Session Title: *Strategies for fostering undergraduate research and design*

Session Leaders:

Name	Institution
Elizabeth Ambos	Council on Undergraduate Research
Jeffrey Hill	Idaho State University
Jeremy Wojdak	Radford University
Louise Hainline	City University of New York – Brooklyn College
Anya Goodman	California Polytechnic State University, San Luis Obispo
Ann Saterbak	Rice University
Shelley Presley	Washington State University
Mitch Malachowski	University of San Diego
Oscar Schofield	Rutgers University

Session Abstract:
Fostering undergraduate research and design requires both faculty and student engagement. This highly interactive workshop will focus on identifying challenges as well as solutions for faculty who seek to increase student participation in research and engineering design across campuses. Particular topics include: faculty change, student acculturation, scaling best practices to diverse campuses, and defining and assessing student learning outcomes.

Key Points:

1. Faculty engaged in developing undergraduate research and design educational programs need targeted and continuous professional development and institutional support to successfully teach and support research and design activities, both in and outside of the classroom.
2. Transitioning STEM education to more active/inquiry-based modalities is fundamental to cultivating undergraduates' intellectual ownership and professionally relevant acculturation to creative undergraduate research and design.
3. Good models are in place for research and design-focused curricula, and many faculty are actively developing these types of curricula: the current challenge is to share, scale, and modify these practices to fit campus resources, curricular structures, and department and institutional cultures.

Supporting Work:

- DUE CCLI III 09-20275 Transformational Learning Through Undergraduate Research: Comprehensive Support for Faculty, Institutions, State Systems, and Consortia (Malachowski, Ambos, Osborn, Karukstis)
- DUE TUES 1140286 Early Integration of Research Experiences into the Undergraduate Biology Curriculum (Hill, Finney, Weber)

- DUE TUES 1140828 Preparing the Next Generation of STEM Professionals: Integrating Computational Thinking into an Applied Molecular Forensics Research Program (Kitts, Black, Dekhtyar, Goodman)
- DUE TUES 1244928, Teaching Freshman Design Using a Flipped Classroom Model (Saterbak, Oden)
- DUE IUSE 1431671, AIMS: Analyzing Images to learn Mathematics and Statistics (Wojdak)
- DUE IUSE 1525503, Peer Assisted Team Research (PATR): A Method for Early Undergraduate Research (Hainline, Sims)
- DUE IUSE 1525635. Polar Interdisciplinary Coordinated Education (Polar-ICE). (Schofield, McDonnell, Kohut).

References:

Goodman AL, Dekhtyar A (2014) Teaching Bioinformatics in Concert. PLoS Comput Biol 10(11): e1003896. doi:10.1371/journal.pcbi.1003896

Goodnoe TT, Hill JP, Aho K (2016) Effects of variation in carbon, nitrogen, and phosphorus molarity and stoichiometry on sex determination in the fern *Ceratopteris richardii*. *Botany* 94: 249-259, doi:10.1139/cjb-2015-0187

Malachowski MR, Osborn JM, Karukstis KK, Ambos EL (2015) Enhancing and Expanding Undergraduate Research: A Systems Approach, San Francisco, CA, Jossey-Bass.

Goals for Workshop

1. Understand obstacles and challenges faced by faculty when trying to implement research and design for various audiences of undergraduate STEM students.
2. Generate practical solutions and strategies to successfully implement research and design for various audiences of undergraduate STEM students.
3. Each workshop participant will identify three to five new strategies or best practices that could be tried on their home campus.
4. Identify topics and areas of further investigation and support that could be focus of future grants, workshops, etc.

Three Themes

1. Developing faculty to teach and support research and design activities
    - Working with administrators to build and sustain needed infrastructure
    - Changing campus culture, curriculum and expectations
2. Acculturation to research and design
    - Focus on 1st (or 2nd) experience
    - Develop ways to actively engage both lower and upper division students in research
3. Scaling and modifying best practices in research and design to fit with available resources and existing curricular structures

- Includes research/design-only courses, projects within courses, and projects outside of courses
- Resource issues with respect to student and faculty time and equipment/supplies
- Disciplinary-specific content
- Process or "how-to" knowledge, skill development
- Motivational issues and student ownership

Schedule

0-0:05 Introduce people. Brief remarks introducing the themes, each of which is listed on giant post-it note board.

0:05-0:15 People are given small post-it notes and asked to identify major problems or challenges they face, within each of these themes. They stick their notes under any of the major themes.

0:15-0:25 People select a group and sort stated problems on post-it notes into sub-themes. Discuss.

0:25-0:35 Each group reports their emerging challenges to whole group.

0:35-0:50 People are given small post-it notes and asked to identify potential/existing solutions, things that work, resources, documents, etc. that tackle the stated problems. Everyone should circulate across the three areas.

0:50-1:00 People select a group and sort stated solutions, resources, etc. on post-it notes into sub-themes. Discuss.

1:00-1:20 Each of the three groups reports their emerging solutions to whole group.

(Note, after the session is done, participants are encouraged to enjoy follow-on conversations, and possibly initiate collaborations)

Session Title: Broadening Participation: Getting Beyond Grants to Institutional Change with [Disruptive/Innovative/Revolutionary] Evidence Based Methods

Session Leaders:

Name	Institution
Mary Ann Leung	Sustainable Horizons Institute
Esther Wilder	Lehman College, The City University of New York
Jeannie Choi	University of California, Los Angeles
Javier Kypuros	The University of Texas Rio Grande Valley
Stasinos Stavrianeas	Willamette University

Session Abstract: Broadening participation in STEM fields is embedded in the NSF Strategic Mission. Accomplishing this goal happens in many stages, from vision to reality, and at many levels, from a single course to an entire institution. In this session we will discuss approaches to broadening participation and identify best practices, obstacles, and solutions to accomplishing this goal with a focus on sustainability, institutional change, and getting beyond grant funding.

Key Points:

1. What does broadening participation mean to you?
2. What are the greatest barriers you have faced in broadening participation at your institution?
3. What are some of the effective strategies/solutions for broadening participation you have developed or implemented?
4. What are your plans for broadening participation when the grant ends? What would you like to do after the grant ends that you don't know how to do now or don't have the resources for?
5. Summary

Agenda

- Brief introductions of session leaders and their projects
- Setting the context and landscape
- Break into small groups
- Discuss each of the key points in small groups with report out from each group after each question
- Summary

Supporting Work:

CCLI-DUE 0837830. Promoting Science Literacy Through Neuroscience Laboratory Exercises. Stasinos Stavrianeas and Mark Stewart, Willamette University, Salem, OR.

Supercomputing Conference 2014 Broader Engagement Technical Session Poster Submission Workshop, Mary Ann Leung, Sustainable Horizons Institute

Numeracy Infusion Course for Higher Education (NICHE): A Project of The City University of New York (CUNY) Quantitative Reasoning (QR) Alliance
Award Number:1121844; Principal Investigator:Esther Wilder; Co-Principal Investigator:Dene Hurley, Frank Wang; Organization:CUNY Herbert H. Lehman College.

An Ecosystem for Success in Engineering and Computer Science in Rio South Texas Award Number:1317661; Principal Investigator:Javier Kypuros; Co-Principal Investigator:Stephen Crown, Arturo Fuentes, Virgil Pierce, Horacio Vasquez; Organization:The University of Texas Rio Grande Valley.

Use of Video Production to Promote Collaborative Learning and Higher Level Cognitive Understanding in an Introductory Life Science Curriculum. Award Number: 1140951; Principal Investigator: Paul Barber; Co-Principal Investigator: Jeannie Choi; Co-Principal Investigator: Deb Pires; Organization: University of California Los Angeles.

References:

Leung, M.A., McNeely, C.L., "Opening doors to communities of practice: Programmatic interventions for inclusion in the computing sciences", Proceedings of Research in Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT), 2015

Wang, Frank and Esther Isabelle Wilder. 2015. "Numeracy Infusion Course for Higher Education (NICHE), 1: Teaching Faculty How to Improve Students' Quantitative Reasoning Skills through Cognitive Illusions." Numeracy 8(2): Article 6.

Toven-Lindsey B., Levis Fitzgerald M, Barber PH, Hasson T (2015) Increasing Persistence in Undergraduate Science Majors: A Model for Institutional Support of Underrepresented Students *CBE—Life Sciences Education* Vol. 14, 1–12, Summer 2015.

Stewart, Mark and Stavrianeas, Stasinos. Adapting the Learning-Cycle to Enrich Undergraduate Neuroscience Education for All Students, The Journal of Undergraduate Neuroscience Education (JUNE), Spring 2008, 6(2):A1-A4.

J. A. Kypuros, S. W. Crown, A. A. Fuentes, H. Vasquez, V. Pierce, J. Lavariega Monforti, "Developing an Ecosystem for Student Success in Engineering in Rio South Texas," *Proceedings of the ASEE/IEEE Frontiers in Education Conference*, El Paso, TX, October 21-24, 2015.

Session Title: *Curriculum Development Working Group: Challenges of Interdisciplinary Curriculum Development in STEM*

Session Leaders:

Name	Institution
Jennifer Burg	Wake Forest University
Melanie Cooper	Michigan State University
Edgar Fuller	West Virginia University
Priscilla Hill	Mississippi State University
Tongyan Pan	Illinois Institute of Technology
Mark Pauley	University of Nebraska at Omaha
Anne Rosenwald	Georgetown University
Beth Pratt-Sitaula	UNAVCO
Dianna Spence	University of North Georgia
William Tapprich	University of Nebraska at Omaha

Session Abstract: *Curricula that promote active learning and student engagement have been shown to increase student performance in a variety of STEM fields (Freeman et al. [2014] PNAS 111, 8410). Developing effective curriculum modules at the intersections of STEM fields requires a balance between delivery of field-specific information and authentic research practices in those fields. In this session, we will discuss the challenges of creating effective interdisciplinary curricula using several examples: Chemistry and Biology, Biology and Computer Science (Bioinformatics), Chemical Engineering and Nanotechnology, Computer Science and the Arts, and Data Science (incorporating Computer Science, Mathematics/Statistics, and Applied Domains).*

Key Issues / questions:

1. What are common issues for interdisciplinary curriculum development?
2. How can the curriculum be made portable for different institutions?
3. What are the best practices for development, deployment, and evaluation?
4. How to construct scaffolded progressions of core ideas?
5. What supporting frameworks are necessary to facilitate development, deployment, and evaluation?
6. What supporting research is necessary to evaluate effectiveness?

Supporting Work:

Burg (PI) Collaborative Research: Computing in the Arts – A Community-Building Initiative (DUE 1323593)

Cooper (PI) and Klymkowsky (Co-PI) – Chemistry, Life the Universe and Everything (CLUE) (DUE 0816692 and DUE 1359818)

Hill (PI) – NSF NUE: Multifunctional Nanostructures for Integrated Electrical, Chemical, Mechanical and Geological Applications: A Multidisciplinary Laboratory Education Program (NUE 1343708)

Miller (PI), Pratt-Sitaula (Co-PI), and Charlevoix (Co-PI) – Collaborative Research: Geodesy curriculum for the 21st century--Innovative science for addressing societally critical issues (DUE 1245025)

Pan (PI) – NSF NUE: Development of a Minor in Nanotechnologies for Surface Engineering (Nano-SurfEng) - A Cross-Departmental Effort at Illinois Institute of Technology (NUE 1446008)

Pauley (PI), Dinsdale (CoPI), Morgan (CoPI), Rosenwald (CoPI), and Triplett (CoPI) – RCN-UBE: Network for Integrating Bioinformatics into Life Sciences Education (DBI 1539900)

Pauley (PI) and Tapprich (Co-PI) – Integrating Bioinformatics into the Life Sciences – Phase 2 (DUE 1122971)

Rosenwald (PI) – NextGen Genome Solver (DUE 1505102)

Spence (PI) – Discovery Learning Projects in Introductory Statistics (DUE 1021584)

Tapprich (Co-PI) – Supporting Research Opportunities for Underprivileged Youth Through Teacher-Researcher Partnerships (Sherwood Foundation Grant #3973)

References:

References to work done by the session leaders.

Burg (in press) Digital Sound and Music: Concepts, Applications, and Science. Portland, OR: Franklin Beedle (Freely available, with interactive learning supplements, at http://digitalsoundandmusic.com)

Cooper and Klymkowsky (2013) "Chemistry, Life, the Universe and Everything (CLUE): A new approach to general chemistry, and a model for curriculum reform" J Chem Educ, 90, 1116

Cutucache et al. *"NE STEM 4U: an out-of-school time academic program to improve achievement of socioeconomically disadvantaged youth in STEM areas" International Journal of STEM Education 3, 1*

Duncan et al. *"Laboratories for Integrating Bioinformatics into the Life Sciences—Part 2," Proceedings of the 37th Workshop/Conference of the Association for Biology Laboratory Education (ABLE) (in press).*

Hill et al*. (2015) "A Multidisciplinary Undergraduate Nanotechnology Education Program with Integrated Laboratory Experience" 2015 ASEE Annual Conference & Exposition, Seattle, June 2015; https://peer.asee.org/23412.*

Hill et al. *(in press) A Multidisciplinary Undergraduate Nanotechnology Education Program with Integrated Laboratory Experience and Outreach Activities. 2016 ASEE Annual Conference & Exposition, New Orleans, June 2016*

Pan and Cheng (2015) "An Ab Initio *Molecular Dynamics Analysis of Lignin as a Potential Antioxidant for Hydrocarbons." J Molecular Graphics and Modelling. 62, 325*

Pratt-Sitaula et al. *"Undergraduate teaching modules featuring geodesy data applied to critical social topics (GETSI: GEodetic Tools for Societal Issues)" American Geophysical Union Annual Meeting, December 12-16, 2015.*

Rosenwald et al. (2016) "The CourseSource Bioinformatics Learning Framework" CBE – Life Sciences Education 15, 1

Rosenwald, Russell, and Arora (2012) "The Genome Solver Website: A Virtual Space Fostering High Impact Practices for Undergraduate Biology" J Microbiol Biol Educ 13, 188

Tapprich et al (2016) "Enhancing the STEM Ecosystem through Teacher-Researcher Partnerships" Metropolitan Universities Journal 27, 71

Spence and Bailey (2016). "Technologies to facilitate each stage of student-directed statistics projects" in P. Bogacki (Ed.), Proceedings of the Twenty-Seventh Annual International Conference on Technology in Collegiate Mathematics (pp. 220-228). Pearson Education, Inc.

Other related references

Burg et al. *"A STEM Incubator to Engage Students in Hands-on, Relevant Learning: A Report from the Field" To appear in Proceedings of ItiCSE 2016, Arequippa, Peru, July 2016.*

Freeman et al. (2014) "Active Learning Increases Student Performance in Science, Engineering, and Mathematics" Proc Natl Acad Sci 111, 8410.

Cooper et al. (2015) "Challenge faculty to transform STEM learning" Science 350, 281

Session Title: *Digital Teaching Tools: Best Practices, Challenges, and Opportunities*

Session Leaders:

Name	Institution
Carl Dietrich	Electrical and Computer Engineering, Virginia Tech
Tomas Helikar	Biochemistry, University of Nebraska - Lincoln
Douglas B. Meade	Mathematics, University of South Carolina
Venkatesh Merwade	Civil Engineering, Purdue University
Stephen Moysey	Env. Eng. & Earth Sciences, Clemson University
Murali Sitaraman	School of Computing, Clemson University
Philip Yasskin	Mathematics, Texas A&M University

Session Abstract:

The session will begin with a brief summary of experience in developing and using digital reasoning tools by the organizers. Participants will break into working groups devoted to areas focused on (i) guided learning, learning analytics (videos, applets, homework systems); (ii) online collaboration, communication/social (videos, chat rooms); (iii) simulations, games, experiential activities; and (iv) in class activities (clickers, adaptive and online learning) to discuss best practices, challenges, opportunities, and sustainability as related to each focus area. The session will conclude with summary of the discussions from each focus area.

Key Points:

1. Dissemination, both to expand adoptions and as a "publication"
2. Avoiding/Delaying obsolescence (e.g., Java/Javascript/HTML5)
3. How to predict future trends (e.g., developing for future generations of smartphones)
4. Sustainability (e.g., through commercialization)
5. Comprehensiveness (including a variety of technologies in a single resource)

Supporting Work:

NSF DUE IUSE 1432416 (Dietrich) - Wireless Communication Testbeds for Authentic STEM Learning
NSF DUE TUES 1123170 (Meade) and 1123255 (Yasskin) - Collaborative Research: Maplets for Calculus
NSF DUE IUSE 1432001 (Helikar) - An innovative computational modeling intervention to facilitate learning of biology in university courses using simulation and dynamical systems approaches
NSF IUSE EHR 1504619 (Moysey) - Enabling field experiences in introductory geoscience classes through the use of virtual reality.
NSF IUSE GEOPATHS 1540702 (Moysey) – GP-EXTRA: Building an affective pathway to the geosciences through experiential learning opportunities for non-geoscience majors.
NSF CCLI Phase II (Expansion) 1022941 (Sitaraman) – Collaborative Research: "Hands-On" Collaborative Reasoning across the Curriculum
NSF DUE TUES 1043980 (Merwade) Collaborative Research: Cyber Enabled Data and Modeling Driven Curriculum Modules for Hydrology Education

References:

Drachova S. V., J. O. Hallstrom, J. E. Hollingsworth, J. Krone, R. Pak, and M. Sitaraman, Teaching Mathematical Reasoning Principles for Software Correctness and Its Assessment. Transactions on Computing Education 15, 3, Article 15 (August 2015), 22 pages. DOI=10.1145/2716316 http://doi.acm.org/10.1145/2716316

Helikar T., Cutucache C., Herek T., Rogers J. (2015) Integrating interactive computational modeling in biology curricula. PLoS Computational Biology. 11(3):e1004131

Kulczycki G., M. Sitaraman, N. Sridhar, and B. W. Weide, Panel: Engage in Reasoning with Tools, Proceedings 47th ACM SIGCSE Conference, Memphis, TN, March 2016, 161-162, DOI=10.1145/2839509.2844657

Marojevic V. , R.M. Goff, C.B. Dietrich, T. Yang, C.W. Hearn, N.F. Polys, R.M. Buehrer, "Wireless Communication Testbed and Tools for Authentic STEM Learning," ASEE Annual Conference, Seattle, WA, June 14-17, 2015.

Meade, D.B. and Yasskin, P.B., Maplets for Calculus: A Model for Multi-Use Mathematical Software, in R&E Source (Open Online Journal for Research and Education: http://journal.ph-noe.ac.at/index.php/resource/article/view/81), Issue 7 (Special Issue for Proceedings of TIME 2014), ISSN: 2313-1640, 2014.

Merwade, V., and B. Ruddell, Moving university hydrology education forward with geoinformatics, data and modeling approaches (2012), Hydrology and Earth System Sciences, Vol. 16 (8), pp. 2393–2404.

Moysey, S., E. Smith, V. Sellers, P. Wyant, D.M. Boyer, C. Mobley, S. Brame, 2015, Enabling Field Experiences in Introductory Geoscience Classes through the Use of Immersive Virtual Reality, ED14B-07, AGU Fall Meeting, Dec.14-18, 2015, San Francisco, CA.

Sanchez, C. A., B. L. Ruddell, R. Schiesser and V. Merwade, (2016) Enhancing the T-shaped learning profile when teaching hydrology using data, modeling, and visualization activities, Hydrol. Earth Syst. Sci., 20, 1289-1299, doi:10.5194/hess-20-1289-2016.

Session Title: Making change happen: Promoting productive use of evidence-based practices (Dissemination Working Group)

Session Leaders:

First	Last	Email	Institution
Lecia	Barker	lecia@ischool.utexas.edu	University of Texas at Austin
Cynthia	Furse	cfurse@ece.utah.edu	University of Utah
Edward	Gehringer	efg@ncsu.edu	North Carolina State University
Joshua	Halpern	jhalpern@howard.edu	Howard University
Charles	Henderson	charles.henderson@wmich.edu	Western Michigan University
Karen	Kortz	kkortz@ccri.edu	Community College of Rhode Island
Eleanor	Sayre	Esayre@gmail.com	Kansas State University
Bernard	Van Wie	bvanwie@wsu.edu	Washington State University
Sandra	Webster	Websters@westminster.edu	Westminster College

Session Abstract:

This working group will focus on what it takes to promote effective scaling and spread of educational innovations. Discussion topics will include: What more do we need to know in order to promote widespread use of evidence-based teaching practices? (i.e., a research agenda); What are promising practices to promote widespread use of evidence-based teaching practices? (i.e., what change strategies already exist and should be used more widely?); What practices to promote widespread use of evidence-based teaching practices should be abandoned? (i.e., what change strategies do we commonly use that we know are not effective?); and What can/should the NSF do to help support PIs in doing a better job of promoting widespread use of evidence-based teaching practices?

Key Points:

1. In order to promote adoption of their product, it is important for education developers to do something beyond the usual dissemination methods.
2. Instructors rarely adopt products “as is”, but rather blend elements from many places to build instruction that suits their local needs.
3. Focusing only on individual instructors is unlikely to result in widespread instructional change. It is important to also focus on environments and structures that constrain teaching practices.
4. Effective dissemination of teaching practices should take into account the information sources faculty find trustworthy, the nature of information needed for evaluating whether to sample a practice, and demonstrate understanding of institutional constraints.

5. The I-Corp L program is an excellent way to learn about effective product development and dissemination.
6. Effective product development proposals can involve a team effort with some collaborators being primarily responsible for dissemination.

Supporting Work:

- 1122446, 1122416, 1236926: “Increasing the Impact of TUES Projects through Effective Propagation Strategies: A How-To Guide for PIs”
- 1432347, 1431856, 1432580, 1432690, 1431975, “Collaborative Research: Research in Student Peer Review: A Cooperative Web-Services Approach”
- 1432674, 1545654: “Affordable Desktop Learning Modules (DLMs) to Facilitate Transformation of Undergraduate Engineering Classes”
- 1524638, 1525862, 1525057, 1525021, 1524990, 1525037, “Collaborative Research: Developing and Assessing Effective Cyberlearning within the STEMWiki Hyperlibrary”
- 1546979: “I-Corps L: Hands-on Modules for Fluid Mechanics and Heat Transfer, A Market Transition”
- 1245004: “Training Teachers for the Flipped Hybrid Classroom” (See Teach-Flip.Utah.Edu)

References:

- Abdul, B, Thiessen, DB, Adesope, OO, Van Wie, BJ, (2016) Comparing the effects of two active learning approaches in an engineering education classroom, *International Journal of Engineering Education, 32(2(A))*, 654-669.
- Barker, L., Hovey, C. L. & Gruning, J. (2015). What influences CS faculty to adopt teaching practices? In Proceedings of the 46th ACM Technical Symposium on Computer Science Education. ACM, New York, NY (pp. 604-609). DOI: 10.1145/2676723.2677282.
- Halpern, J.B., *Why the ChemWIKI*, DivCHED CCCE: Committee on Computers in Chemical Education Fall Newsletter, November 2015: <http://confchem.ccce.divched.org/sites/confchem.ccce.divched.org/files/2015FallCCCENLP7.pdf>
- Henderson, C., Cole, R., Froyd, J., Friedrichsen, D., Khatri, R., & Stanford, C. (2015). *Designing educational innovations for sustained adoption: A how-to guide for education developers who want to increase the impact of their work*. Kalamazoo, MI: Increase the Impact. <http://www.increasetheimpact.com/>
- Webster, S.K. & Karpinsky, N. (2015). Using COEUR to assess the undergraduate research environment: A three stage model for institutional assessment. C*UR Quarterly, 36(1)*, 32-39.
- Yang Song, Zhewei Hu, and Edward F. Gehringer, “Pluggable reputation systems for peer review: a web-service approach,” *Frontiers in Education 2015, 45th Annual Conference*, El Paso, TX, October 21–24, 2015

Session Title: *Evaluation and Assessment*

Session Leaders:

Name	Institution
Sharon Cooper	Columbia University
Luca DeAlfaro	University of California – Santa Cruz
Jennifer Drew	University of Florida
Heidi Ellis	Western New England University
Joanna Garner	Old Dominion University
Sarah Heckman	North Carolina State University
Greg Hislop	Drexel University
Tom Holme	Iowa State University
Jean McGivney-Burelle	University of Hartford
Clifford Shaffer	Virginia Tech
Toby Smith	Association of American Universities
Robert Talbot	University of Colorado – Denver
David Yaron	Carnegie Mellon University

Session Abstract: *This workshop will explore several key aspects of assessment and evaluation. There will be opportunities to consider (a) appropriate choices of research methods and analysis; (b) the role of project scale and (c) scaffolding considerations for the design of assessments. Each of these roles will be considered in terms of projects that take place at any of several levels, including (i) course; (ii) discipline; (iii) institution or (iv) multi-institution projects.*

Key Points:

1. The identification of tools and resources that have been developed for assessment/evaluation
2. The identification of factors and strategies that lead to success in assessment/evaluation
3. The identification of key questions that must be addressed to move assessment/evaluation efforts forward.
4. Prioritization of the various possible trajectories to improve assessment/evaluation in education innovation.

Supporting Work:

Evaluation and Assessment at NSF. http://www.nsf.gov/attachments/123272/public/NSFE&A_ONeil.pdf

Reference:

Framework for Systemic Change in Undergraduate STEM Teaching and Learning. Available on-line at : https://stemedhub.org/groups/aau/framework

Session Title: Working Group on Faculty Instructional Development

Session Leaders:

Name	Institution
Tessa C. Andrews	University of Georgia
Eric M.D. Baer	Highline College
Juan R. Burciaga	Bowdoin College
Janet Callahan	Boise State University
Kristin Jenkins	BioQUEST
Jennifer J. Kaplan	University of Georgia
Marsha Lakes Matyas	American Physiological Society
Jill Nelson	George Mason University

Session Abstract:

This Working Group will focus on sharing models for and research about successful Faculty Professional Development programs with a focus on Professional Development that promotes undergraduate success in STEM fields. Depending on audience size and interest we will discuss the key points listed below including sharing topics around which professional development is needed, models and solutions to problems encountered in establishing and maintaining professional development programs (getting faculty in the door and keeping them there), and providing evidence-based results on the efficacy of professional development. Some potential outcomes of the session are a list of references, potential speakers, and/or mentors for those interested in professional development as well as the creation of subgroups of PIs with similar implementation and/or research interests in faculty professional development.

Key Points:

1. **List existing models and successful implementations of Faculty Professional Development**
2. **Find solutions to problems that have been encountered in running Faculty Professional Development**
3. **Discuss methods of researching the effectiveness of Faculty Professional Development**
4. **Identify areas related to Faculty Professional Development in which more work is needed**
5. **Create networks of participants with similar interests related to Faculty Professional Development**

Supporting Work:

DUE 0856815: The Idaho Science Talent Expansion Program
DUE 1122737: Supporting and Advancing Geoscience Education at Two-year Colleges through Workshops and Web Resources
DUE 1322895: Conference on Introductory Physics for the Life Sciences
DUE 1322962: Collaborative Research: Expanding a National Network for Automated Analysis of Constructed Response Assessments to Reveal Student Thinking in STEM (AACR)
DBI 1346220: RCN-UBE Incubator: Growing a Physiology Education Community of Practice
DUE 1347675: SIMPLE Design Framework for Teaching Development Across STEM
DUE 1446269, DUE 1446258, and DUE 1446284 Collaborative Research: BIO IUSE Ideas Lab: Supporting Faculty in Quantitative Undergraduate Biology Education and Synthesis (QUBES)
DUE 1504587: Fostering Active Learning in Statistics: Research on Students and Graduate Teaching Assistants (FALS: R)

DUE 1504013: The HILT-LAS Project: High Impact, Little Time activities that address Lexical Ambiguity in Statistics (HILT-LAS)

DUE 1504904: Promoting active learning in large undergraduate STEM courses: Identifying critical knowledge used by effective instructors

References:

Session Leaders:

American Association of Physics Teachers (2015) *Conference on Introductory Physics for the Life Sciences Report.* Author: College Park, MD: http://www.compadre.org/IPLS/documents/IPLS-Final-Report.pdf, referenced April 19, 2016

Andrews, T.C. and Lemons, P.P. (2015) "It's personal: Biology instructors prioritize personal evidence over empirical evidence in teaching decisions." *CBE-Life Sciences Education, 14(1):*1-18*. doi: 10.1187/cbe.14-05-0084.*

Baer, E. M., Blodgett, R.H. and Macdonald, R.H. (2013) "Teaching All Geoscience Students: Lessons Learned From Two-Year Colleges", *Eos Trans. AGU*, 94(45): 411.

Bullock, D., **Callahan, J.** and Shadle, S. (2015) "Coherent Calculus Course Design: Creating Faculty Buy-in for Student Succe," AC 2015-14209, American Society for Engineering Education Annual Conference & Expo, 2015

Donovan, S., Diaz Eaton, C., Gower, S.T., **Jenkins, K.P**., LaMar, M.D., Poli, D., Sheehy, R., and Wojdak, J.M. (2015) "QUBES: a community focused on supporting teaching and learning in quantitative biology", *Letters in Biomathematics*, 2(1): 46--55, jun, (DOI: 10.1080/23737867.2015.1049969).

Kaplan, J.J., Rogness, N., & Fisher, D. (2014) " Exploiting Lexical Ambiguity to Help Students Understand the Meaning of *Random*." *Statistics Education Research Journal, 13*(1), 9 – 24*.* http://iase-web.org/documents/SERJ/SERJ13%281%29_Kaplan.pdf

Matyas, M.L. and Silverthorn, D.U. (2015) "Harnessing the Power of an Online Teaching Community: Connect, Share, and Collaborate." *Advances in Physiology Educatio, 39* (4), 272-277. DOI:10.1152/advan.00093.2015

Nelson, J. K., & Hjalmarson, M. (2015) "Faculty Development Groups for Interactive Teaching." *Proceedings of the 2015 ASEE Annual Conference and Exposition*. Seattle, Washington. *Reference to conference and outcomes*

Background Material:

American Association for the Advancement of Science (2010) *Vision and Change in Undergraduate Biology Education: A Call to Action*. Author: http://visionandchange.org/, referenced April 19, 2016

D'Avanzo, C. (2013) "Post-*Vision and Change:* Do we know how to change?" *CBE-Life Sciences Education, 12*(3), 373 – 382.

Henderson, C., Beach, A. & Finkelstein, N. (2011) "Facilitating change in undergraduate STEM instructional practices." *Journal of Research in Science Teaching, 48*(8), 952-984.

Kober, N. (2015) *Reaching Students: What Research Says About Effective Instruction in Undergraduate Science and Engineering*. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Session Title: Educational innovation through online learning and global collaboration

Session Leaders:

Name	Institution
Ariel Anbar	Arizona State University
Abul Azad	Northern Illinois University
Lisa Dierker	Wesleyan University
Chris Mortensen	University of Florida
Darrin York	Rutgers University

Session Abstract: Session leaders will facilitate discussion of the current and future challenges and opportunities that online learning presents in the development and dissemination of innovative and accessible STEM education. Our goal is to actively plan online collaboration that may assist attendees in disseminating their own teaching and learning innovations.

Key Points:

1. Strategies for engaging faculty
2. Optimizing student engagement
3. Consideration of emerging on-line platforms for active learning
4. Best practices for assessment of online curriculum
5. Bringing multiple classrooms together in the online world

Supporting Work:

- Passion-Driven Statistics: A multidisciplinary, project-based, supportive model for statistical reasoning and application (NSF-TUES grant #0942246 and 1323084).
- Internet Accessible Remote Laboratories with Collaborative Design (NSF-TUES grant #1140502).
- Universal Environment for Delivering Remote-Laboratories within the STEM Disciplines (NSF-CCLI grant #0837138).
- Wild Discoveries, Zooming into the Scientific Method (NSF-IUSE grant #1503322).
- Exploration-Driven Online Science Education: Habitable Worlds 2.0 (NSF-TUES grant #1225741)

References:

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- Mortensen, C. J., Nicholson, A.M. (2015) The flipped classroom stimulates greater learning and is a modern 21st century approach to teaching today's undergraduates, *Journal of Animal Science* 93, 3722-3731.

- Vakati, K.C., Azad, A.K.M., and Hashemian, R. (2016). Integration of Engineering Systems Within A Remote Laboratory Facility, *Computers in Education Journal*, April-June issue (scheduled to be published).
- Anbar, A.D. and the ASU Center for Education Through eXploration Research Team (2016) Education through Exploration: Evaluating the Unknown, 2016 Fall Meeting of the American Geophysical Union, ED53A-0843, https://agu.confex.com/agu/fm15/meetingapp.cgi/Paper/78036

Session Title: Navigating the landscape of organizational change

Session Leaders:

Name	Institution
Michelle Withers	West Virginia University
Scott Franklin	Rochester Institute of Technology
Susan Shadle	Boise State University
Emily Miller	Association of American Universities
Leen-Kiat Soh	University of Nebraska
Howard Jackson	University of Cincinnati
Renee Cole	University of Iowa
Claire Wladis	Borough of Manhattan Community College at the City University of New York
James Middleton	Arizona State University
Ann McKenna	Arizona State University
Anne Egger	Central Washington University
Paul Craig	Rochester Institute of Technology
Geoffrey Herman	University of Illinois at Urbana/Champaign
Joan Esson	Otterbein University
Thomas Litzinger	Penn State University

Session Abstract:

The purpose of this session is to engage participants in discussions about frameworks and models for organizational change. Participants will focus on the key levers and contexts that should inform change strategies within and across institutions.

Key Points:

1. Systems thinking provides a useful framework for organizational change
2. Effective change strategies take the local context into account

3. There are many different categories of change strategies.
4. The process of organizational change is iterative, requiring feedback and revision over time.

Supporting Work:

- NSF-DUE-IUSE #1432728 *TILE: Transform, Interact, Learn, and Engage for success in STEM education*
- NSF-DUE-TUES #1122446, #1122416, and #1236926 *Collaborative Research: Increasing the Impact of TUES Projects through Effective Propagation Strategies: A How-To Guide for PIs*
- NSF-DUE-STEP Center #1125331 *InTeGrate: Interdisciplinary Teaching of Geoscience for a Sustainable Future*
- NSF-DUE-IUSE #1503811 *Collaborative Research: Using protein function prediction to promote hypothesis-driven thinking in undergraduate biochemistry education*
- NSF-DUE-IUSE #1431874 *IUSE: Design, Development, and Implementation Projects: Computational Creativity to Improve CS Education for CS and non-CS Undergraduates*
- NSF-DUE-TUES #1122956 Integrating Computational and Creative Thinking (IC2Think)
- NSF-DUE-WIDER #1347722 Scaling cultures of collaboration: Evidence-based reform in portal STEM courses
- NSF-DUE-WIDER #1347830 PERSIST: Promoting Educational Reform through Strategic Investments in Systemic Transformation
- NSF-DUE-IUSE # 1431350 and #1544001 *Enhancing Student Success in Biology, Chemistry, and Physics by Transforming the Faculty Culture*
- NSF-DUE-IUSE-EHR #1525421 *Mobile Summer Institutes: Creating Points of Transformation in Post-Secondary STEM Education*
- NSF-DUE-STEP #13174510, *Metacognition: A Transformative Approach to Retaining Deaf/HoH and first generation STEM Majors*
- NSF-DUE-WIDER #1347243, *Opening Doors: A WIDER Examination of STEM Teaching and Learning, Culture, and Support at Otterbein University*

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2. Kastens, K. A., and Manduca, C. A., 2016, *Using systems thinking to design, implement and evaluate a complex educational intervention*: InTeGrate White Paper.
3. Flanigan, A., M. Peteranetz, D. F. Shell, and L.-K. Soh (2016). Students' Initial Course Motivation and Their Achievement and Retention in College CS1 Courses, in *Proceedings of the 47th ACM Technical Symposium on Computing Science Education (SIGCSE'2016)*, Memphis, TN, March 2-5, pp. 639-644.
4. Flanigan, A., M. Peteranetz, D. F. Shell, and L.-K. Soh (2015). Exploring Changes in Computer Science Students' Implicit Theories of Intelligence Across the Semester, in *Proceedings of the International Computing Education Research (ICER'2015)*, Omaha, NE, August 9-13, pp. 161-168.
5. Soh, L.-K., D. F. Shell, E. Ingraham, S. Ramsay, and Brian Moore (2015). Viewpoint: Improving Learning and Achievement in Introductory Computer Science through Computational Creativity, *Communications of the ACM*, **58**(8):33-35.
6. Herman, G. L., Hahn, L., & West, M. (2015). Coordinating college-wide instructional change through faculty communities, In Proceedings of the 2015 International Mechanical Engineering Congress & Exposition, (IMECE2015-51549). Houston, TX, Nov. 13-19. DOI: 10.1115/IMECE2015-51549

7. A. Marker, P. Pyke, S. Ritter, K. Viskupic, A. Moll, R. E. Landrum, T. Roark, & S. Shadle (2015). Applying the CACAO Change Model to Promote Systemic Transformation in STEM. In In G. Weaver, W.D. Burgess, A.L. Childress, L. Slakey (Eds.) *Transforming Institutions: Undergraduate Stem Education for the 21st Century* (176-188) West Lafayette, IN: Purdue University Press.
8. C. Henderson, A. Beach, N. Finkelstein (2011) Facilitating Change in Undergraduate STEM Instructional Practices: An Analytic Review of the Literature, JRST, 48, 952-984
9. Scott V. Franklin, From Grassroots to Institutionalization: RIT's CASTLE. In *Transforming Institutions: Undergraduate STEM Education for the 21st Century.* Purdue University Press, Lafayette, IN (2015).

Working Group: Project Management
Session Title: Harnessing the Beast: Managing Your Project Before, During and After

Session Leaders:

Name		Institution
Robert Potter		University of South Florida
Margaret Franzen		Milwaukee School of Engineering
Carrie Diaz Eaton		Unity College
Jamie Schneider		University of Wisconsin River Falls
Edward Berger		Purdue University
Debra Major		Old Dominion University
Steve Hsiung		Old Dominion University
Karen Olmstead		Salisbury University

Session Abstract: *2-3 sentences*
NSF awards are complex projects that may involve diverse activities, challenging timeframes, and multiple partners, including external agencies and organizations. This is an interactive session led by individuals from diverse institutional backgrounds working on a variety of grants. The discussion will allow you to more effectively implement and sustain your project.

Key Points:
1. Collaboration
2. Budget and Flexibility
3. Evaluation and Accountability
4. Creating Sustainability

Supporting Work:
- M. Franzen, TUES-1343212: CREST: Connecting Researchers, Educators and Students
- D. Major, IUSE-1504741: *"I AM an engineer!"* Assessing Engineering Identity, Its Development, and Its Contribution to Retention among Engineering College Students
- S. Hsiung, TUES-1120000: "Dissemination of Microprocessor Courses through Classroom and Interactive Cyber-Enabled Technologies."
- E. Berger, TUES-1524069: "The Engineering Genome Project"
- E. Berger, RED-1519412: "An Engineering Education Skunkworks to Spark Departmental Revolution."
- E. Berger, IUSE-1525671: "Understanding and Supporting Mechanical Engineering Undergraduate Student and Faculty Engagement with an Active, Blended, and Collaborative (ABC) Learning Environment."
- J. Schneider, TUES-1140914: "Collaborative Research: Immediate Feedback Assessment in Chemistry Courses." Park of a multi-institutional collaborative grant with award #1140351.

- J. Schneider, STEP-1317149: “The GREAT (Graduate-Retain-Engage-Advise-Team Learning) Falcon Project” (PI M Kahlow).
- R. Potter, IUSE-525574: “Systemic Transformation of Education Through Evidence-Based Reforms (STEER).”
- K. Olmstead, STEP - 0969428: “Bridges for Salisbury University’s Connections to Careers for Every STEM Student (Bridges for SUCCESS).
- CD. Eaton, NSF IUSE Ideas Lab-1446258: “IUSE Collaborative Grant: QUBES: Quantitative Undergraduate Biology Education and Synthesis,” (PI M. Drew LaMar). Part of multi-institutional collaborative grant with awards #1446269 and #1446284.

References:

- Thomas R. Blackburn “Getting Science Grants: Effective Science Grants” Jossey-Bass:San Francisco, CA, 2003.
- https://stem-central.net/ See Working Groups on several topics including Collecting, Organizing and Making Use of Data; Project Sustainability and Institutionalization; Faculty Development and Networking; Project Coordinatrion and Management; etc.
- Henderson, C., Beach, A. & Finkelstein, N. Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *J. Res. Sci. Teach.* **48,** 952–984 (2011).
- https://qubeshub.org/

Session Title: *Rising to the Challenge: Strategies for Improving STEM Instruction*

Session Leaders:

Name	Institution
Cheryl Bodnar	Rowan University
Bob Hilborn	American Association of Physics Teachers
Elaine Marzluff	Grinnell College
Jennifer Wiley	University of Illinois at Chicago
Meena Balgopal	Colorado State University, Fort Collins
Chris Hulleman	University of Virginia
Denise Thorsen	University of Alaska
Michael Scott	University of Illinois at Chicago
Andy Johnson	Black Hills State University
David Meltzer	Arizona State University
Heidi Manning	Concordia College
Shandy Hauk	WestEd/University of Northern Colorado

Session Abstract: *This session will focus on providing participants with the opportunity to learn more about ongoing research within STEM instructional environments on different techniques that can be applied to improve student learning. Thematic areas that will be discussed include student motivation, assessment practices, accommodating different student types and instructional environments, ensuring the students are doing the learning, making learning steps appropriate for students and how to motivate faculty to improve their teaching practices. Faculty will leave with new best practices and references that can facilitate their incorporation of these techniques within their own classroom.*

Key Points:

1. **Variety of different methods exist for improving student motivation and learning**
2. **Proper assessment of educational interventions is important to broaden their application within diverse programs and institutions**
3. **Educational contexts and student backgrounds should be considered when selecting methods for modifying class instruction**
4. **Communities (learning or practice based) can be integral in helping with implementation of STEM instructional methods**
5. **Improving STEM education requires a focus on the learners**

Supporting Work:

- Collaborative Research: Inspiring Innovation and Creativity through Physical Simulations and Moving Analogies (NSF DUE#1504844)
- Collaborative Research: Transforming Undergraduate Physical Chemistry Education using a Context Rich Pedagogy to Teach Kinetics, Quantum Mechanics, and Spectroscopy (NSF DUE#1140327 and NSF DUE#1140326, PI's: Elaine Marzluff and Mary Crawford)
- Effects of diagrams and spatial skills on undergraduate students' illusions of understanding of introductory biology and geoscience texts (NSF DUE-1535299) (Wiley)
- Collaborative Research: Enhancing Undergraduate STEM Education: Workshops and Learning Communities for Physics and Astronomy Faculty (NSF DUE 1431638) Hilborn PI

- Increasing undergraduate cell biology literacy through writing-to-learn activities administered through Online educational platforms. (NSF DUE– Balgopal) and Dilemmas and decisions: : Using guided writing to increase ecological literacy in undergraduate biology students (NSF DUE #0930978, Balgopal)
- Removing Barriers to Success in Mathematics: An Integrative Expectancy-Value Intervention (NSF HRD 1534835; PI: Chris Hulleman)
- Transforming a Freshman Electrical Engineering Lab Course to Improve Access to Rural Students and to be a Model for Future STEM Distance Lab Courses (NSF DUE-1245815; PI: Denise Thorsen)
- Radioactivity by Inquiry For College Science Courses (NSF DUE 0942699, PI Andy Johnson)
- WIDER: EAGER: Recognizing, Assessing, and Enhancing Evidence-Based Instructional Practices in STEM at Arizona State University, Polytechnic (NSF DUE #1256333; PI: David Meltzer)
- Enhancing the First Year for STEM Majors. (NSF DUE # 0969568; PI: Heidi Manning)
- Mathematics Capstone Course Resources for Preparing Secondary Mathematics Teachers (NSF DUE #1504551; PI: Shandy Hauk)

References:

- Bodnar, C.A., Tranquilo, J., Matthew, V., Britos Cavagnaro, L., Monroe-White, T., Turrentine, A. (2015). Iteration by Design: Development of a Game-Based Workshop for Teaching Innovation and Entrepreneurship Concepts. *Experiential Entrepreneurship Exercises Journal*, 1(4), 28-33.
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- Hulleman, C. S., & Harackiewicz, J. M. (2009). Promoting interest and performance in high school science classes. *Science, 326*, 1410-1412.
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- Kohl, Patrick, B., Kuo, Vincent, Ruskell, Todd G. (2008). Documenting the conversion from traditional to Studio Physics formats at the Colorado School of Mines: Process and early results. AIP Conf. Proc. **1064**, 135 (2008); http://dx.doi.org/10.1063/1.3021236

Session Title: *Student Engagement and Success*

Session Leaders:

Name	Institution
Claudia J. Rawn (CJR)	University of Tennessee, Knoxville
Edmund Tsang (ET)	Western Michigan University
Beth Cady (BC)	National Academy of Engineering
Amy Freeman (AF)	Pennsylvania State University
Jonathan Stolk (JS)	Southern Methodist University
Gloria Kim (GK)	Northwestern University
Angelia Gibson (AG)	Maryville College
Kristi J. Shryock (KJS)	Texas A&M University
Robert E. Beck (REB)	Villanova University
Joel Moore (JM)	Towson University

Session Abstract: The terms “student success” and “student engagement” are ubiquitous in discussions of STEM learning, curriculum design, and educational reform. What exactly do we mean when we use these phrases? Do we all hold similar definitions about student success and engagement? How does the meaning of student success and engagement vary across individuals, groups, institutions, or disciplines? In this session, we will explore our explicit definitions and implicit assumptions about student success and engagement, by sharing stories of curriculum design and student learning activities, and by analyzing our approaches to educational goals setting, measurement, and reporting. We’ll examine alignment or

misalignment in our definitions, and attempt to explain our findings based on our personal or systemic underlying values and beliefs about STEM learning.

Key Points:

1. What do we mean by “student engagement” and “student success”?
2. In what ways are our definitions of student engagement and student success similar and different?
3. How are our definitions of student success and student engagement shaped by departmental, institutional, disciplinary, or personal factors?

Supporting Work:
Please list the award numbers and titles

(CJR) The Research and Instructional Strategies for Engineering Retention (RISER) at the University of Tennessee, Knoxville is funded by the National Science Foundation (NSF) through the Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) award number 1068103.

(ET) Effective Academic and Student Affairs Collaboration to Increase Student Success in Engineering and Applied Sciences is funded by the STEM Talent Expansion Program (STEP IB) award number 0969287.

(BC) INSPIRE Track 1: Understanding the Engineering Education--Workforce Continuum. award number 1344190.

(JS) Collaborative Research: Understanding and Supporting Student Intrinsic Motivation in STEM Courses, with M. Gross (Wake Forest), Y. Zastavker (Olin), and A. Dillon (Olin). NSF TUES Type 2, Award #1322684.

(GK) IUSE: EHR - Enhancing and Expanding Experiential Learning Modules across Disciplines and Institutions, Award #1504952.

(AF) Engineering Pathways: An Undergraduate Scholars Program at Pennsylvania State University, University Park, is funded by National Science Foundation through Scholarships in Science, Technology, Engineering and Math (S-STEM) Award #1154473

(AF) Sustainable Bridges from Campus to Campus: Retention Models for Transitioning Underrepresented Engineering Students, Pennsylvania State University, is funded by National Science Foundation through Improving Undergraduate STEM Education (NSF-IUSE), Award #754754.

(AG) Scots Science Scholars (S^3). Award 1161297

(KJS) “I AM an engineer!” Assessing Engineering Identity, Its Development, and Its Contribution to Retention among Engineering College Students, Texas A&M University and Old Dominion University, is funded by National Science Foundation (NSF) through Improving Undergraduate STEM Education (NSF-IUSE), Award #1504741.

(REB) Computing in Context, Villanova University, North Carolina A&T University, Virginia Tech, University of Central Florida is funded by National Science Foundation (NSF) through TUES Type 1, Award # 1141209.

(JM) GP-EXTRA: TU GEO Careers (Towson University Geoscience Educational Opportunities for Careers) is funded by National Science Foundation (NSF) through Improving Undergraduate STEM Education (NSF-IUSE) and administered by the Directorate for Geosciences, Integrative and Collaborative Education and Research (ICER), Award #1540631

References:

Include 1 reference each to work done by the session leaders. Limit references to other background materials to 2-3 references total.

(CJR 1) “Engineering Introduction in Pre-Calculus Courses”, R.M. Bennett, M.H. Russell, and C.J. Rawn, 120th ASEE Annual Conference and Exposition, NSF Grantees’ poster session, Atlanta, GA, June 24, 2013 (uploaded poster and paper)

(CJR 2) http://ef.engr.utk.edu/RISER/index.php See specifically http://ef.engr.utk.edu/RISER/pre-calculus/math-130-fa15/

(ET 1) “Create Learning Communities to Enhance Success for Students with Diverse Academic Preparation Background,” E. Tsang and C. Halderson, Proceedings of Frontiers In Education Conference, Saratoga Springs, NY, October 22-25, 2008, CD-Rom, Session S1D, Paper 1771.

(ET 2) http://www.wmich.edu/step

(JS) “Motivation is a Two-Way Street: Examining Correlations Between Student Motivations and Incidences of Lecture and Discussion Activities,” A. Dillon, J. Stolk, Y. V. Zastavker, and M. Gross, “ 123rd Annual ASEE Conference and Exposition, New Orleans, LA, 2016 (Paper accepted February 2016).

(GK 1) “Perspective on Flipping Circuits I,” Gloria J. Kim, Erin E. Patrick, Ramakant Srivastava, and Mark E. Law, IEEE Transactions on Education, 57 (2014) 188-192

(GK 2) “Lessons Learned from Two Years of Flipping Circuits I,” Gloria J. Kim, Allen Turner, Ramakant Srivastava, Mark E. Law, Proceedings of the ASEE Annual Conference and Exposition, Seattle, WA (2015).

(AF) Cohan, C., Yin A., Freeman, A.L., Gomez-Calderon, J., Margle, Lane, J., et al. (2014). Toys and Mathematical Options for Retention in Engineering (Toys’n MORE) Final Outcomes for STEM Students Who Participated in Math Tutoring, a Toy-Based Freshman Engineering Design Course, or a Summer Bridge Program. Conference proceedings. American Society for Engineering Education Annual Conference & Exposition. Indianapolis, IN

(AG) Siopsis, M and Gibson, A. Progress report on the effectiveness of a summer STEM enrichment program for college freshmen at a liberal arts college. Joint Mathematics Meeting. Seattle, WA. January 2016.

(REB 1) Chung, W. (editor) *Proceedings of the NSF Workshop on Curricular Development for Computing in Context*, Association for Computing Machinery Press, 2015, available at: http://dl.acm.org/citation.cfm?id=2757218.

(REB 2) Beck, R. Computing in Context: Inquiry Based Learning for the Knowledge Society, AACU Learning Strategies for STEM, San Diego, October 2013.

(JM) Proposal was just awarded in September 2015 so nothing has yet been presented or published on the funded work.

Session Title: Teacher *Preparation and Professional Development That Supports Interdisciplinary STEM Teaching and Learning*

Session Leaders:

Name	Institution
Ute Kaden	University of Alaska Fairbanks
Ralph Morelli	Trinity College, Hartford CT
David Shernoff	Rutgers University
Peter Youngs	University of Virginia

Session Abstract:

This session will focus on institutional challenges and efforts to establish and sustain teacher education and professional development programs that support interdisciplinary STEM teaching and learning. After brief introductions in which each participant states their name, institution, and position/role and a discussion on the session topic, we will spend time in small groups sharing strategies for addressing these institutional challenges, including lessons learned from successful NSF projects. Finally, we will share these strategies as a large group.

Key Points:

1. To what extent are interdisciplinary teams of STEM educators required to build new programs with an interdisciplinary approach to STEM teaching and learning? University structures (e.g., departments and colleges) and priorities (i.e., rewards for research) may present challenges to interdisciplinary STEM undergraduate teaching and learning; what are some strategies to overcome these obstacles?

2. To what extent can computer science (CS) topics be introduced into other STEM subjects? Does CS have any advantages/disadvantages as an integrating discipline? (Similar question applies for engineering)

3. What are the needs and challenges to support K-12 educators (pre-service and in-service teachers; school leadership) to implement STEM curricula? (Focus on possible new NSF proposals to support those needs)

4. What are innovative culturally relevant ways/programs/projects/collaborative partnerships (e.g., university departments, school districts, teacher education programs) to engage/educate minority students and teachers of minority students in STEM?

Supporting Work:

*Preparing GeoSTEM teachers for the Arctic region - **NSF#1540674** (PI Kaden, Ute)*
*The Development of Ambitious Instruction in Elementary Mathematics – **NSF#1535024** (PI Youngs, Peter)*

References:

Qian, H., & Youngs, P. (in press). The effect of teacher preparation programs on future elementary mathematics teachers' knowledge: A five-country analysis using TEDS-M data. Journal of Mathematics Teacher Education.