

## **Project Summary**

**Title:** Reaching the Greatest Number of Learners: Improving Access to STEM Undergraduate Education Through Online Engineering Labs for Students Across Virginia

**Directors:** Michele D. Estes, PhD, James Madison University, Co-Director/PI  
Stephanie Moore, PhD, University of Virginia, Co-Director/PI

**Type of Grant:** Collaborative research/evaluation

### **Partners/Collaborators:**

At James Madison University, Co-PI Estes has a working and collaborative relationship with Ms. Sarah Cheverton, Director of the JMU Center for Instructional Technology (CIT), and her staff. Ms. Cheverton has committed her staff to an ongoing partnership with our 4VA work. Recently, Co-PI Estes and CIT staff Drs. Liu and Zha, conducted an applied research study involving JMU STEM lab redesign. They reported findings and made preliminary recommendations that will be used to inform the current study. Data collection involved working with STEM faculty including Drs. Kevin Giovanneti, Bob Kolvoord, Eric Maslen, Robert Nagel and Nathan Sprague. The researchers, these faculty, and CIT leaders are already part of a larger group of individuals involved in course redesign and collaboration at Virginia Tech, and these efforts provide a nice foundation for building and sustaining similar relations with experts at UVA. Co-PI Estes also works collaboratively with JMU Outreach to deliver an online Masters degree program and related certificates. This partnership enables the delivery of quality courses and programs to off-campus constituents who require flexibility in scheduling, pacing and delivery formats. Outreach accepts course proposals, advertises courses, enrolls students and works to offer students a personal connection to the institution. These services appeal to off-site students, and this partnership could enhance the delivery of off-campus lab instruction proposed here.

At the University of Virginia, Co-PI Moore has developed collaborative relationships both internally within the School of Engineering across the engineering departments and with the school's Assistant Dean for Research and Outreach, as well as with other schools around Grounds. Gail Hunger, Director of Instructional Quality for the School of Continuing and Professional Studies has offered her direct support and efforts to develop rubrics for articulating and evaluation instructional effectiveness for undergraduate, online engineering education. She has already worked with Co-PI Moore to draft a preliminary rubric and is involved in on-going development and documentation. Co-PI Moore also holds an affiliated position with the Curry School of Education in Instructional Technology and has engaged Jennie Chiu, Assistant Professor in IT, who has done work already in virtual labs and simulations in STEM. Additionally, faculty from Electrical and Mechanical engineering - Ron Williams, Harry Powell, Joanne Dugan, and Gavin Garner - have been working with Co-PI Moore and Dean Groves on drafting preliminary plans for online labs employing the "virtual glovebox" approach as articulated by NASA. Finally, support is available through the Engineers PRODUCED in Virginia, which employs support staff and engages graduate students in aspects of the programs that have research promise. Co-PI Moore currently has three such students engaged in such research activities, and the established relationship with Curry provides a direct conduit for engaging graduate students in research and development work related to labs.

## **Narrative**

Distance education can and does serve a significant purpose in the Commonwealth of Virginia, allowing universities that have traditionally offered place-based education to reach students who for a variety of reasons cannot relocate in order to access educational opportunities. Additionally, the use of distance education in the state has played a role in economic and workforce development in parts of the state where industries have disappeared or there has been a shortage of professional workforce, such as engineers, to help grow industries and economic opportunities. For example, the *Engineers PRODUCED in Virginia* program at the University of Virginia has built the initial infrastructure for offering the last two years of an undergraduate engineering degree to students throughout rural Virginia who complete their first two years at community colleges. Despite the growth and success of this program, substantial barriers still exist. Specific to the expansion of STEM educational opportunities, labs that are common to STEM domains present a unique challenge; additionally, because labs present such a substantial challenge, the main accrediting body for engineering - ABET - has thus far been reticent to accredit an online undergraduate engineering degree. The aim of this proposal is to address the challenge of distributed labs in STEM so the state's infrastructure for online learning can meet the unique demands of STEM domains, expand its reach to all parts of the state, and establish standards of quality that satisfy or exceed accreditation needs and eventually inform development and accreditation nationally.

### **Activity Summary:**

Under this proposal, we seek to establish a collaborative partnership among two of the four partner 4VA institutions focused on the development of distributed labs for STEM education, specifically in the area of mechanical engineering where workforce needs are high but lab solutions have proven the most challenging. Both institutions have been independently involved in investigation of labs; through this proposal, we will bring together lessons learned by both institutions as well as bring to bear a broader pool of expertise and talent.

Both Co-PI Estes and Moore also have extensive experience in accessibility and universal design, which will play an important role in the development of online labs that serve the greatest number of learners, to the greatest extent possible. Together, we propose to conduct a thorough front-end needs and task analysis of undergraduate labs in mechanical engineering, collect and summarize the extant data from pilot efforts that have been conducted already independently at both institutions, articulate common learning objectives and outcomes in a manner that is independent from any given delivery mode, articulate indicators and characteristics of instructional quality of online labs, and develop a plan and instructional strategy for the development and evaluation of online labs.

If awarded \$5,000 from 4VA, grant monies will be used as seed funds for a National Science Foundation (NSF) proposal. We intend to apply for one of the following opportunities: Science, Technology, Engineering and Mathematics Talent Expansion Program (STEP) Type 2, Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES) Phase II, or Cyberlearning: Transforming Education CAPs.

We would use any additional funds strategically, to build a more innovative and sustainable collaboration among 4VA institutions and public schools in Virginia. For example, we could expand our project scope to include K12 schools like Harrisonburg High School where in-school facilities are limited given the high number of STEM students moving to the new Academy; and/or Rockingham County and other rural sites in VA, where there appears to be great interest in STEM without access to program resources. With additional funds we could explore innovative techniques like remote labs that enable real experiments at a distance. This skill could yield great returns for STEM students seeking coveted careers with employers including but not limited to NASA.

The co-leads on this initial proposal are both experts in instructional design with extensive experience in online learning. Co-PI Estes is Director of the Master of Education degree with a concentration in Educational Technology for the James Madison University College of Education. She is also a co-PI on the “Designing and Refining Collaborative and Learner-Centered STEM Spaces” 4VA research at JMU. Co-PI Moore is Director of Engineering Instructional Design for the School of Engineering and Applied Sciences at UVa and has been one of the primary personnel on the *PRODUCED* program at UVa. She is currently investigating engineering lab designs for distributed undergraduate engineering education and is working on assessment of instructional quality in online and hybrid engineering education and ABET accreditation of online undergraduate engineering programs.

This collaborative relationship serves the mission of both institutions. James Madison University, for example, carries the Carnegie Community Engagement Classification in recognition of the university’s “collaboration between institutions of higher education and their larger communities ... for the mutually beneficial exchange of knowledge and resources in a context of partnership and reciprocity” (JMU homepage). The university serves a very high undergraduate student body in the Shenandoah Valley and recruits students who would benefit from the project outcomes and contribute to the rigor and values of the institution. The University of Virginia offers specialized expertise in the area of innovative online lab implementation and testing. The very high research activity at UVA serves the more innovative aspects of this proposal very well.

Anticipated outcomes and deliverables:

By the end of this project, we anticipate the following outcomes and deliverables:

- Summary of needs and task analysis
- Summary of pilot efforts from both institutions
- Set of common learning objectives for mechanical engineering labs that are independent from a specific lab facility
- Rubric of indicators and characteristics of instructional quality that can be used both for front-end design and for on-going evaluation; this rubric will become an essential tool that can be refined through further grant efforts and shared nationally to inform the additional challenges such as accreditation of undergraduate engineering degree with lab requirements.
- Plan for development of labs and articulation of an instructional strategy specific to online STEM labs that will then inform next steps in the collaboration process such as further grant proposals.

- Develop a proposal specifically for NSF (National Science Foundation) focused on accreditation of undergraduate engineering online education with attention to labs and accessibility
- Formation of a joint university team that develops experience working together and can parlay that experience into additional support and development
- Relevant publication(s) and presentation(s) on the findings from the front-end needs and task analysis to inform professional and national dialogue in the area of online STEM education

#### Assessment plan:

In order to assess the proposed effort, at the end of the project we will survey all those involved in the project for their reflections and recommendations for improvements, next steps, concerns and lingering questions, and overall impression of the accomplishments to date.

#### Timeline:

Phase I: February 2013 - April 2013

- Obtain institutional IRB approvals for rubric use, for surveying those involved, and as needed for administering assessments.
- Gather extant data from partner institutions on previous efforts and summarize findings (similarities, differences)
- Review syllabi from mechanical labs, and hold meetings with faculty who teach in mechanical labs.
- Survey students in PRODUCED program to know student needs and perspectives.

May 2013 / June 2013

- Develop first draft of instructional quality rubric.
- Gain feedback from students and faculty on draft rubric - revise as necessary.
- Develop and plan an instructional strategy for labs.
- Generate specific recommendations for student learning assessment and lab evaluation in conjunction with ABET accreditation areas of concern.

Phase II: July 2013 - August 2013

- Draft an outline of the NSF proposal.

September 2013 - December 2013

- Pilot-test instructional quality rubric in one lab. Collect data about the lab itself and about suggested rubric refinements. Revise.
- Initiate assessment survey.
- Develop full proposal(s) for NSF - Primary targets: Science, Technology, Engineering and Mathematics Talent Expansion Program (STEP) Type 2, Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES) Phase II, or Cyberlearning: Transforming Education CAPs.

## Budget

Phase I - \$10,000 Total  
\$5,000 from JMU + \$5,000 from UVa

### *From JMU 4VA*

\$3000	Overload time
\$1500	Travel to/from U.S. location(s) for lab observations; 3 roundtrips to/from JMU and UVa; Travel to/from NSF
\$0500	Central campus dedicated support (time, testing, travel)
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\$5000	Subtotal*

### *From UVa 4VA*

\$3000	Overload time
\$1500	Travel to/from U.S. location(s) for lab observations; 3 roundtrips to/from JMU and UVa; Travel to/from NSF
\$0500	Central campus dedicated support (time, testing, travel)
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\$5000	Subtotal*

\*Assumes that 4VA funding is available elsewhere for small equipment purchase for small-scale testing.

Phase II - \$30,000 Total  
\$15,000 from JMU + \$15,000 from UVa

*From JMU 4VA*

\$3000	Overload time
\$3000	Travel to/from international location for lab observations / participation in REV (European conference on virtual lab developments); 3 roundtrips to/from JMU and UVa; Travel to/from NSF; Travel to/from other 4VA sites**
\$7500	Lab development and pilot testing**
\$1000	Central campus dedicated support (time, testing, travel)
\$0500	Hosting joint university team meeting
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\$15,000	Subtotal

*From UVa 4VA*

\$3000	Overload time
\$3000	Travel to/from international location for lab observations / participation in REV (European conference on virtual lab developments); 3 roundtrips to/from JMU and UVa; Travel to/from NSF; Travel to/from other 4VA sites**
\$7500	Lab development and pilot testing**
\$1000	Central campus dedicated support (time, testing, travel)
\$0500	Hosting joint university team meeting
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\$15,000	Subtotal

\*\*Intend to supplement with NSF funds.