

Training, STEM Education, and Workforce Development Research Roadmap Constellation

Description:

This research constellation represents the necessary collaboration among industry, K-12 schools, and postsecondary education to narrow the skills gap through workforce development, training, and education. These skills include technical knowledge but also essential skills including teamwork, innovation, leadership, and communication. This constellation focuses on not only training for the current workforce but also the pipeline of students in pk-12 schools who are the future for higher education and industry. This constellation will focus on the development and study of innovative partnerships and programs, including possible new academic programs. Much research in this area includes aspects of diversity, equity, and inclusion. As the population of the nation diversifies, research should focus on different populations than have traditionally been studied. This means more innovative research techniques may be needed because of the small populations available to study.

The interdisciplinary research conducted in this area includes quantitative, qualitative, and mixed methods as needed to answer the research question. Research in this area may also result in development of a psychometrically validated instrument such as a rubric. This constellation interfaces with other constellations by researching the impact of training, teacher professional development, K-12 student outreach programs, and workforce development initiatives and policy. The emphasis of this constellation is not that these activities are occurring, but if they are ***accomplishing the stated outcomes with meaningful impact.***

To respond to the needs of industry, government, and other organizations, effective recruitment, teaching, and training methods must be studied for creation of the necessary STEM-capable workforce. This constellation will provide opportunities to enhance the training of graduate students in existing programs by collaborating on projects focused on workforce development and STEM education. Legislation, such as [H.R. 4979](#), the Rural STEM Education Act in the Senate at the time of this writing, offer other potential for NSF funding.

This constellation will contribute to the knowledge base in the field and expand the funding opportunities available to researchers from individual disciplines. Many funding opportunities in these areas are currently available, as referenced at the end of this document, but one example is the [U.S. Department of Education's investment of \\$540 million](#) in grants for STEM education in 2019. Grants such as this fall in the non-STEM category for R1 research expenditures, and S&T has not traditionally pursued those opportunities.

Vision:

The Training, Education, and Workforce Development Research Constellation will enhance the economic growth of communities by researching the efficacy of existing strategies, structures, and policies while collaborating with organizations, industry, and schools. These collaborations and community engagement will result in innovative approaches that appeal to foundations,

state and national agencies, and industry for large scale funding opportunities that are new or previously unavailable to S&T.

The interdisciplinary research produced by members of this constellation will be collaboratively developed using principles of team science; all members will be involved in teams at the outset of project development, and every voice will be valued. Using research, this constellation will also provide recommendations for university, local, state, and national policies on workforce development and STEM education. This constellation will produce research that enhances access to STEM for all people, not just dominant groups, resulting in a more diverse, creative, entrepreneurial, and skilled workforce.

Missouri S&T Advantage:

Unlike some of our competitors and aspirational universities, Missouri S&T has a standalone teacher education department. For example, Georgia Tech and Colorado School of Mines do not offer teacher certification and have only a few “pre-teaching” courses designed to transfer. The education programs at S&T offer an accessible population of future teachers who can serve as pilot participants for research projects. The faculty in the department also have expertise in reading difficulties such as dyslexia, effective feedback on teaching performance, rubric development, and assessment.

On campus, various centers, departments, and faculty focus on aspects of workforce development or educational training; however, this work, while beneficial, often occurs in silos with little collaboration. For example, the South Central Regional Center for Professional Development is housed on S&T’s campus, but most faculty are unaware of its existence or its purpose, to provide training to teachers in the region. The same is true for the Missouri Small Business Development Center. These centers are underutilized because their staff typically do not focus on research, providing an opportunity for partnerships with faculty. Similarly, Missouri S&T’s well known summer camps provide an existing infrastructure to research K-12 student STEM experiences. Project Lead the Way is another opportunity to connect with K-12 students and teachers.

Rationale:

The physical, mental, and economic wellbeing of a community is dependent upon a capable workforce and an effective education system to supply the pipeline. The existing ecosystems should be analyzed to determine opportunities for more inclusion, particularly in STEM fields. As the population in the U.S. diversifies, additional research with more representative samples is needed in differing geographic areas, including rural communities.

Without a well trained, diverse workforce, new technologies will falter when implemented at scale. New scientific discoveries need to be translated for integration into K-12 school curriculum to prepare these students for careers they may be currently unaware. For the development of future scientists, engineers, and mathematicians, teachers at all levels need more skills to engage students in STEM and other needed areas. If students have lackluster

experiences with STEM in K-12 schools, they will be uninspired to pursue these professions and gain needed skills.

Faculty in social sciences such as education and psychological sciences have contributed to multiple, large grant proposals with teams from CEC. However, there is a need for more expertise to contribute to grants with broader impact, K-12 education, and human factors requirements. Currently there are few graduate programs that connect to these areas, which makes building research in this area more challenging. Grant proposals typically involve funding for graduate students, but right now, there are no graduate students to fund. This means this research falls on faculty who have little support. As our institution produces more graduate and PhD students in STEM fields, we are only perpetuating the lack of essential skills in these areas.

As existing workforce development and education programs are organized, strengthened, and expanded through collaboration within the university and other stakeholders, research and funding in this area will increase. Increasing the number of graduate programs and certificates in more diverse areas of study would strengthen the entire campus. More diverse graduate courses would offer opportunities for cross-disciplinary collaboration; for example, graduate students in STEM disciplines could take an education course or seminar in assessment. The hiring of the new VP for Corporate and Professional Education should increase demand for short courses and other workforce development training opportunities. This constellation offers an opportunity for faculty to use those courses for interdisciplinary research.

To reach R1 status, S&T needs to increase the number of research & development expenses in non-science & engineering fields. This constellation would support interdisciplinary research and development of academic programs in both STEM and non-STEM fields, or even new degrees that are a combination of both such as engineering education. The large-scale grants that would be accessible from increased resources are even more important for R1 status if they are in non-STEM fields.

Future Initiatives and Programs (outputs):

- Increased funding in non-STEM research expenditures
- STEM Education/Workforce Development Center, our only current center related to this type of work is CSTS
- Mobile lab for workforce development/education demonstrations in rural communities
- Diversified doctoral and masters programs for R1 status, would increase non-STEM funding because graduate student tuition could be used
- Conference for STEM educators, perhaps specifically focused on research of equity issues
- Conference focused on workforce development for new technologies
- Events so teachers can experience workplaces such as manufacturing
- Pairing education faculty with STEM (esp. CEC faculty) to offer workshops to teachers through RPDC and write NSF and other grants for STEM education

- Diversity, equity, and inclusion certificate that is interdisciplinary (4 classes, business has inclusive workplace course SP 21, psychology has a few, teacher ed has a few)
- Skill-based, earn a badge, 1 hour class focused on something specific, these could possibly stack, example could be bias in AI, fits with existing programs and is focused on one specific element, 1 credit is more manageable for corporate education. We need to incentivize faculty creation of these classes, work with new VP of CPE on this.
- Engineering education graduate certificate and possibly graduate degree? (Mizzou does not have this)
- Workforce development graduate certificate

Resource Needs:

- Faculty with pedagogical content knowledge in STEM fields, e.g. engineering education, earth science education, biology education, chemistry education, math education. These faculty could assist with curriculum revision for “bottleneck” courses as well as contribute to grants designed to improve STEM experiences for students.
- Workforce development staff with expertise in this area.
- OSP resources dedicated to non-STEM funding opportunities
- Seed funding for non-STEM research projects focused on possible funding opportunities
- Assistantships to fund students in masters programs to help with this work, research, grants, etc. Many of the centers on campus come with assistantships.
- Center dedicated to STEM Education and Workforce Development. S&T lags behind the other UM System schools in staffing and resource devoted to workforce development.
- Resources devoted to summer camps, high school competitions, and other programs that bring youth onto campus for potential research opportunities. Better data is needed about the impact of these programs, need to be studied from a research rather than admissions perspective. Funding for low SES students to attend these experiences.
- Expanded use of testing center for workforce development with community members, needs partnerships with nearby industry
- Tuition model for dual credit/dual enrollment courses with high school students to funnel them into STEM professions, provides opportunity for longitudinal research and increased enrollment in summer camps if course credit offered for both counselors and K-12 students

Potential Barriers:

- Sustainable medium-range (3-5 years) funding to allow for full implementation of Initiatives and Programs to take effect.
- Highly selective status is not well suited for adult degree completion/workforce development initiatives if connected to current programs/coursework. Need alternative routes to course delivery and admission that are efficient and customer-friendly.
- Perspective that university is STEM-focused rather than education/training, perception of lack of support, particularly for nontraditional students and STEM-minority students
- Duplication of effort through different initiatives from different organizations

- Promotion and tenure committee did not accept broadening definition of “scholarly activities” that relate to education/outreach.
- Differing promotion and tenure expectations from department to department, i.e. grants not valued the same
- Social scientists and educators are often asked to participate in large grants from CEC, but this may take time away from grants that count for non-STEM research expenditures.
- Higher enrollments in courses, especially grad students, makes the workload higher, particularly with the pivot to hybrid/online. These courses require extensive feedback, but they also are a tuition draw. This makes balancing teaching and research more challenging.
- Non-thesis masters students are often unfunded. Their students turn over after two years.
- Lack of substitute teachers to make time for practicing teachers to come on campus or attend training, reduced funding in K-12 for teacher PD
- Difficulty partnering with school districts in the area because other universities offer dual enrollment/dual credit at reduced rates
- VP of CPE is a new position, may take time to develop these relationships and incentivize course creation for faculty

Potential Research Directions:

- Social-psychological theory and research for improving recruitment/retention and reducing achievement gaps in STEM (and in higher education more broadly). Examples:
 - [Factors that contribute to gender gaps in STEM](#)
 - [Emphasizing communal goals in STEM](#) (here's another [review](#) of this work)
 - [How stereotypes contribute to gender gaps in STEM](#)
 - [“Wise” interventions for teachers and institutions](#)
 - [Providing critical feedback to students across the racial divide](#)
 - [Addressing achievement gaps with psychological interventions](#)
 - [Teaching students a contextual understanding of difference can help them succeed](#)
 - [Psychological insights for improved physics teaching](#)
- Small business/rural organization development connecting relevant undergrad and grad programs to facilitate small business needs in the area through the Missouri Small Business Development Network
- Research about teaching STEM in higher education, SoTL projects for student engagement, retention, etc.
- Study of K-12 students' interaction with STEM activities while on campus for events, field trips, or in school settings, also study of knowledge gained and retained over time from such activities
- Summer camps for high school and middle school offer ample opportunities for studying STEM education, follow up when these students go back to school, did they retain the knowledge? Do these experiences lead to more awareness of STEM careers?

- Curricular and instructional revision of “bottleneck” courses, comparison of outcomes

Sample Activities:

- Collaboration across campus for improved teaching in STEM and other disciplines using innovative and inclusive strategies
- Inclusive workforce development and training so capable adults have access to the skills needed for success for a specific technology, etc.
- Investment in communities by increasing the skills of adults, including teachers, to narrow/eliminate the STEM and technology gap.
- Assessment of the impact of training, workforce development, and broader impact/outreach programs. Outside program evaluators are always needed for grants.
- Implementation of Teacher-Workforce Mentor Days to allow for better understanding of essential workforce skills needed in today’s ever-changing workforce. Could invite industry and engineering departments for teachers to circulate.
- Program evaluation of STEM educational efforts on campus, in the community/school districts, and for other organizations/universities for grants
- Partnering with testing center to deliver workforce development skills tests as needed for the community

Resources and Funding Opportunities:

- Future Scholars for Science, Technology, Engineering, and Mathematics (STEM) Workforce Development Program <https://www.grants.gov/web/grants/view-opportunity.html?oppld=327212>
- Department of Education’s STEM Education Strategic Plan <https://www.ed.gov/stem>
- Spencer Foundation: <https://www.spencer.org/>
- Rural STEM Education ACT (if passed) https://www.aip.org/fyi/federal-science-bill-tracker/116th/rural-stem-education-act?utm_medium=email&utm_source=FYI&dm_i=1ZJN,71EKR,WPVOG3,SE96D,1
- Union Pacific Workforce Development grant, Civil and electrical engineering priorities (partner with 502c3 status like 4H) <https://www.up.com/aboutup/community/foundation/local-grants/index.htm>
- NSF Noyce Teacher Scholarship Program, <https://www.nsfnoyce.org/>
- NSF AISL: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504793
- NSF NRT: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505015
- <http://www.ala.org/news/member-news/2020/05/ala-announces-steam-funding-and-exhibitions-rural-libraries-serving-latino>
- <https://www.ims.gov/sites/default/files/grants/re-95-17-0065-17/proposals/re-95-17-0065-17-full-proposal-documents.pdf>
- <http://ed.buffalo.edu/information/news-events/features/rural-libraries.html>

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Definitions:

Workforce Development: system of learner-focused trainings and programs to support people in meeting their career goals

Training: short term development of specialized skills needed to perform a job function, e.g. learning how to use a new software system, that is often employer-focused

Education: preschool through 12th grade formal schooling, primarily focused on public schools for the purposes of this document

Engineering Education: focus on the knowledge and skills, both technical need to be successful as an engineering professional; science, technology, engineering, and mathematics or STEM

Outreach: K-12 school engagement and business outreach, alignment with needs of these stakeholders

While activities in this pillar may overlap with outreach, the focus is research in these areas. For example, presentations in K-12 schools about research are outreach, but research would involve assessment of students' knowledge or attitudes before and after the presentation.