

University of Virginia’s Research Experience for Teachers (RET): Program Overview and Outcomes

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Introduction

The Research Experience for Teachers (RET) program, funded by the National Science Foundation (NSF), is designed to encourage active participation of K-12 teachers in science, technology, engineering, and mathematics (STEM) research in order to enable them to teach STEM concepts to their students and to encourage students to pursue careers in engineering and computer science (NSF, 11-509). Since its inception in 2001, the NSF RET program has facilitated research experiences for teachers that span either one or two summers in duration. Participants use their research as a springboard for the development of new classroom teaching materials. These materials provide students with new knowledge, skills, and abilities while communicating the wonders of science and the marvels of cutting-edge innovations across STEM disciplines. The role of teachers in schools is of great importance for cultivating student engagement and academic achievement in STEM fields, since teachers are in regular contact over a number of years with students during critical stages of their academic and personal development. Teacher participation in an RET program has been linked to student achievement gains as tracked by standardized test scores in the sciences, and to increased teacher retention (Dubner, Glied, Loike, Miller & Silverstein, 2009).

The University of Virginia RET site location is hosted by the UVA Center for Diversity in Engineering (CDE), under the direction of Principal Investigator (PI) Carolyn Vallas, Director of the CDE. The RET site has the following specific program focus: “Creation of instructional kits and modules for integrating biomedical and nanoscale sciences in school classrooms.” The program accepts highly-qualified K-12 STEM teachers from elementary, middle, and high schools for a summer research program of approximately six weeks in duration. Program recruitment targets Virginia teachers who work in schools serving high proportions of females, underrepresented minorities (URM), students receiving free and reduced lunch, and persons with disabilities. Additionally, teachers who are women, URM, or individuals with disabilities are strongly encouraged to apply. While these populations are targeted, applications are accepted for K-12 teachers regardless of race, gender, or disability, who instruct in any STEM subject area.

Recruitment efforts are focused within the state, but out-of-state applications are also accepted. During the summer program, participants, guided by faculty mentors and graduate students, develop independent research endeavors on which to base novel teaching kits and modules. All related standards, such as the State and/or National Standards of Learning, are integrated into the design and delivery of all RET teaching kits and materials.

Rationale for RET Programs

This program contributes to national efforts to improve America's global competitiveness through the development of a skilled 21st-century workforce, particularly in the STEM fields. President Obama, in his September 16, 2010 address launching his *Change the Equation* initiative describes the mandate for improving STEM education and preparation: Our nation's success depends on strengthening America's role as the world's engine of discovery and innovation...Leadership tomorrow depends on how we educate our students today—especially in science, technology, engineering and math....Our success will not be attained by government alone. It depends on teachers and parents and students and the broader community. It depends on us restoring an insistence on excellence in our classrooms and from our children.

(Sabochik, 2010)



The *Change the Equation* initiative builds upon a National Science Board January 2009 report articulating “Essential Components of an Effective STEM Education System,” which include the need for high-quality teachers, for providing teachers with “world-class resources and assistance,” and for enabling early student exposure to STEM concepts in pre-kindergarten and elementary school (NSB-09-1, 2009). The UVA RET program addresses these essential components through the inclusion of elementary, middle, and high school teachers in a mentored and supportive program environment. While the inclusion of elementary-level teachers is permissible in the NSF guidelines for RET programs, it is not yet a common practice. Thus, the UVA program's successful inclusion of elementary teachers is a notable accomplishment of this site.

Overview of 2010 RET Program

The UVA RET program hosted fifteen teachers in summer 2010: three from elementary, five from middle, and seven from high schools. 14 of the participants were Virginia teachers and one was from out of state. Also, 13 teachers were first-time participants and two were returning, or “RET2,” participants brought on to conduct a second summer of research with the program. Teachers were matched to appropriate labs and faculty mentors by subject area and through an “Areas of Research Interest” essay submitted with their application materials. Wherever possible, participants were placed in pairs in participating research laboratories. This paired placement allows participants to problem-solve with a fellow K-12 teacher throughout the development of research investigations and classroom extension materials. It also helps to prevent feelings of isolation, and seeks to empower both participants to ask questions and make progress while working in a busy university research laboratory. Teacher-pairs do not necessarily work on the same research project within the host laboratory; rather, each conducts independent investigations and creates a unique teaching kit and module for use in his/her own classroom.

Over the course of the program, participants develop a short research paper as well as three final deliverables presented during the RET Final Colloquium: a poster, a working demonstration version of their RET teaching kit, and a PowerPoint or Prezi slideshow delivered with an oral presentation. Participants then utilize the new teaching modules and kits in their classrooms during the subsequent school year. The program administration team collects outcome data for program evaluation by two surveys, one dedicated to evaluating the summer program and the other for evaluating teaching extension activities in the classroom. Table 1 provides an overview of the departments, host research labs, and projects developed by the 2010 RET cohort.

Outcomes of RET Program: Assessment

The summer 2010 RET program was the first at this site to host a participant cohort of more than four teachers. The “scaling up” to a cohort of fifteen yielded some challenges, although the overall satisfaction level of participants remained very high. As mentioned, assessment data

Table 1
UVA RET Summer 2010 Participants Overview

Participant	K12 Subject(s) Taught	RET Department	RET Host Research Lab	RET Teaching Kit Topic
1	9-12 Chemistry	Biomedical Engineering	Laboratory for Tissue Engineering	“Electrospun Nanofibers for Tissue Engineering Applications”
2	9-12 Biology	Biomedical Engineering	Vascular & Tissue Systems Bioengineering Laboratory	“EphrinB2 Reverse Signaling in Pathological Retinal Neovascularization”
3	6-8 Life/Physical Sciences & Math	Biomedical Engineering	Vascular & Tissue Systems Bioengineering Laboratory	“Alginate Beads as a Method to Simulate Nanoparticles for DUVAg Delivery”
4	K-4 Multi-age Classrooms	Civil & Environmental Engineering	Environmentally Sustainable Technologies Laboratory	“ALGAE: A Likely Gasoline Additive for the Environment”
5	9-12 Earth/Physical Sciences	Civil & Environmental Engineering	Environmentally Sustainable Technologies Laboratory	“Evaluating CO2 Leakage from Sequestration Sites Using Column Studies”
6	9-12 Integrated Sciences & Math	Electrical & Computer Engineering	Nanoelectronic Modeling and Simulation Laboratory	“Effect of Insulator Thickness on an MTJ Model & Pedagogical Bridges for Nanotechnology Concepts”
7	9-12 Technical & Engineering Drawing	Materials Science Engineering	Computational Methods for Materials Modeling Laboratory	“Computational Modeling of Atomic Mixing and Defects with Laser Interactions”
8	Grade 8 Physical Sciences	Mechanical & Aerospace Engineering	Center of Applied Biomechanics	“Development of a Geometric Model of a Human Rib”
9	Grade 8 Physical Sciences	Mechanical & Aerospace Engineering	Center of Applied Biomechanics	“Crash Testing Newton”
10	2-5 Math/Science	Mechanical & Aerospace Engineering	Multiscale Muscle Mechanics Lab	“Bio-Inspired Design: Investigating Ray Architectural Form and Function with Resultant Biomechanical Model”
11	Grade 6 Science	Mechanical & Aerospace Engineering	Multiscale Muscle Mechanics Lab	“Biomechanical Engineering in the Multiscale Muscle Lab”
12	9-12 Biology	Mechanical & Aerospace Engineering	Multiscale Muscle Mechanics Lab	“Variability in Muscle-Tendon Morphology”
13	6 & 8 Science	Physics	“Phun” Physics Laboratory	“Maximizing Energy Efficiency: Models for Superhydrophobic Coatings on Wind Turbines”
14	Pre-K & K Math/Science	Systems & Information Engineering	Human-Computer Interaction (HCI) Laboratory	“Designing Curricula through Human-Computer Interface Research”
15	9-12 Mathematics	Systems & Information Engineering	Human-Computer Interaction (HCI) Laboratory	“Developing Curricula through Human-Computer Interfaces”

are gathered through two surveys: the first survey for the 2010 cohort was administered on the final day of the summer 2010 program and a second survey about classroom extension activities was distributed in May 2011. Results of the initial program survey are discussed here.

Completion rate for the on-line survey was 100%, facilitated through scheduling computer lab time for the participants following the program's Final Colloquium. The survey yielded strongly positive results regarding overall program participation, shown in Table 4.

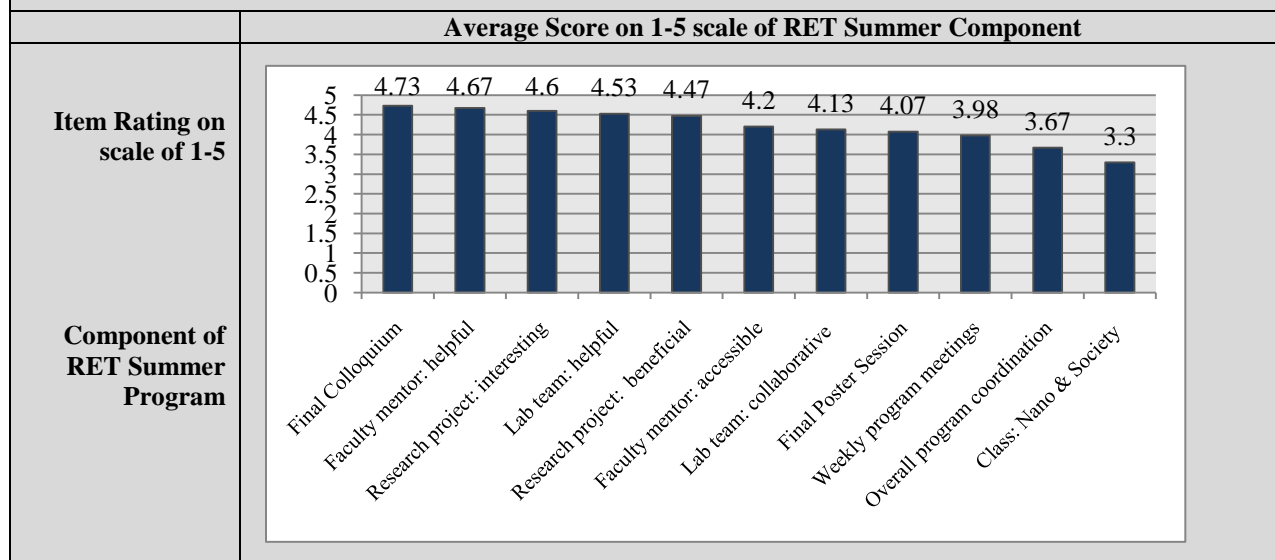
Survey Item	% Teachers responding Agree or Strongly Agree on Likert Scale
I would recommend this program to colleagues.	100%
I am interested in conducting scientific research again in the future.	100%
I was able to develop a novel teaching kit/module/demo/lesson based on my research experience.	100%
I feel comfortable presenting my novel RET teaching materials in the classroom next year.	100%
I had sufficient contact with the RET program staff.	100%
I would recommend my faculty mentor to other RET participants.	87%

Open field comments allowed participants to provide more detailed feedback regarding program highlights and areas for improvement. Examples of positive verbatim statements from qualitative survey items include: "The RET program has transformed my teaching career and taken it to new heights;" "This experience was exactly what I wanted: it will translate directly into my teaching;" and "I loved the RET experience. I gained many opportunities that would otherwise be unavailable to me in my home county. I will share my experience with my colleagues, friends, and family. I was prepared for the amount of work that was requested of me in the program. Thank you for such a great experience!" The survey allowed participants to indicate satisfaction level with a number of program elements, on a scale of one to five. As shown in Table 5, ratings of elements were also predominantly positive, with only one element rated below 3.5. The quantitative and qualitative data from this survey will be used for future program design, to respond to participant concerns and improve the clarity, efficiency, and overall experience for participants. The Classroom Extensions Survey planned for May 2011 will gather feedback about extension activities, including student responses and academic achievement gains following the delivery of RET teaching module. This survey will also be used to gather information on longer-term program impacts upon the participants personally, and to keep record of RET-based professional and instructional activities beyond individual classrooms.

RET Program Outcomes: Broader Impacts

The 2010 summer RET program yielded a very successful array of teaching kits and modules linked to related Standards of Learning for the cohort of fifteen teachers. Several of the 2010 participants are contributing articles to this issue that will go into further detail about the research conducted, the RET kits and modules developed, the experience of completing an RET program, and utilizing RET kits and modules in the classroom.

Table 5
RET 2010 Program Component Ratings



In order to achieve broader impacts beyond individual classrooms, the teachers are also encouraged to present their research and classroom extension activities to fellow teachers at the school or district level, to participate in state and national meetings, and to contribute articles to scholarly journals. Since summer 2010, the RET program has completed a number of activities for wider dissemination of RET-based teaching innovations. In November 2010, six of the summer 2010 RET participants presented their teaching kits and modules at the Virginia Association of Science Teachers PDI Conference, in a session entitled “Teachers as Researchers.” The program will contribute the present article as well as several teacher perspectives article to the *VJSE* issue dedicated to “Teachers as Researchers.” Two participants will attend the National Science Teachers Association conference being held in San Francisco, CA in March 2011, where they will participate in an RET Poster Session. The program administration team has also been accepted to present and share a poster about RET teaching

innovations at UVA's Presidential Inauguration Faculty Research Symposium to be held on April 14, 2011 at the University of Virginia.

The Center for Diversity in Engineering also utilizes funding from the RET grant to support a K-12 teacher's workshop, held in 2011 on February 11-12. The workshop, entitled "INNOVATION: Teaching Nanotechnology within Virginia Standards of Learning," received record numbers of applications, and therefore expanded capacity from the expected participation of 30 to 65 teachers in 2011. Participants came from across the state of Virginia, representing 46 different elementary, middle and high schools in 25 different school districts, and including teachers of science, mathematics, technology, and engineering. A number of the participants are actively involved in STEM curriculum design for their home schools and districts. The workshop included presentations by faculty and K-12 teachers, incorporating hands-on activities, classroom materials, and articles about nanotechnology and its applications. Faculty presenters for the workshop included distinguished guest Harry Dorn, Director of Virginia Tech's Carbonaceous Nanomaterials Center as well as UVA faculty representing the UVA nanoSTAR Institute and Departments of Materials Science, Electrical Engineering, Chemistry, Mechanical & Aerospace Engineering, and Science, Technology & Society. Two K-12 teachers served as presenters: Eileen Malick, a Computer Science Instructor at Atlee High School, delivered a lesson on the photolithography of semiconductors that was based upon her participation at the 2010 UVA INNOVATION workshop; and Randy Applegate, Technical Education Instructor at Gloucester High School and a summer 2010 RET participant, presented a kit with four associated nanotechnology lessons that include correlations to 78 math and science SOLs for grades six through twelve. Workshop participants are charged with implementing at least one nanotechnology lesson or hands-on activity in their classrooms. All presentations, lesson plans, articles and resources cited during the workshop are available on the Center for Diversity website: <http://www.seas.virginia.edu/innovation>.

It is the goal of the UVA RET site to continue to deliver high-quality summer research programs and workshops for teachers of all grade levels in order to inspire present and future generations of teachers and their students about the wonders of science and engineering and the marvels of research at the frontiers of knowledge. All programming is designed to enable teachers to

develop and utilize innovative STEM teaching lessons, kits, and hands-on activities based on cutting-edge research for implementation in K-12 classrooms.

References

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