Strengthening Undergraduate and Graduate STEM Education

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Education is society's fundamental form of investment in its future.

As a result, we are now deciding among a variety of **possible futures** for our nation. Will we depend on other countries for technological innovation? Or for essential technological infrastructure, such as energy? Will our children grow up to be leading innovators and scientists? The current outlook is somewhat pessimistic.

While, education is a fundamental form of investment in our future, **A critical, perhaps the critical linchpin in our educational system is in Higher Education**. In addition to housing undergraduate and graduate education, it is where STEM disciplines are defined and practiced; it is the destination of students in our pre-college system; it is where teachers are educated and return for professional development; it is where we produce materials, assessments, and standards for the broader system; it is where leading research on student learning occurs. **It is also all too often overlooked in the national discussions in STEM education**.

I make 3 points in this testimony:

1) We know what to do but not how to do it broadly. Through DBER we have shifted our understanding of teaching and learning. We shift from the teacher-centered model of information delivery to student-centered, inquiry-oriented environments that focus on knowledge generation. Application of these ideas, such as Colorado Learning Assistant Program, **have led to improved learning**, where students perform 2 to 3 times better. Yet, despite knowing what to do, **such educational practices not widespread.** Research shows that **we are not taking a scholarly and scientific approach to promoting change in STEM education** on a broad scale.

2) The **challenges in our STEM educational system are complex and intertwined, and so, too, should be our solutions**. We can effect sustained change by coupling, efforts in undergraduate and graduate education, teacher preparation and research in STEM education. Through the Colorado Learning Assistant program, we focus on course transformation, k12 teacher recruitment and preparation, faculty development, and research. The **results lead to increased learning by all students, improved faculty practices, a dramatic increase in teacher recruitment, and fundamental research**. There are plenty of other examples, such as the Science Education Initiative, Informal Science Education and CIRTL that all run on our campus. All of these efforts indicate that **we need to work across levels of the system**.

3) **Key seed-funding from the Federal Government can potentially stimulate and unlock $100's B in latent infrastructure of the higher educational system.** We need to ensure that faculty practices at the university are aligned with our understanding of student learning. We need to establish institutional resources that support faculty engagement in meaningful educational experiences. We need to build on and support discipline based education research in STEM. The **National Science Foundation (NSF)** provides an excellent model in providing both funding and prestige (imprimatur) to effect change. Key NSF programs support individuals, such as **Distinguished Teaching Scholars (DTS)** program, **CAREER, PFSMETE, GRF's.** Similarly, programmatic work supported by **CCLI, REESE, DR-K12,** recent education efforts within NSF's **STEM directorates,** and **Noyce** have led individuals and localized programs to create effective models of educational practice. These are the NSF programs that support the high risk, high reward research that is the hallmark of American innovation.

Meanwhile **sustained Federal support** is necessary and a characteristic of other Federal Departments.

What is needed is a cultural shift – within science, technology, engineering and math:

- for STEM **departments** to take up the mantle of educational reform and assume leading roles in STEM education challenges across all levels,
- for **institutions** to integrate efforts across STEM disciplines and teacher education programs,
- for **professional organizations** and societies to assume leadership in endorsing, enabling, and connecting efforts across the nation in reform. National societies play an essential role. In physics and at the University of Colorado, the commitment of the Am. Assoc. of Physics Teachers, Am. Inst. of Physics, Am. Physical Society, and the Assoc. of Public and Land-grant Universities have been critical in supported sustained transforation.

and for this **Committee to catalyze and to endorse both in name and in action (funding) these key stakeholders** in improving STEM education at the undergraduate and at all levels.

Through targeted Federal funding (in the $1B's) we can engage university resources ($100B's) that reside, largely inert, to improve STEM education.

Such cultural shift can be the result of a Grand Challenge, where all Americans realize their identity and agency in STEM education reform.

As such, we can return to our roots as a Democracy based on an educated citizenry.

Thank you for your dedication to this critical issue.

Written testimony, transcripts and video of the hearing is available at:
http://science.house.gov/Publications/hearings_markups_details.aspx?NewsID=2723