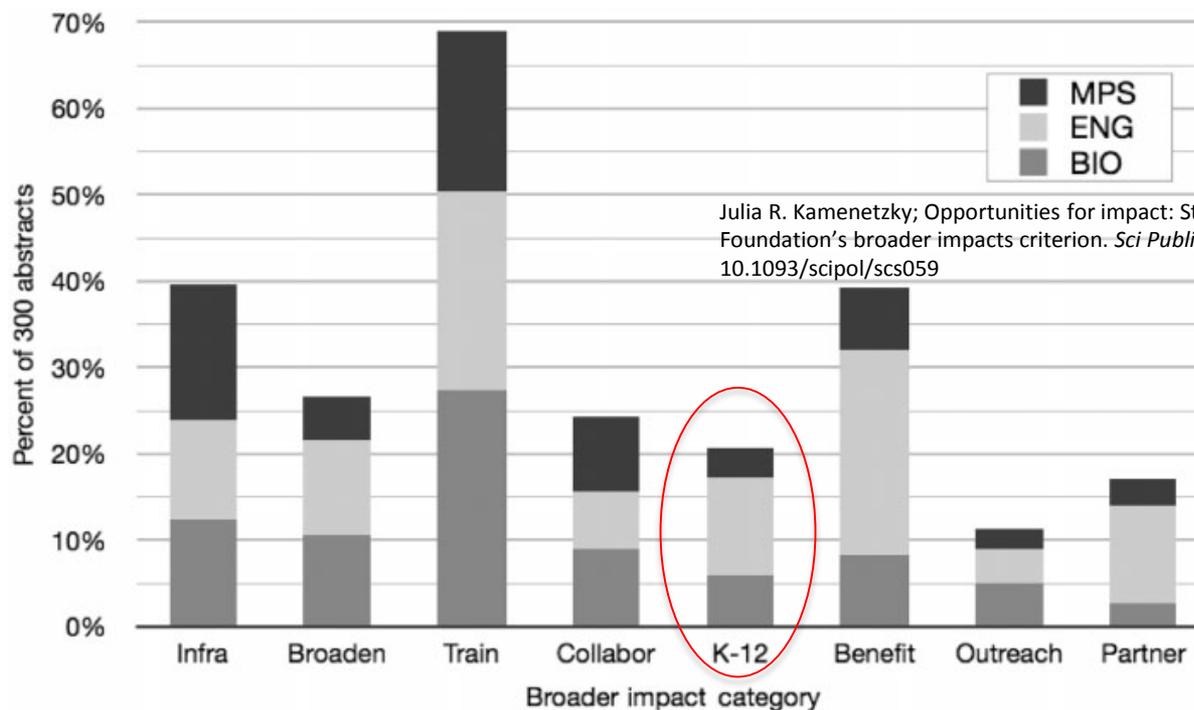


# Working with teachers to integrate toxicology and green chemistry into high school science courses

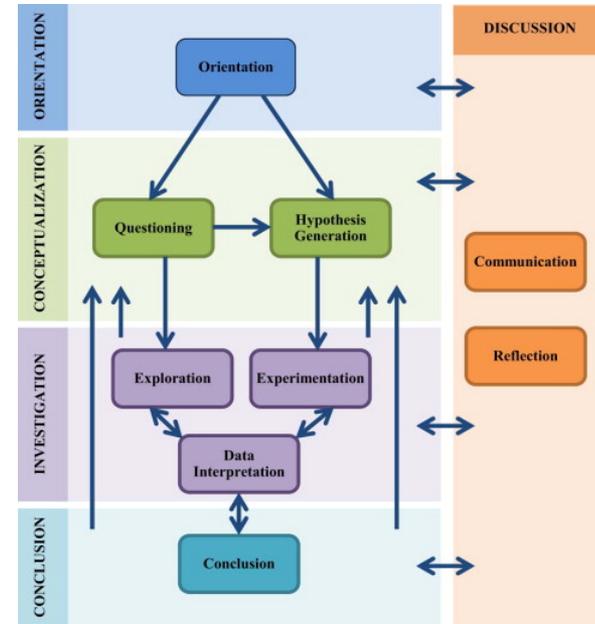
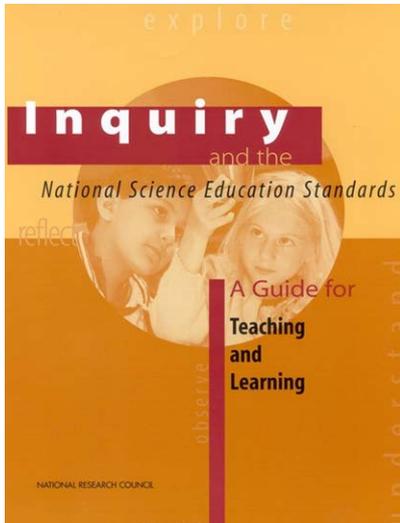
Melissa Mullins, Bryan W. Brooks,  
Suzanne Nesmith, Jone Corrales, Grace  
Lasker, Karolina Mellor, Nancy Simcox,  
Judy York

# Why work with teachers?



Julia R. Kamenetzky; Opportunities for impact: Statistical analysis of the National Science Foundation's broader impacts criterion. *Sci Public Policy* 2013; 40 (1): 72-84. doi: 10.1093/scipol/scs059

# Inquiry and Science Education



Phases of inquiry-based learning: Definitions and the inquiry cycle

Pedaste et al., Educational Research Review, Volume 14, 2015, 47–61  
<http://dx.doi.org/10.1016/j.edurev.2015.02.003>

# Best Practices and Case Studies



Screenshot of the ERIC search results page for "research experiences for teachers".

Search results showing 1 to 15 of 199,275 results. Results are sorted by relevance.

**Collection** | **Thesaurus** | **Search** | [Advanced Search Tips](#)

Peer reviewed only |  Full text available on ERIC

**Publication Date**

In 2017	1946
Since 2016	10509
Since 2013 (last 5 years)	36639
Since 2008 (last 10 years)	78239
Since 1998 (last 20 years)	115215

**Descriptor**

Foreign Countries	44719
Teaching Methods	35504
Higher Education	30896
Teacher Attitudes	27108
Elementary/Secondary Education	25845
Student Attitudes	19624
Interviews	18020
Educational Research	16336
Teacher Education	15829
Academic Achievement	14365
Qualitative Research	13949

**Source**

ProQuest LLC	11111
Online Submission	2216
Teachers College Record	1008
Reading Teacher	758
Teaching and Teacher Education	733
Journal of Research in Science Teaching	631
Educational Research and Evaluation	628
Society for Research on Child Development	475
Journal of Education and Psychology	462
Journal of Teacher Education	459

**Results:**

**I Want to Be the Inquiry Guy! How Research Experiences for Teachers Change Beliefs, Attitudes, and Values about Teaching Science as Inquiry**  
 Herrington, Deborah G.; Bancroft, Senetta F.; Edwards, Molly M.; Schairer, Caroline J. – Journal of Science Teacher Education, 2016  
 This qualitative study examined how and why research experiences for teachers (RETs) influenced middle and high school science teachers' beliefs, attitudes, and values about teaching science as inquiry. Changes teachers reported after participating in the RET ranged from modifying a few lessons (belief change) to a comprehensive revision of what...  
 Descriptors: Qualitative Research, Teacher Researchers, Middle School Teachers, Secondary School Teachers  
[Peer reviewed](#) | [Direct link](#)

**Rutgers University Research Experience for Teachers in Engineering: Preliminary Findings**  
 Laffey, Evelyn H.; Cook-Chennault, Kimberly; Hirsch, Linda S. – American Journal of Engineering Education, 2013  
 In addressing the nation's need for a more technologically-literate society, the Rutgers University Research Experience for Teachers in Engineering (RU RET-E) is designed to: (1) engage middle and high school math and science teachers in innovative "green" engineering research during the summer, and (2) support teachers in integrating...  
 Descriptors: Middle School Teachers, Secondary School Teachers, Program Effectiveness, Engineering  
[Peer reviewed](#) | [Download full text](#)

**Development of Teachers as Scientists in Research Experiences for Teachers Programs**  
 Faber, Courtney; Hardin, Emily; Klein-Gardner, Stacy; Benson, Lisa – Journal of Science Teacher Education, 2014  
 This study examined the teachers' development as scientists for participants in three National Science Foundation Research Experiences for Teachers. Participants included secondary science and math teachers with varying levels of education and experience who were immersed in research environments related to engineering and science topics...  
 Descriptors: Teacher Education Programs, Secondary School Teachers, Science Teachers, Mathematics Teachers  
[Peer reviewed](#) | [Direct link](#)

**Stewart and Ray's Big Adventure: A Research Experience for Teachers at UMASS/Amherst**  
 McCarthy, Ray – Technology and Engineering Teacher, 2011  
 Late in the winter of 2010, teachers across Massachusetts received invitations to apply for six- to eight-week Research Experiences for Teachers (RET) in which middle or high school teachers in STEM subjects would work alongside scientists and their graduate students as they sought to solve real-world problems. This country-wide effort was funded.  
[Peer reviewed](#) | [Direct link](#)

# Partners and Potential Partners

- Education and outreach/broader impacts coordinators, if your institution has any
- School of Education professors
- Local education service centers or their equivalent
- State education agencies (great if they manage a science listserve to help you recruit teachers)
- Other organizations that teachers are likely to be involved in like science teachers association, informal science organizations (museums, nature centers, etc.)

# Regional Education Service Center Baylor Research Innovation Collaborative (BRIC)

- A collaboration among Education, Industry, and Higher Education
- Teachers spent a week in the research lab and a week here



# Molecular Design Research Network (MoDRN)

- Green Chemistry and Green Engineering initiative, which focuses on the rational design of chemicals and materials to reduce toxicity
- **How can we reduce the toxicity of new chemical substances?**
- Research
- Outreach
- Education

# MoDRN teacher workshops

- Professional Development (PD) for teachers
- 2015: 12 teachers (9 Texas, 3 WA)
- 2016: 10 teachers (including 3 teacher mentors returning from previous year)
- Competitive stipend
- Duration: 2 weeks in summer
- Location: Baylor University
- Conducted by: Dr. Bryan Brooks Research Lab and Educational partners

# Goal

Provide an experience that increases teacher engagement of students in inquiry-based investigations around green chemistry and toxicity topics



# 2015 Cohort

## July 6-17

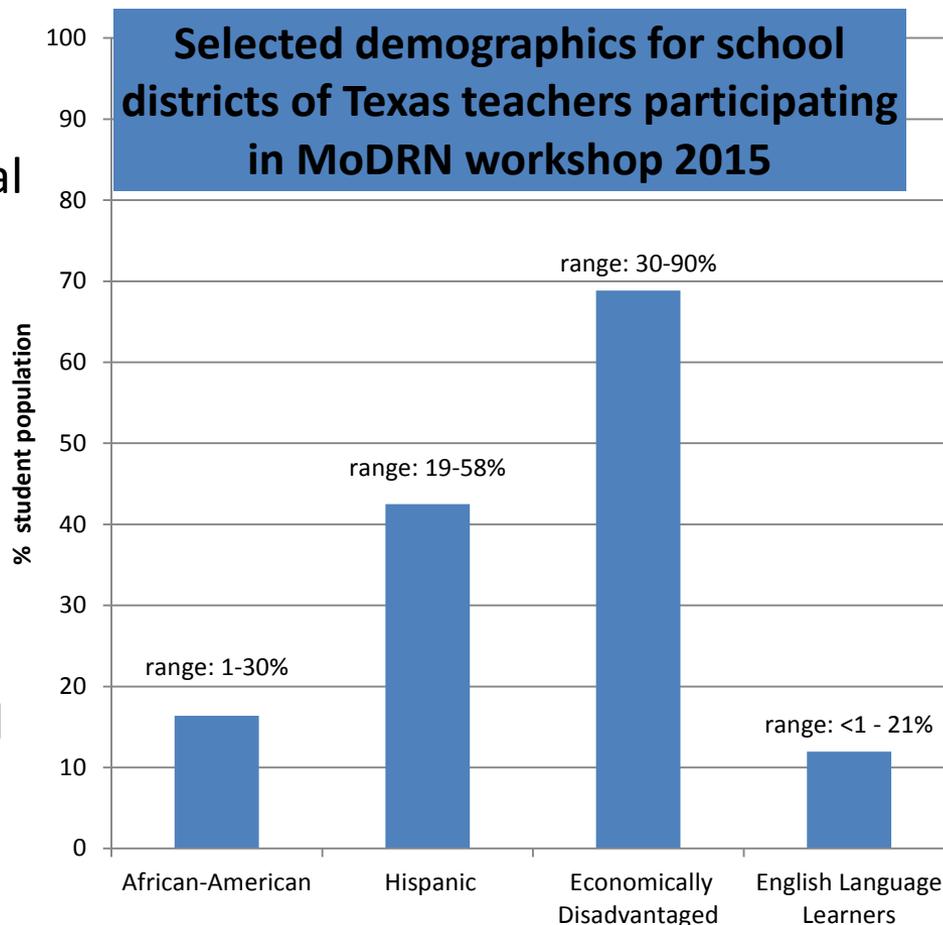
# 2016 Cohort

## July 18-29



# Where do they teach?

- Small rural school districts (1 campus serving 134 students total in all grades K-12)
- Large urban school districts (Dallas ISD with 238 campuses serving 158,495 students)
- Predominantly public schools, one private, a public charter and a couple of magnets
- Serve under-represented student populations



# What do they teach?

- Mirror the interdisciplinary nature of MoDRN research team
- Teachers rarely teach one subject
- Teachers report assignments change from year to year and often with little warning

- Teaching assignments of 2016 participants

Subject(s) taught

Integrated Physics and Chemistry, Physics

Environmental Science, Anatomy and Physiology

Chemistry (College), Physics

Chemistry, Environmental Science

Biology, IPC

Biology, Chemistry, IPC, Environmental Science, Food Science, Health, Marine Biology

Chemistry, Physics, Engineering

7th grade science, biology, honor biology, chemistry, anatomy

Biology, Earth and Space Science

Chemistry, Pre-AP chemistry, physics, Pre-AP physics, Principles of Technology, Principles of Engineering

# What did teachers do?

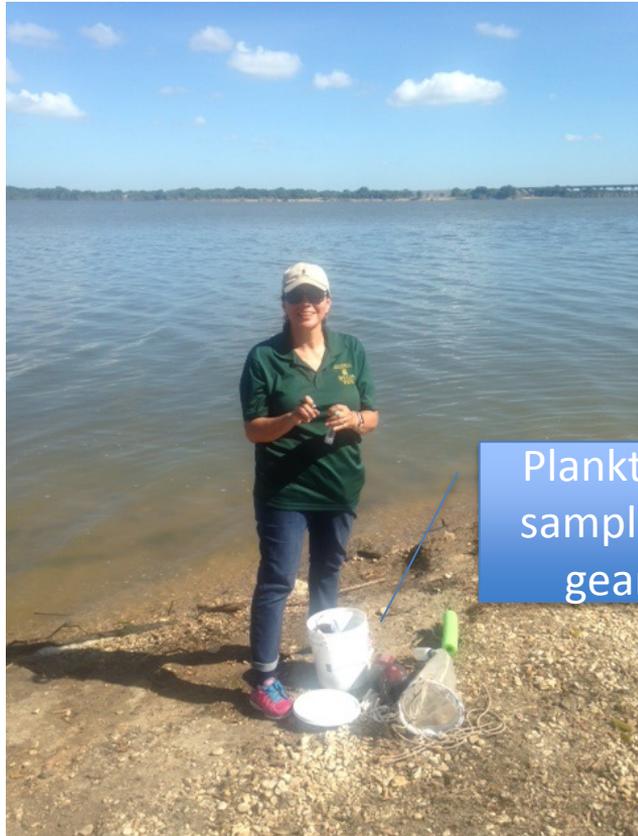
- Learned about MoDRN and Green Chemistry
  - Lectures (by researchers), green chemistry videos, background readings, guest speakers (distance), MoDRN modules (website)
- Second year implemented a peer-to-peer teaching component (returning teacher mentors)
- Worked in cross-disciplinary groups in research lab to conduct toxicity tests, analyze and present results
- Designed lesson plans to field test in their own and colleagues classrooms to prepare for broader dissemination



# *Daphnia magna* as a model organism



# Field ecology of *Daphnia* sp.



Plankton  
sampling  
gear



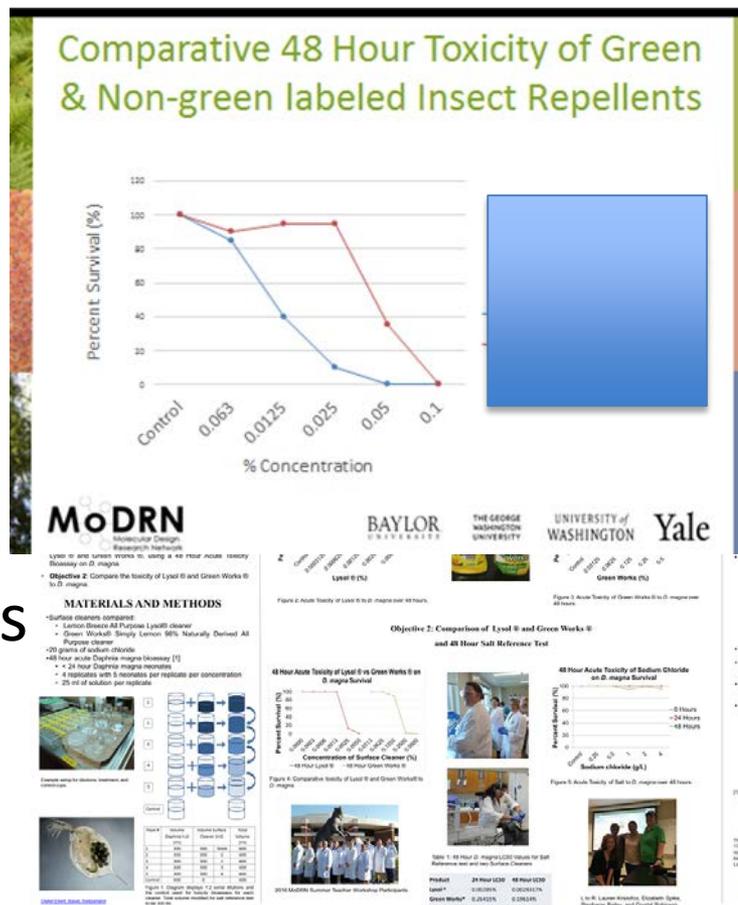
Not a  
daphnia



Also not  
a  
daphnia

# Teacher research presentations

- Is there a difference in toxicity to *D. magna* between consumer products marketed as green versus those not specifically marketed as green in four different product categories?



# Evaluation Research

- Evaluations conducted both summers (Dr. Suzanne Nesmith, Baylor School of Education, PI)
- What is impact of participating in Baylor MoDRN professional development on inquiry-based instruction, particularly in regards to green chemistry?
- Pre- and post- workshop evaluations (2 types)
- Classroom observations
- Open-ended survey items
- Reliable and valid instrument for assessment of quantity and quality of inquiry in K-12 math and science classrooms was adapted for use (EQUIP, Marshall et al. 2009)

# Preliminary Research results

Table 1. Inquiry Data

Inquiry Items	Mean (SD) <sup>a</sup>		<i>t</i>	<i>p</i>
	Pre	Post		
Instructional Factors	2.67 (.527)	2.98 (.639)	3.44	.003**
Instructional Strategies	2.89 (.832)	2.89 (1.08)		
Order of Instruction	2.06 (.938)	2.50 (.985)		
Teacher Role	2.83 (.514)	2.89 (.583)		
Student Role	2.83 (.707)	3.28 (.669)		
Knowledge Acquisition	2.72 (.669)	3.33 (.594)		
Discourse Factors	2.89 (.720)	3.19 (.705)	1.86	.08
Questioning Level	3.28 (.752)	3.28 (.669)		
Complexity of Questions	2.89 (.963)	3.17 (.857)		
Questioning Ecology	2.78 (.943)	3.00 (1.09)		
Communication Pattern	2.83 (.942)	3.28 (.826)		
Classroom Interactions	2.67 (.907)	3.22 (.943)		
Assessment Factors	2.82 (.692)	3.11 (.694)	2.03	.06
Prior Knowledge	2.78 (1.00)	3.00 (1.09)		
Conceptual Development	3.17 (.786)	3.39 (.778)		
Student Reflection	2.44 (1.04)	3.11 (.963)		
Assessment Type	2.61 (.778)	2.89 (1.08)		
Role of Assessing	3.11 (.963)	3.17 (.786)		
Curriculum Factors	2.72 (.680)	3.19 (.705)	3.61	.002**
Content Depth	3.11 (.676)	3.39 (.608)		
Learner Centrality	2.67 (.767)	3.06 (.802)		
Integrate Content & Investigation	2.67 (.970)	3.11 (.900)		
Organize & Record Information	2.44 (1.04)	3.22 (1.00)		

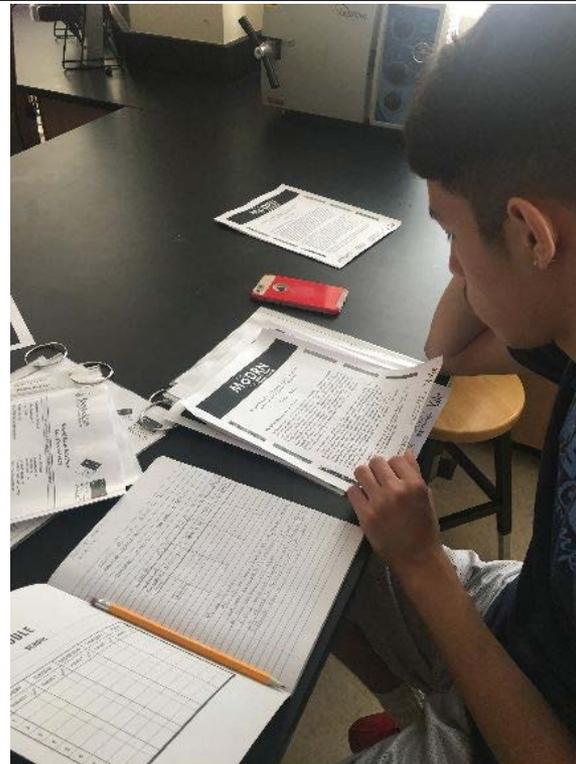
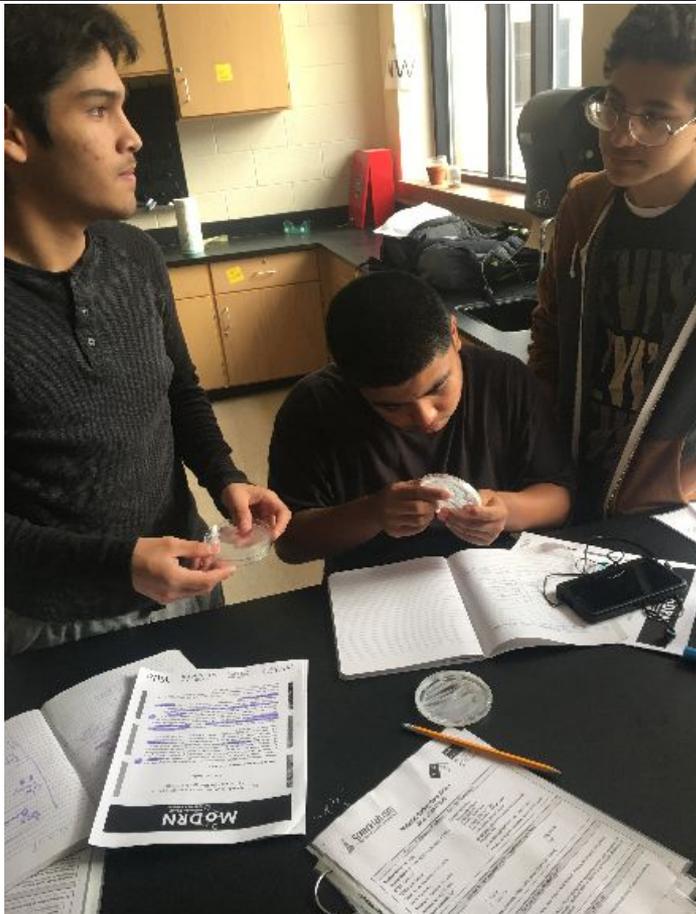
<sup>a</sup>Measured on a 4-point scale where 1 = pre-inquiry; 2 = developing inquiry; 3 = proficient inquiry; 4 = exemplary inquiry

\*\*Significant at .01 level (two-tailed)

- Significant gains resulted from the pre- to post-workshop scores related to teacher participants' perceptions of inquiry instructional factors and curriculum factors
- Analysis of qualitative data (responses to open-ended items) regarding teachers beliefs about inquiry and their understanding of green chemistry are underway

# Presentations by teachers at professional conferences:

- Conference for the Advancement of Science Teaching, Nov 2015 Fort Worth TX (4 TX teachers)
- National Science Teacher Association (NSTA) regional conferences (2 Washington teachers)
- NSTA National meeting: March 30-April 2, 2017 Los Angeles CA (3 TX teachers and evaluation research PI)



## MoDRN at a current HS summer advanced academics camp

“We are incorporating STEM activities centered around the theme of "Destination Mars". The students will work for two weeks on developing solutions for space exploration to Mars, including building a go-cart for travelling on martian terrain and MoDRN green chemistry investigations aimed at the careful selection of taking safe products into outer space”

# Acknowledgements

- Teachers
  - Jeanette Alexander
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  - Rachel Stolle
  - Patricia Weaver
  - Justin Jones
  - Carolyn Hess
  - Jill Flatt
  - Elizabeth Spike
  - Christina Londenberg
  - Crystal Robinson
  - Richard Sevcik
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  - Bryan Brooks
  - Jone Corrales
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- Education Partners
  - ESC R12, Judy York
  - Lake Waco Wetlands, Nora Schell
  - Suzanne Nesmith, Baylor SOE
- MoDRN E&O Team
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  - Karolina Mellor
  - Grace Lasker

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