fine, Caitlin  
Florence, Stephanie  
Forbes, Cory  
Forsythe, Michelle  
Fortus, David  
Foster, Jacob  
Francis, Tam'ra-Kay  
Frank, Carolin  
Fulmer, Gavin  
Garik, Peter  
Ghent, Chrysta  
Giamellaro, Michael  
Gilbert, Willard  
Gitomer, Drew  
Gnanakkan, Dionysius  
Godwin, Allison  
Golden, Barry  
Goldman, Daphne  
Gonczi, Amanda  
Gong, Xiaoyang  
Gonzalez-Howard, Maria  
Gooden, Shannon  
Goodnough, Karen  
Gravel, Brian  
Gray, Ron  
Grimberg, Bruna  
Grino, Paulina  
Gunckel, Kristin  
Gupta, Preeti  
Gutierrez, Kristie  
Guyen, Devrim  
Guy, Candice  
Habig, Robert  
Hacieminoglu, Esme  
Hall, Jonathan  
Hardcastle, Joseph  
Hartry, Ardice  
Haverly, Christa  
Hayes, Kathryn  
Heredia, Sara  
Herman, Ben  
Herrmann Abell, Cari  
Hestness, Emily  
Hill, Kathleen  
Hillman, Peter  
Hodges, Georgia  
Hoeg, Darren  
Hokayem, Hayat  
Hong, Zuway-R  
Horton, Cheryl  
Huang, Xiao  
Huffling, Lacey  
Ibourk, Amal  
Ibrahim, Bashirah  
Idsardi, Robert  
Ince, Kayahan  
Irish, Tobias  
Irmak, Meltem  
Jackson, David  
Jackson, Wendy  
Jeffery, Tonya  
Jeong, Sophia (Sun Kyung)  
Jho, Hunkoog  
Jimenez, Juan  
Jin, Hui  
Johnson, Joseph  
Johnson, Kathleen  
Johnson, Matthew  
Ju, Eunjeong  
Judson, Eugene  
Jung, Karl  
Kademian, Sylvie  
Kamarainen, Amy  
Kamp, Brandi  
Kara, Yilmaz  
Karaarslan, Güliz  
Karahan, Engin  
Kararo, Alex  
Keast, Stephen  
Keles, Nurcan  
Kelly, Angela  
Kelly, Gregory  
Khishfe, Rola  
Kim, Hyoungbum  
Kim, Young Ae  
King, Gretchen  
King, Natalie  
Kisiel, James  
Klein, Vanessa  
Koenen, Jenna  
Kong, Yi  
Kornreich-Leshem, Hagit  
Koul, Rekha  
Koulagna, Yotah  
Kowalski, Susan  
Krall, Rebecca  
Kremer, Kerstin  
Krist, Christina  
Kruse, Jerrid  
Kubarek-Sandor, Joy  
Kubsch, Marcus  
Kye, Hannah  
Lamb, Richard  
Lan, Deborah  
Langbeheim, Elon  
Langenhoven, Keith  
Lardy, Corinne

Lark, Amy	Mumba, Frackson	Rahman, S M Hafizur	Suh, Jee Kyung
Lavi, Rea	Murakami, Christopher	Ramnarain, Umesh	Summers, Ryan
Le, Thanh	Murray, Jaclyn	Rannikmae, Miia	Suriel, Regina
Lederman, Norman	Myers, John	Raven, Sara	Swanson, Hillary
Lee, May	Myers, Kimberly	Rebello, Carina	Swanson, Lauren
Lee, Soonchun	Nakedi, Mmamontle	Rees, Carol	Swanson, Rebecca
Lee, Tammy	Namdar, Bahadir	Ricketts, Amy	Swirski, Hani
Lee, Yonghee	Nargund-Joshi, Vanashri	Riedinger, Kelly	Szostkowski, Alaina
Lewis, Anna	Nation, Molly	Ring, Elizabeth	Tal, Tali
Li, Yi	Nelson, Tamara	Rivera, Seema	Talbot, Robert
Liang, Ling	Neumann, Knut	Rivero, Ana Margarita	Tekkumru Kisa, Miray
Liaw, Yuan-Ling	Newell, Alana	Rodriguez, Brandon	Telli, Sibel
Lima, Cynthia	Newsome, UrLeaka	Roehrig, Gillian	Testa, Italo
Lin, Jing	Nite, Sandra	Rogan-Klyve, Allyson	Thompson, Meredith
Lindahl, Mats	Nixon, Ryan	Rollnick, Marissa	Thompson, Stephen
Lipscomb, Kemper	Nkrumah, Tara	Romance, Nancy	Todd, Amber
Liu, David	Ntemngwa, Celestin	Romine, William	Tofel-Grehl, Colby
Liu, Shiyu	Nyachwaya, James	Ross, Danielle	Topcu, Mustafa
Lo, Stanley	Nyirenda, Euginia	Ryu, Minjung	Tuan, Hsiao-Lin
Longhurst, Max	Ogan-Bekiroglu, Feral	Sabel, Jaime	Tucker-Raymond, Eli
Ludwig, Tobias	Ogodo, Justina	Sadler, Troy	Tupper, Benjamin
Lundgren, Lisa	Ogunniyi, Meshach	Salgado, Michelle	Tutwiler, Michael
Lynch, Sharon	Okafor, Ngozi	Salinas, Ivan	Tzou, Carrie
Lyons, Luke	Okebukola, Peter	Salloum, Sara	Upadhyay, Bhaskar
Lyu, Xiaoxin	Oktay, Özlem	Saltinski, Ronald	Vaishampayan, Abha
Macalalag, Augusto	Olimpo, Jeffrey	Sandoval, William	Vallett, David
MacPherson, Anna	Omoifo, Christiana	Sato, Takumi	Van De Kerkhof, Mary
Madden, Lauren	Oner, Ayse	Sbeglia, Gena	Van Dusen, Ben
Madura, John	Opitz, Sebastian	Schaffer, Dannah	Van Horne, Katie
Malcolm, Stephen	Oqunsola-Bandele, Mercy	Schenkel, Kathleen	Vanmali, Binaben
Marbach-Ad, Gili	Ortega, Irasema	Schuchardt, Anita	Vaughn, Ashley
Marco-Bujosa, Lisa	Owens, David	Sciaky, Elizabeth	Vedder-Weiss, Dana
Marsan, Lynnsay	Owolabi, Tunde	Sen, Mutlu	Vesterinen, Veli-Matti
Martin, Anita	Ozdem-Yilmaz, Yasemin	Seo, Kyungwoon	Vezino, Beau
Martin, Ron	Ozturk, Gokhan	Shapiro, Marina	Vincent-Ruz, Paulette
Martin, Sonya	Ozturk, Nilay	Shepard, Kelly	Vo, Tina
Mawyer, Kirsten	Padilla-Martinez, Kira	Sheth, Manali	Waight, Noemi
McBeath, Jasmine Kyle	Palincsar, Annemarie	Shiverdecker, Terry	Waldrip, Bruce
McClain, Lucy	Park, Mihwa	Sikorski, Tiffanyrose	Wallon, Robert
McConnell, William	Park, Soonhye	Silva Mangiante, Elaine	Walter, Emily
McDermott, Mark	Parker, Carolyn	Simpson, Amber	Wang, Hui-Hui
McFadden, Justin	Patrick, Patricia	Singer, Jonathan	Wang, Jianlan
Mcgee, Steven	Pearson, Nelson	Skaza Acosta, Heather	Wang, Kuo-Hua
McGinnis, J.	Pegg, Jerine	Skeeles-Worley, Angela	Warfa, Abdi
McGowan, Veronica	Perin, Suzanne	Smith, Leigh	Weible, Jennifer
McGregor, Deb	Peters-Burton, Erin	Smith, Mike	Weiser, Gary
Menon, Preetha	Petty, Lori	Sonam, Tenzin	Wendell, Kristen
Michel, Hanno	Pietrocola, Mauricio	Song, Youngjin	Wendt, Jillian
Mikeska, Jamie	Pimentel, Diane	Sorge, Stefan	Wenger, Matthew
Miller, Alison	Plummer, Julia	Sozbilir, Mustafa	Wertheim, Jill
Miller, Bridget	Powell, Wardell	Stammen, Andria	White, Francesca
Minogue, James	Price, Aaron	Stapleton, Sarah	Whittington, Kirby
Minshew, Lana	Pringle, Malcolm	Staus, Nancy	Whitworth, Brooke
Momsen, Jennifer	Purzer, Senay	Stephens, Marilyn	Wieselmann, Jeanna
Moore, Michael	Quinlan, Catherine	Strimaitis, Anna	Williams, Grant
Morrison, Deb	Qureshi, Azhar	Strippel, Christian Georg	Witzig, Stephen
Moscarella, Rosa	Rachmatullah, Arif	Stuhlsatz, Molly	Wizner, Francine
Mulvey, Bridget	Radoff, Jennifer	Subramaniam, Karthigeyan	Wood, Krista

Wortel-London, Stephanie  
Wray, Kraig  
Wright, Christopher  
Wulff, Peter  
Yamaguchi, Etsuji  
Yarden, Anat  
Yilmaz Senem, Beril  
Yilmaz-Tuzun, Ozgul  
Yin, Yue  
Yoon, Sae Yeol  
You, Hye Sun  
Yu, Shu Mey  
Yuksel, Tugba  
Zaidi, Sania  
Zangori, Laura  
Zimmerman, Randi  
Zwiep, Susan  
Sen, Hanife  
Sengul, Ozden  
Seo, Kyungwoon  
Seung, Eulsun  
Shah, Ashima  
Shama, Ajay  
Shapiro, Marina  
Sharma, Meenakshi  
Sheffield, Adriane  
Shehab, Saadeddine  
Shemwell, Jonathan  
Sherwood, Carrie-Anne  
Sheth, Manali  
Shimek, Christine  
Shin, Myunghwan  
Shofner, Marcia  
Siatras, Anastasios  
Siegel, Marcelle  
Smith, Mike  
Smith, Patrick  
Smolek, Tamara  
Sondergeld, Toni  
Soobard, Regina  
Spray, Jason  
Staus, Nancy  
Stefanile, Adam  
Strimaitis, Anna  
Strippel, Christian Georg  
Strohl, Carrie  
Stromholt, Shelley  
Stroupe, David  
Stuessy, Carol  
Subramaniam, Karthigeyan  
Suh, Jee Kyung  
Summers, Ryan  
Sun, Baoling  
Sung, Shannon  
Swanson, Lauren  
Szyjka, Sebastian  
Tal, Tali  
Tan, Yuen Sze Michelle

Tanis Ozcelik, Arzu  
Telli, Sibel  
Thummaphan, Phonraphee  
Todd, Amber  
Tolbert, Sara  
Topcu, Mustafa  
Townes, Leonard  
Tran, Lynn  
Trujillo, Caleb  
Tucker-Raymond, Eli  
Tuncay-Yuksel, Busra  
Tunncliffe, Sue  
Tupper, Benjamin  
Tutwiler, Michael  
Upadhyay, Bhaskar  
Urueta, Tathali  
Vallett, David  
Van Duzor, Andrea  
Vanmali, Binaben  
Vaughn, Ashley  
Vergara, Claudia  
Verma, Geeta  
Veron, Dana  
Vesterinen, Veli-Matti  
Vhurumuku, Elaosi  
Vieira, Rodrigo  
Waight, Noemi  
Waldrip, Bruce  
Walter, Emily  
Wan, Zhi Hong  
Wang, Jian  
Wang, Jianlan  
Wang, Jing-Ru  
Wardrip, Peter  
Webb, Aubree  
Weeks, Faith  
Weible, Jennifer  
Weiland, Ingrid  
Wendel, Paul  
Wendell, Kristen  
Wengrowicz, Niva  
Wenner, Julianne  
Wertheim, Jill  
Wessnigk, Susanne  
Wetzstein, Lia  
Wheeler, Lindsay  
Whittington, Kirby  
Whitworth, Brooke  
Wild, Andrew  
Wilkerson-Jerde, Michelle  
Williams, Grant  
Witzig, Stephen  
Wizner, Francine  
Wolfe, Teresa  
Wong, Sissy  
Wood, Krista  
Wortel, Stephanie  
Wray, Kraig

Wright, Ann  
Wright, Christopher  
Wright, Elizabeth  
Wu, Jason  
Yang, Yang  
Yarema, Sandra  
Yarker, Morgan  
Yerrick, Randy  
Yoho, Rachel  
Yoon, Sae Yeol  
You, Hye Sun  
Young, Tyron  
Zangori, Laura  
Zastavker, Yevgeniya  
Zhai, Xiaoming  
Zisk, Robert  
Zoellick, Bill  
Zwiep, Susan  
Wang, Jianlan  
Webb, Angela  
Webb, Aubree  
Weitzel, Holger  
Wendt, Jillian  
Wengrowicz, Niva  
Wessnigk, Susanne  
West, Andrew  
Wheeler, Lindsay  
White, Francesca  
Whitworth, Brooke  
Wiebke, Heidi  
Wiggins, Benjamin  
Wild, Andrew  
Wilhelm, Jennifer  
Williams, Grant  
Wilmes, Sara  
Wilson, Rachel  
Wingert, Kerri  
Wiseman, Dawn  
Witzig, Stephen  
Wizner, Francine  
Wong, Sissy  
Wood, Krista  
Woods-Townsend, Kathryn  
Woolcott, Geoff  
Wright, Ann  
Wyner, Yael  
Xiao, Sihan  
Yalaki, Yalcin  
Yamaguchi, Etsuji  
Yan, Xiaomei  
Yarden, Anat  
Yarema, Sandra  
Yarker, Morgan  
Yerdelen, Sündüs  
Yestness, Nissa  
Yeung, Yau-yuen  
Yilmaz-Tuzun, Ozgul  
Yin, Xinying

Yin, Yue  
Yoon, Sae Yeol  
Zaidi, Sania  
Zangori, Laura  
Zastavker, Yevgeniya  
Zhang, Chunlei  
Zimmerman, Randi  
Zisk, Robert  
Zoellick, Bill

# Program Committee

## Co-Chairs:

Mei-Hung Chiu	National Taiwan Normal University	meihungchiu@gmail.com
Barbara Crawford	University of Georgia	barbarac@uga.edu

## Ex-Officio:

Bill Kyle	University of Missouri – Saint Louis	bill_kyle@umsl.edu
Toni A. Sondergeld	Drexel University	tas365@drexel.edu

## Members (Strand Co-Coordinators):

### Strand 1: Science Learning, Understanding, and Conceptual Change

(18) Knut Neumann	IPN, Germany	neumann@ipn.uni-kiel.de
(17) Ibrahim Delen	Usak University	delenibrahim@gmail.com

### Strand 2: Science Learning: Contexts, Characteristics and Interactions

(18) Fang-Ying Yang	National Taiwan Normal University	fangyang@ntnu.edu.tw
(17) Christopher G. Wright	University of Tennessee	cwrigh48@utk.edu

### Strand 3: Science Teaching – Primary School (Grades preK-6)

(18) Laura Zangori	University of Missouri	zangoril@missouri.edu
(17) Mandy Biggers	Penn State University	msb33@psu.edu

### Strand 4: Science Teaching – Middle and High School (Grades 5-12)

(18) Tom Bielik	Michigan State University	tbielik@msu.edu
(17) Regina L. Suriel	Valdosta State University	rlsuriel@valdosta.edu

### Strand 5: College Science Teaching and Learning (Grades 13-20)

(18) Carina Rebello	Purdue University	rebelloc@purdue.edu
(17) Rebekka Darner-Gougis	Illinois State University	rldarne@ilstu.edu

### Strand 6: Science Learning in Informal Contexts

(18) Kelly Riedinger	David Heil & Associates	kriedinger@davidheil.com
(17) Joy A. Kubarek-Sandor	PEER Associates	kubareksandor@yahoo.com

### Strand 7: Pre-service Science Teacher Education

(18) Sara Raven	Texas A&M University	sraven@tamu.edu
(17) David Stroupe	Michigan State University	dstroupe@msu.edu

### Strand 8: In-service Science Teacher Education

(18) Emily A Dare	Michigan Technological University	eadare@mtu.edu
(17) Lisa A. Borgerding	Kent State University	ldonnell@kent.edu

### Strand 9: Reflective Practice

(18) Patricia Gail Patrick	University of Warwick	trish.patrick.ise@gmail.com
(17) Gayle Buck	Indiana University	gabuck@indiana.edu

### Strand 10: Curriculum, Evaluation, and Assessment

(18) Mauricio Pietrocola	University of São Paulo	mpietro@usp.br
(17) Amy Trauth-Nare	University of Delaware	anare@udel.edu

### Strand 11: Cultural, Social, and Gender Issues

(18) Anna Lewis	University of South Florida Saint Petersburg	arlewis@usf.edu
(17) Neporcha Cone	Kennesaw State University	ncone@kennesaw.edu

### Strand 12: Educational Technology

(18) Joshua Alexander Ellis	Michigan Technological University	ellisj@mtu.edu
(17) Diana Jass Ketelhut	University of Maryland	djk@umd.edu

### Strand 13: History, Philosophy and Sociology of Science

(18) Ben Herman	University of Missouri	hermanb@missouri.edu
(17) Christine McDonald	Griffith University-Australia	c.mcdonald@griffith.edu.au

### Strand 14: Environmental Education

(18) Teresa Shume	North Dakota State University	teresa.shume@ndsu.edu
(17) Cassie Quigley	Clemson University	cassieq@clemson.edu

### Strand 15: Policy

(18) Kathryn Hayes	California State University, East Bay	kathryn.hayes@csueastbay.edu
(17) Jacob Foster	Massachusetts Department of Education	jfoster@doe.mass.edu

influenced career interests positively after grade 6 and 7, and possible influencers causing a decrease in interest in STEM careers after grade 8.

*How Sentiments and Approaches Change from AP to Regular and to Honors Science Courses*

Eugene Judson, Arizona State University

Lydia Ross, Arizona State University

**ABSTRACT:**

Eighty-five high school science teachers indicated how their approaches to teaching, their beliefs about learning, and the autonomy they have over a course varied between either an Advanced Placement (AP) and a regular science course or between an AP and an honors science course. Findings included the anticipated result that teachers spent a great deal more time having students prepare for tests in AP courses. Similarities between course types included strong sentiment that students should share their reasoning and relatively low emphasis on memorizing science vocabulary and facts. Significant differences included teachers having AP students complete homework more frequently, engage in more discussion, and analyze data more than regular-track students. Teachers were also more focused on honors students developing an interest in science and generally feel they have less control over content and goals in AP than in regular or honors courses. The gravity of these findings are placed in the context of the ongoing growth of AP STEM courses and the high value placed on the establishment of STEM AP courses by national organizations.

*Improvement of Students' Science Knowledge and Socio-scientific Reasoning through Socio-scientific Issue Teaching*

Hai T. Nguyen, University of Missouri, Columbia

Troy Sadler, University of Missouri

Andrew T. Kinslow, University of Missouri

**ABSTRACT:**

The purpose of this study was to identify evidence in students' socio-scientific reasoning improvement within the context of real-world socio-scientific issues (SSI). We used mixed methods research design to explore high school students' (n = 36) learning and reasoning. Results revealed that there was a significant improvement in students' socio-scientific reasoning (SSR) regarding complexity and inquiry before and after an SSI-based course. The teaching and learning activities in the SSI-based course were discussed as a potential source for the development of socio-scientific reasoning among participants. This study supports and extends other work related to how teachers' implication of SSI-based curriculum may influence students' SSR and has an impact on students learning scientific content knowledge.

*Teaching Electrical Resistance to 6<sup>th</sup> Grade Visually Impaired Students*

Betul Okcu, Ataturk University

Mustafa Sozbulir

Mustafa Bulbul

**ABSTRACT:**

This study aims to develop an instructional design teaching electrical resistance to 6th grade visually impaired students. Initially the needs of visual impairment students for particularly learning science were identified. An instructional setting was designed to meet their needs and it is evaluated. The study was conducted as a Design Based Research (DBR). The research groups are consisting of six visually impaired students including one blind at the needs analysis stage while the implementation of the developed instructional design was carried out with seven visually impaired students including one blind. The results showed a high achievement in gaining the intended learning outcomes regarding the concepts of electrical resistance. The results also indicated improvement in students' scientific process skills as well as developing positive attitude towards science.

**Strand 5: College Science Teaching and Learning (Grades 13-20)**

**Poster Session A**

3:15-4:15pm, Hyatt Texas Ballroom A, B, and C

*Disappearing trends: Examples of Simpson's Paradox in Introductory Science Courses*

Rebecca L. Matz, Michigan State University

Zachary D. Nusbaum, Michigan State University

James T. Laverty, Kansas State University

Melanie M. Cooper, Michigan State University

**ABSTRACT:**

As calls for improvements in science education continue, it is important that researchers and practitioners be able to reliably characterize changes in instruction and assessment practices. We have developed two protocols for undergraduate introductory science courses, one for observation of classroom instruction and one for assessments. Using these protocols, we investigated the relationship between time spent lecturing and both student enrollment and how much high-stakes exams reflect the dimensions laid out in the Framework for K-12 Science Education. Scientific practices, crosscutting concepts, and core ideas form the foundation of the Framework and together are a vision for science education that emphasizes providing students opportunities to experience how science is practiced. Across biology, chemistry, and physics courses in aggregate, we find time spent lecturing is positively correlated with student enrollment and negatively correlated with proportion of exam questions that incorporate the dimensions. However, we