Proposal Narrative

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Significance.

"I like to think that talent and ability is evenly distributed across the world, but sometimes opportunity isn't," states J. Williams, a Kentucky college student from a small, rural, low-income Kentucky town studying computer science.[1] This sentiment rings true for most schools in south central Kentucky, a mostly rural, low-income region. Rural poverty is isolating by its very nature. "A child born into deep poverty in the rural South has just a 5% chance of reaching the top quintile of income as an adult. More than four out of five of the U.S. counties designated as 'persistently poor' today are rural."[2] In fact, 8 counties in south central Kentucky are identified by the Congressional Research Service as persistently impoverished counties.[3]

In 2016, the ACT Condition of STEM report showed **48% of Kentucky students expressed interest in STEM majors and careers** (science, computer science and mathematics, medical and health, and engineering and technology), and the level of student interest had been steady during the five years prior.[4] However the report also states that while underserved learners have a high interest in STEM, ACT STEM Benchmark attainment lags far behind their peers, especially for students with multiple characteristics of underserved (i.e., low income, first generation in college, and/or minority race/ethnicity). Thousands of students in this region are waiting to realize their potential, to be inspired, to find their niche in a subject or potential occupation to use their talent and have excitement about the future. Yet state/district budget cuts and lack of specific teacher training and course work in STEM and computer science (STEM^{CS}) means few options for students, and graduation becomes just something to "get through."

(A)(1) Knowledge/understanding of educational problems, issues, or effective strategies.

In the last few years Kentucky has recognized this issue of limited expectations, limited opportunity, and the continuing cycle of producing students with minimal skills to fill low-skill, low-wage local jobs. This prompted the state to provide funding for equipment and teacher training/support for approved districts to begin AP-level courses in STEM[CS]. However, based on readily available research, it is not enough. The ACT Center for Equity in Learning reported in February of this year (2019) that, "consistent with prior research, rural students…were…less likely than non-rural students to participate in AP courses."[5] Typically, most students in AP-level courses already have a drive to achieve and a goal of attending college. However, the ACT study states, "consistent with prior research, rural students in our study were more likely than non-rural students to enroll in dual or concurrent enrollment courses…."[5]

According to data from the US Congress Joint Economic Committee (2014), over the next decade **the United States will need one million more STEM professionals than it can produce.**[6] Pew Research Center (PRC) data shows STEM workers tend to earn more than similarly educated non-STEM workers (typically 24-26% more on average),[7] and while STEM occupational demand continues to increase, US students continue to fall behind in skills needed for STEM areas. In 2017, PRC data shows **US students continue to rank in the middle and behind many other advanced industrial nations** in STEM subjects.[8] Additional data from the Program for International Student Assessment (PISA) (2015) shows US 15-year-old students ranked 38th of 71 countries in math literacy, and 24th in science literacy.[9] On the 2015 National Assessment of Educational Progress (NAEP), **only 25% of 12th graders were at or above proficient in mathematics,**[10] and **only 22% in science**.[11] The National Science Board (NSB) in 2018 stated, "**STEM knowledge and skills will continue to play a critical role in fostering individual opportunity and national competitiveness**."[12]

In rural areas, it is also not enough to focus solely on student need and achievement; in addition, rural districts and teachers face their own set of challenges. Rural schools struggle with a smaller teacher candidate pool making it difficult to find qualified math and science teachers. This can leave positions open for months with courses taught by long-term substitute teachers. And **high school coursework in rural schools can tend to be measurably less rigorous** leaving students unprepared for college courses should they decide to pursue higher education.

Rural teachers maintain close community ties with 80% staying within thirteen miles of their hometown when seeking employment.[13] Teacher candidates for vacant rural positions who also completed a rural K-12 education likely had many of the same academic barriers as current students, but are the largest share of the rural school candidate pool. This created, ongoing cycle of “growing your own” teacher candidates perpetuates the achievement gap continually experienced by most rural students. A study of Kentucky teachers shows both urban/suburban teachers and rural teachers with superior academic qualifications were less likely to be employed in rural Appalachian schools.[14] On average, rural teachers have more years of experience, yet are slightly more novice than suburban/town peers, and rural teachers are less likely to have obtained their credentials through alternative certification methods than urban teachers.[15] Teachers in rural areas are also less likely to have a Master’s degree, with a 10% point gap in attainment (between rural and suburban teachers), and **the likelihood of rural teacher postgraduate education decreases the more isolated the community is**[10]. Many rural teachers may not receive ongoing training or professional development (PD) needed to truly be effective, and **many come to the classroom with lower levels of academic preparation than urban/suburban peers**. All of these factors influence student learning and perpetuate the achievement gap. Rural students face numerous serious barriers to obtaining a quality, rigorous education, opportunities in college, and careers in STEM^{CS} fields simply because of where they live.

With the STEM^{CS} Project, we will seek to address student barriers as well as teacher needs (PD, training). The contribution will be providing increased knowledge/understanding regarding whether focused, intensive teacher PD and support, combined with the ability to increase Rank (creating teacher buy-in and motivation), has a positive effect on student achievement in STEM^{CS} courses of rural, high-poverty, underserved students.

The Green River Regional Educational Cooperative (GRREC) is a nonprofit regional educational agency serving 46 mostly rural, high-poverty, preK-12 school districts with a mission of unwavering commitment to service and support of our schools through building adult capacities and channeling resources to increase student success in school and life. With our mission in mind, our proposed STEM^{CS} Project seeks to combat student and teacher barriers related to STEM^{CS} education in rural, low-income, high-poverty districts.

(A)(2) Proposed project has promising new strategies that build on existing strategies

Keeping in mind all of the previously referenced issues (i.e., STEM-deficient nation, lack of students prepared for STEM jobs, lack of quality teacher PD) pose continued significant barriers to long-term academic/vocational success of rural students, an effective solution must be put forward and tested. Our proposed STEM^{CS} Project hones in on teacher PD, increased teacher Rank, and multiple systems of support for rural teachers specifically for STEM^{CS} instruction. We believe if we can provide specific in-depth training/coursework in STEM^{CS} to increase teacher knowledge; provide multiple tracks to increase teacher Rank and therefore teacher salary; provide topic/subject-specific certification(s), ongoing, job-embedded, collaborative PD and networks; and work with teachers/districts to create/implement rigorously designed STEM^{CS} curriculum, teacher effectiveness will improve, thereby improving/growing student achievement. Research has shown that **what distinguishes high-performing, high-poverty schools from lower-performing schools is effective collaborative professional development for teachers**.[16]

We know when teacher effectiveness is raised, increased student achievement is a natural result.

With this project, we will build on What Works Clearing House (WWC): a practice guide (Turning Around Chronically Low-Performing Schools[17]), and Intervention Report (Teach for America[18]). From the practice guide, we will use teacher collaboration/teams for instruction, instructional planning/goals and improvement by incorporating a regional Community of Practice (COP), school Data Teams, and the Endeavor national network. We will also focus on targeted PD in specific content to improve instructional/content skills and content knowledge. From the Intervention Report we will include ongoing PD and support, mentoring/coaching for participating educators, observation and feedback on instruction, and small group sessions to reflect on the experience, gain feedback, and analyze student progress. Each COP will meet together to share best practices, discuss ideas and gain input from one another. Project staff, Mentors/Coaches, and partners will work together to assist teachers in completing required components and implementing learnings in their classrooms. We will build in additional practices/strategies shown to improve teacher and/or student performance (i.e., project-based learning (PBL)) as well as project-specific components already mentioned to create a holistic strategy for bringing $STEM^{CS}$ to our region's rural, high-need districts.

Teacher Effectiveness. By increasing teacher effectiveness and engagement in $STEM^{CS}$ we will increase student engagement/interest in $STEM^{CS}$ subjects, realize growth in math and science assessment scores, and see gains in the average grade point average in participating districts.

Certifications/Rank Change/Master's. We have **four tracks** in which teachers can gain certification, potentially increase teacher Rank, and/or work toward/obtain their Master's degree. For the **first track** we will partner with **U.S. Satellite Laboratory** to offer all participating teachers the opportunity to earn the **Endeavor STEM Leadership Certificate**, sponsored and overseen by Teachers College, Columbia University. Educators take live and online graduate-level courses in STEM education to develop their understanding of STEM content and pedagogy and the Next Generation Science Standards (NGSS) 3-dimensional teaching and learning. All courses incorporate National Aeronautics and Space Administration (**NASA - a partner with U.S. Satellite Laboratory**) resources, including subject matter experts (such as NASA scientists/engineers), space-related content and live NASA guest speakers. Endeavor employs doctoral-level subject matter expert instructors nationwide, provides opportunities to engage with teachers across the country through a STEM online network, allows guest speakers to join live sessions, and ensures STEM resources are updated and shared frequently for educator access. Teachers can also opt to apply graduate credits to a Master's degree with one of Endeavor's partner universities (Adams State Univ. or Northeastern State Univ.). GRREC selected Endeavor for its rigorous graduate-level coursework, dedication to making courses available for educators without disruption to their regular teaching schedule, and for courses counting as credit toward a Master's degree as well as toward increasing teacher Rank.

The **second track** is GRREC's Micro-credentialing Pathway. GRREC is working with national experts BloomBoard to develop specific, rigorous courses/work in STEM^{CS} subjects/pedagogy for educators. Though still finalizing development, the Kentucky Education Professional Standards Board (KY-EPSB) has approved the use of this non-traditional track for obtaining continuing education credit toward a Rank increase. This Micro-credentialing track will have five core subject-area requirements and two electives to count toward an increase in Rank.

The **third track** is through a Western Kentucky Univ. (WKU) Master's degree in teaching or STEM^{CS} subject area. This is the traditional route to move from Rank III to Rank II educator.

The **fourth track** is by pursuing National Board Certification (NBCT). This track can also be combined with any of the other three tracks.

Track One - earning the STEM Leadership Certificate - will be required for all STEM^{CS} teachers. In addition to the four tracks, we will identify what teachers need to become credentialed to offer **Dual Credit** courses. Following the research evidence of what works for rural students, **we will increase dual-credit course offerings in STEM^{CS} subjects in each of our participating high schools** (HS) using our higher education partners (WKU, SKYCTC). This will help ready STEM^{CS} students for college-level course rigor, thereby increasing college readiness. In addition, higher education partners and local community industry partners will encourage STEM^{CS} students to participate in industry internships/apprenticeships, and earn industry certifications to be career ready upon graduation (industry partners will be identified and MOUs obtained upon grant award due to variances in geographic location; see Appendix F). By building on existing proven strategies (such as collaborative professional development, COPs, Data Teams, PBL, etc.) we have incorporated them all into one overall strategy of focusing on teachers, their learning (academically and subject-specific), and their instruction (practice/pedagogy) to impact student academic achievement.

B. Quality of the Project Design

The STEM^{CS} Project addresses **AP 1:** Demonstrates a Rationale; **AP 3:** Field-Initiated Innovations –Promoting Science, Technology, Engineering, or Math (STEM) Education, with a Particular Focus on Computer Science; and the **CPP:** Expanding access to and participation in rigorous computer science coursework for traditionally underrepresented students.

For STEM^{CS} we will work with eight rural, high-poverty, high and middle schools (MS) (Appendix F). In considering STEM^{CS}, we will seek to answer two questions:

1. Will investing in educator STEM^{CS} PD and education, providing multiple tracks for teachers

to obtain STEM certification, NBCT, dual-credit credentials, their Master's degree or credits toward it, and/or increase teaching Rank increase educator effectiveness in the classroom, thereby increasing student academic growth/achievement in multiple STEM^{CS} courses for all learners (i.e., not solely for AP learners)? And,

2. Can rural, low-income students make large gains in STEM^{CS} and academic achievement when teachers are provided with the training, PD, and ongoing support needed to institute rigorous STEM^{CS} courses in HS and MS?

(B)(1) Goals/objectives/outcomes are clearly specified and measurable.

The STEM^{CS} Project will improve teacher effectiveness in STEM^{CS}, which we anticipate will directly affect student academic achievement, including scores on science and math assessments and transition (college/career) readiness in participating districts. **STEM^{CS} has two main goals**: 1) Improve teacher STEM^{CS} knowledge, practice, implementation and effectiveness; and 2) Improve opportunities, access and outcomes for high-need, rural students in STEM^{CS}. The first goal leads directly to and fully influences the second. By improving teacher STEM^{CS} knowledge, practice, implementation and effectiveness, we will increase the number of students who meet transition readiness state standards, benchmarks on state/national assessments (ACT, CPE), complete STEM^{CS} dual-credit college courses and/or early college degrees through our post-secondary partners, and complete industry certifications in STEM^{CS} and related fields.

Below are project objectives and measures by goal, followed by outcomes:

Goal 1: Improve teacher STEM-CS knowledge, practice, implementation & effectiveness	
Objectives	**Measures**
Objective 1.1: 100% of participating educators will obtain at least one certification (Endeavor STEM Leadership, Dual-Credit, and/or NBCT) during the grant period.	**Measure 1.1:** Measured by obtaining the # of educators who currently have a STEM certification &/or NBCT, & comparing with the number obtained by the end of the grant period.

Objective 1.2: By May 2020, Micro-credentials for educators in STEM-CS topics/courses will be available for participating teachers to obtain through a partnership with national experts BloomBoard.	**Measure 1.2.a:** Measured by whether Micro-credentials were successfully created and/or implemented for STEM-CS topics.
	Measure 1.2.b: Measured by how many educators obtained Micro-credentials by the end of the grant period.
Objective 1.3: By the end of project year two, each participating district will have (a) teacher(s) certified to teach dual-credit STEM-CS courses through WKU &/or SKYCTC.	**Measure 1.3:** Measured by comparing currently offered dual-credit courses in STEM-CS fields to those offered by the end of the grant period.
Objective 1.4: 100% of participating educators will actively participate in the STEM-CS COPs, Data Team(s), STEM-CS regional and national Networks, and (an) Industry Partnership(s).	**Measure 1.4.a:** Measured by how many educators benefit from active participation in at least one STEM COP (surveys).
	Measure 1.4.b: Measured by how many educators benefit from participating in the STEM-CS Network(s) developed through this project (surveys).
	Measure 1.4.c: Measured by how many educators benefit from participating in local/regional industry partnerships (surveys).
	Measure 1.4.d: Measured by the benefit(s) educators have seen/experienced in the classroom and with student achievement from the educator's participation (surveys).
Objective 1.5: 100% of participating educators will receive training in, and regularly implement Project-Based Learning within their STEM-CS courses.	**Measure 1.5:** Measured by how many educators effectively include PBL throughout their STEM-CS courses.
Objective 1.6: 100% of participating educators/districts will create/implement rigorously designed STEM-CS curriculum no later than the end of project year two for HS, and the end of project year three for MS.	**Measure 1.6.a:** Measured by actual completion of rigorously designed STEM-CS curriculum.
	Measure 1.6.b: Measured by how effective the created/ implemented curriculum is by comparing student achievement/ scores within the course with prior course achievement/scores.
	Measure 1.6.c: Measured by student surveys of their opinion of the coursework.
Objective 1.7: To determine effectiveness of focused teacher professional development on student achievement	**Measure 1.7.a:** Measured by comparing math and science scores prior to, during, and post grant period.

	Measure 1.7.b: Measured by comparing transition readiness scores prior to, during, and post grant period, particularly in STEM-CS subjects/fields.
	Measure 1.7.c: Measured by comparing educator effectiveness in STEM-CS topics prior to, during, and post grant period, utilizing individual teacher surveys, student surveys of teacher effectiveness, and fellow educator surveys & input.
Objective 1.8: 100% of participating educators will have improved effectiveness.	**Measure 1.8:** Measured by student growth and proficiency scores, transition readiness rates, student engagement, and participation in PBL.
Goal 2: Improve opportunities/access/outcomes for high-need, rural students in STEM-CS	
Objectives	**Measures**
Objective 2.1: Student engagement & participation in STEM-CS courses will increase 30% annually.	**Measure 2.1.a:** Measured by student surveys and interviews of the course, their learnings, and their teacher's instruction at the beginning, during, and at the end of each course.
	Measure 2.1.b: Measured by attendance rates in each STEM-CS course.
	Measure 2.1.c: Measured by the # of students taking STEM-CS elective courses before, during, and post-grant period.
Objective 2.2: Student math and science assessment scores will increase 25% by the end of the project period, with an over all proficiency target of 75%.	**Measure 2.2:** Measured by assessment scores before, during, and post-grant period.
Objective 2.3: Transition readiness rates will increase by 25% by the end of the project period, particularly in STEM-CS fields.	**Measure 2.3.a:** Measured by transition readiness rates before, during, and post-grant period.
	Measure 2.3.b: Measured by surveys of 12th grade students before graduation and one year post-graduation.
Objective 2.4: Increase by 30% (starting in year two) the # of students participating in STEM-CS dual-credit courses each year.	**Measure 2.4.a:** Measured by the # of students enrolled in dual-credit courses (any, & STEM-CS) before, during, and post-grant period.
	Measure 2.4.b: Measured by the # of students who enroll in dual-credit STEM-CS courses during this project.
Objective 2.5: Increase by 30% the number of students interested in STEM-CS career pathways.	**Measure 2.5.a:** Measured by the # of students enrolled in STEM-CS courses &/or dual-credit courses.

	Measure 2.5.b: Measured by the # of students who continue on to a STEM-CS field post-graduation.

When implemented with fidelity, we anticipate the following Outcomes:
1. Increased opportunity for educators to further knowledge/career by obtaining specific certifications in STEM-CS areas, obtaining credits towards their Master's or receiving a Master's degree, credits toward a Rank change, and/or through obtaining their National Board Certification (NBCT).
2. Increased teacher effectiveness through participation in STEM-CS and its professional development opportunities.
3. Ongoing STEM-CS COP, Data Teams, and networks – locally, regionally and nationally.
4. Ongoing local/regional community/industry partnerships for STEM-CS to include: 1) student apprenticeships/internships, and 2) class/course and industry connections.
5. Ongoing regional network of STEM-CS and STEM certified educators.
6. Rigorous STEM-CS curriculum specific to each school/district's needs.
7. Increased student preparation for college/career with a focus on STEM-CS pathways.
8. Increased/expanded student opportunities in STEM-CS fields, and access to rigorous STEM-CS curriculum to prepare for those fields.
9. Increased opportunity for students to obtain college-level credit for dual-credit courses, up to and including an Associate's degree, with a specific, intentional focus on STEM-CS courses.
10. Increased student interest and knowledge in STEM-CS and STEM fields.
11. Growth in student math and science assessment scores annually.
12. Increase in the average GPA of students involved in STEM-CS courses.
13. Increase in overall attendance of students involved in STEM-CS courses.
Overall Outcomes: 17,000+ students will have increased opportunity and access to STEM-CS pathways, and more than 50 teachers will improve efficacy in STEM-CS. We will achieve these objectives over 5 years, in 8 rural, high-poverty school districts (RLIS, 2019; NCES).

(B)(2) A conceptual framework underlying the research and the quality of that framework.

The STEM^{CS} logic model may be found in Appendix G. The overall picture for STEM^{CS} is this: we will improve opportunities, access and outcomes for rural, high-need students in STEM^{CS} by investing in teachers through ongoing PD leading to STEM and/or NBCT certification, dual-credit credentials, Micro-credentials, and/or gaining credit toward a Master's degree. All will count toward an increase in teacher Rank (KY-EPSB classifies teacher education and experience in a Rank system).[19] STEM^{CS} will use the following **key elements**:

Understanding Students/Schools/Districts: During Oct.-Nov. 2019 (Oct.-Nov. 2021 for Cohort 2 MS) we look in-depth at participating HS, and gather student achievement data in current

STEM classes. We will analyze how information is currently disseminated and examine effectiveness. A comparison study between participating districts' STEM classes will determine what is effective, and what is not. We will also examine the use of data-driven decision-making to change practice for continuous improvement.

<u>Understanding the Educators:</u> During Oct.-Nov. 2019 (Oct.-Nov. 2021 for Cohort 2 MS teachers), we will meet with Cohort 1 HS teachers to gather data/information specific to them. This will include: a survey of certifications, content-specific $STEM^{CS}$ PD they have received (if any), and an assessment of individual teacher effectiveness in $STEM^{CS}$ classes through analyzing data, personal teacher surveys, student surveys, and fellow-educator/building leader surveys. Teachers will also determine which $STEM^{CS}$ track they will take for this project.

<u>U.S. Satellite Laboratory's Endeavor STEM Leadership Certificate Program</u>: The Endeavor STEM Leadership Certificate program is a rigorous graduate-level program sponsored by Teachers College, Columbia University, which provides a common language for integrated teaching and learning based on NGSS, using NGSS 3-dimensional teaching and learning incorporating NASA resources and subject matter experts, and space-related content. Endeavor's Space Act Agreement with NASA affords the ability to invite NASA scientists/engineers to speak directly to teachers, helping bridge the research community and classroom. Educators learn directly from NASA personnel about current missions, the $STEM^{CS}$ driving the missions, and available resources included in mission outreach. Doctoral-level national Endeavor instructors facilitate meaningful experiences/discourse leading to authentic adult learning. Teachers will also participate in a national online Endeavor network focused on contextual concerns and challenges. Educators bring their "STEM Problems of Practice" to collaborative groups for substantial feedback, working through ideas in a professional problem-solving environment. In turn, teachers provide feedback and learn how other districts across the country address STEM, leading to important dialogue specific the teaching context. Endeavor's network provides support for critical thinking about STEM teaching through reflective collaboration.

Addressing Rural/Generational Poverty: STEM^{CS} will provide teachers training in understanding the effects of poverty on student thinking and learning through a workshop-style event in the Fall of 2019/2021 on A Framework for Understanding Poverty[20], based on Ruby Payne's research. Teachers will begin work to improve teaching strategy by embedding specific, intentional strategies, understanding personal limits students place on themselves, or their family places on them. Understanding poverty is a necessary first step in this process.

Data Teams: Participants will form school STEM^{CS} Data Teams to look specifically at student academic data in STEM^{CS} courses. GRREC specialists in Data Teams will work with participants to go through the 5-step Data Team process: 1) collect and chart data; 2) create a hypothesis of practice/identify root causes; 3) discuss/select a SMART goal; 4) consider/ employ instruction strategies; and 5) review results indicators (determined by each school data team) for continuous improvement, and to determine level of success experienced. Data Teams will center on priority standards, including Kentucky's new STEM^{CS} standards. Data reviewed includes a comparison study of student achievement scores over the last five years in math and science, and information from initial student surveys to understand student thinking around STEM^{CS} courses/fields. Data Teams will meet at the school-level monthly and as part of the STEM^{CS} COP each quarter. This will help implement a Plan-Do-Study-Act (PDSA) cyclical approach to improvement, and allow the COP to share/discuss learnings from each teacher's classroom throughout the project period. Incorporating PDSA allows teachers to plan for, implement, study and monitor, analyze, and make refinements to implemented strategies. PDSA forms a continuous improvement process.

Networks: As part of STEM^{CS}, teachers can participate in the Endeavor network, which (as mentioned prior) allows STEM^{CS} teachers to interact with teachers from across the country employing STEM^{CS} courses in their schools. This promotes idea sharing, gaining input on issues/ questions on instruction, and will be a help when instituting new, rigorous STEM^{CS} curriculum and PBL. The regional COP consists of all STEM^{CS} teachers, as well as regional subject-matter experts in STEM^{CS}, education, PBL, and Data Teams. The COP allows teachers to ask questions, share ideas, and continue to problem-solve together with a local/regional base of support.

Project Based Learning: PBL is a “teaching method in which students gain knowledge/skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge.”[21] In laymen’s terms, PBL helps students solve “real world” problems through hands-on learning. STEM^{CS} will partner with experts in PBL training to provide PD in understanding and incorporating PBL within STEM^{CS} classrooms.

Curriculum Review: Utilizing WKU SKyTEACH (undergraduate math/science teacher preparation program) instructors, a curriculum review of all current and any “to be offered” STEM classes will be completed and a determination made of value and rigor of each. Reviewers will assist teachers/schools/districts in selecting appropriate grade-level and subject curriculum based on: a) the use of evidence-based approaches; b) alignment with state/national standards in STEM^{CS}; c) the inclusion of multiple learning resources; d) the inclusion of PBL opportunities; and e) the level to which there is interaction with computer science including technology and digital resources (such as makerspace, robotics, virtual reality, etc.).

Micro-credentials: GRREC is collaborating with BloomBoard to develop STEM^{CS}-specific Micro-credentials (a form of micro-certification). Teachers personalize learning using Bloom-Board, and prove competence through a “portfolio of evidence” created in classroom practice for each Micro-credential chosen. Each one defines a specific goal/purpose, helps teachers grow in practice/competence in each skill, and provides recognition for that growth through a digital certification. Micro-credentials address individual achievement of competence, and are building blocks for educator professional growth, career advancement and increased Rank.

Industry Partnerships: STEM^{CS} teachers, and school/district leaders will work together to build STEM^{CS} industry partnerships with local/regional businesses and organizations to develop internships/apprenticeships for students in STEM^{CS} industries. These partnerships will provide resources, support, and meaningful industry internships/apprenticeships for STEM^{CS} students - all in an effort to further and broaden this important work. By adding real world experience to back-up classroom learning, students will be better able to determine career/occupation goals leading to increased transition readiness. This also helps local industries develop future employees with needed/desired skills they are looking for directly out of HS.

(B)(3) Procedures for ensuring feedback and continuous improvement

GRREC uses a Continuous Improvement Cycle espoused by Dr. Diana Oxley[22]. Initial school and teacher surveys will serve as the “existing practice” from which the project will progress. Annual and mid-year targets will be included; school data teams meet monthly to determine progress and whether changes are needed. Quarterly STEM^{CS} COP meetings will gather project feedback and data to inform continuous improvement. The Project Director will interact and/or meet with participants bi-monthly or more often as needed. The Project Director, Associate Executive Director of GRREC, and the Advisory Council will engage in continuous monitoring so any weaknesses or shortfalls in meeting targets or objectives may be corrected and/or revised immediately. Monitoring and evaluation are key components of management and provide an all-important lynchpin between planning and implementation. While project staff focus on monitoring activities and outputs, project evaluators (The Center for Evaluation, Policy and Research (CEPR) at Indiana University, Bloomington) will focus on monitoring outcomes and goals. CEPR will regularly provide data to project staff through a rapid-response feedback loop (at least quarterly, and as requested by GRREC), ensuring timely findings support warranted changes/ adjustments. CEPR will work closely with the Advisory Council, meeting formally at least quarterly. Project staff will work with individual teachers/schools to create appropriate action steps as needed throughout the project. Other actions will include teacher and student surveys, confidential feedback to CEPR and STEM^{CS} staff; and feedback gathered from STEM^{CS} partners for continuous improvement of all project components. GRREC is committed to continuous improvement and candid reviews of what is working, what is not, and what changes may need made. With the help of CEPR, we will keep abreast of the latest relevant research to ensure implementation of a highly-reliable, high-quality project, and make any revisions deemed necessary by CEPR and the Advisory Council.

C. Adequacy of Resources & Quality of Management Plan *(5 pgs, 1.25 pgs/section; 25 pts)*

(C)(1) Achieve objectives on time and on-budget (responsibilities/timelines/milestones)

A management plan is in place to achieve STEM^{CS} goals/objectives on-time and within budget, including milestones, timelines, and identified responsible persons to complete STEM^{CS} successfully (for more information, see detailed management plan in Appendix I). We also have a work plan/ timeline (see Appendix I) with key components/milestones, dates, and identified responsible persons. The key components and activities are the primary tasks to be monitored throughout the project. GRREC has a history of strong fiscal management and project performance, and will serve as fiscal agent and coordinate all project activities. Our offices in Bowling Green, KY, support 160,400+ students annually in 300+ preK-12 schools in 46 districts, working with 20,000+ educators and faculty. Each GRREC initiative regardless of funding source has operated on time and within budget, from multi-million-dollar federal grants with multiple partners to small foundation grants of a few thousand dollars. Our 50+ educational and administrative staff provide [redacted] Funding is diversified through membership fees, state and federal grants, sponsorships, and fees for service. Each initiative has a half-or full-time director and an evaluation led by a third-party evaluator. All staff report to the Executive Director or Associate Executive Director. Our whole purpose is to support schools, teachers, and leaders to meet the various and specific needs of students.

(C)(2) Qualifications, relevant training, and experience of key project personnel.

Project Director: The STEM^{CS} Project Director will provide overall administration for the implementation of STEM^{CS}, including managing day-to-day activities and operations. We anticipate hiring Mr. Rico Tyler, a Master Teacher for the WKU SKyTEACH Program, a professor of physics and astronomy, and Science Practitioner in Residence at WKU. His strengths include NGSS, teacher preparation and instruction, identifying/implementing rigorous science curriculum, PBL, and STEM instruction. Mr. Tyler will work with project teachers, schools and districts, will supervise the Project Coordinator and Project Assistant, assist the evaluation team, conduct site visits, and guide the Advisory Council. He will work with GRREC staff to ensure financial and resource management, and report to the USDE. Mr. Tyler will serve as a Mentor/Coach to ensure all project requirements/commitments to the project are met on time. He will also work with curriculum specialists from WKU SKyTEACH, and school leaders in creating/implementing rigorous curriculum for STEM^{CS} courses at each school. See Appendix I for a Project Director job description.

Project Coordinator: The Project Coordinator will report to the Project Director and support on-site efforts around implementation, provide mentoring/coaching to participating teachers and coordinate activities for STEM^{CS} (including ongoing review of timelines, individual teacher tracks and their progress, as well as data collection and analysis on behalf of STEM^{CS} and for CEPR). For the mentoring/coaching work, the Coordinator will make on-site visits to STEM^{CS} schools working directly with participating teachers in their classrooms. S/he will have expertise in a STEM field, and also work with school Data Teams on an ongoing basis to help ensure continuous improvement. See Appendix I for a Project Coordinator job description.

Project Assistant: The Project Assistant will report to the Project Director and support project implementation and data gathering/analysis for CEPR. S/he will support STEM^{CS} by preparing and organizing training events, survey dissemination and collection, as well as aid participants in completing requirements for their selected Track. The Assistant will be responsible for administrative tasks including correspondence, planning/organizing materials, scheduling support for events/meetings, and helping with staff and partner meetings (Advisory Council, Evaluator, etc.). See Appendix I for a Project Assistant job description.

Other critical supports include:

Advisory Council

- Project Director (Tyler)
- GRREC Leadership (2)
- GRREC Instr. Tech. Dir. (1)
- Industry Partner (1)
- WKU/SKYTEACH (2)
- CEPR (Evaluators)
- District Superintendent (1)

Advisory Council. The Council's role is to provide support to the implementation of STEM^{CS}, as well as feedback and input for continuous improvement. The Advisory Council is an 8-10-member group representative of project participants, stakeholders, and content experts (see right). The Council will meet in whole at least quarterly, and as needed throughout project implementation. The Council will also provide monitoring and continued oversight of progress at project sites, and through virtual meetings.

External Evaluator. The Center for Evaluation, Policy, and Research (CEPR) at the Indiana

University, Bloomington will evaluate the project. Housed in Indiana University's Office of the Vice Provost for Research, CEPR conducts rigorous, high-quality, and nonpartisan evaluation, applied research, and policy analyses that address real-world problems within, and across, multiple sectors (e.g., government, education, business and industry, human services, etc.) for the purposes of informing decision-making and improving efficiency and effectiveness of a wide range of projects, programs, policies, and organizations. CEPR researchers have experience on international, national, regional, and local levels, including developing and implementing evaluations of large-scale programs/projects funded by the National Science Foundation, US Department of Education, foundations, and state departments of education. Evaluator summaries and vitae may be found in Appendix B. Please also see the Evaluation section (page 21-25) for the evaluation plan and specific tasks.

(C)(3) Potential continued support including commitment of entities to such support.

The STEM^{CS} project has been purposely designed to contain many lasting, ongoing elements for continued growth/support when funding ends. This includes knowledge gained (STEM^{CS}, PBL, poverty work, etc.), Data Teams, the Endeavor Network, regional COP, new resources, rigorous curriculum, industry partnerships (internships/apprenticeships), and dual-credit courses. It also includes teacher Rank changes, certifications, and Master's degree course credit (and/or Master's degree attainment). Mentoring/coaching will continue as a fee for service through GRREC. We anticipate STEM^{CS} schools functioning as STEM^{CS} Learning Labs for interested teachers, schools and districts to visit and learn from. When STEM^{CS} shows the tremendous impact and improvement expected, current STEM^{CS} districts will be willing to continue supporting the work. All GRREC districts are committed to investing in people, and STEM^{CS} is helping define how best to invest. We anticipate all GRREC districts (46) to buy-in to STEM^{CS} when seeing the expected level of improvement in instruction, student achievement and outcomes.

[redacted] rural, high-poverty HS and MS (see Appendix F for rural locale codes of participating districts). In Appendix H, we provide letters detailing the specific commitments and contributions of project partners and school districts to the required match.

[redacted]

[redacted]

D. Quality of the Project Evaluation

CEPR at Indiana University will conduct an independent evaluation of STEM[CS] that addresses key research questions about the impact of the project on students' academic proficiency in mathematics and science, and evaluates the quality and fidelity of program implementation. The CEPR research team has extensive experience conducting field tests of innovative educational interventions (e.g., Race to the Top initiatives), as well as conducting randomized controlled trial studies (RCT), and quasi-experimental design (QED) studies that produce rigorous evidence of the effectiveness and impact of education interventions. The external, independent evaluation consists of two primary components:

(1) Impact on Key Outcomes, including a comparative interrupted time series (CITS) design to produce evidence about the project's effectiveness that meet the What Works Clearinghouse (WWC) Standards with Reservations.

(2) Evaluation of Implementation Fidelity, including a clear articulation of key project components and mediators, and the establishment of a measurable threshold for acceptable implementation.

Impact on Key Outcomes. The overall project addresses the impact of STEM[CS] on the numerous intended outcomes for both teachers (e.g., increased teacher STEM knowledge, practices, implementation and effectiveness) and students (e.g., increased student engagement, increased numbers of students participating in dual-credit STEM courses, etc.) through the on-going collection of benchmark data for established goals and objectives. The independent evaluation conducted by CEPR will supplement the data being gathered by GRREC for benchmarking and formative evaluation, focusing more specifically on providing rigorous evidence of the effectiveness of STEM^{CS} that meets the WWC standards with reservations. The two primary research questions for the impact evaluation are noted below.

RQ1. What is the impact of STEM^{CS} on student academic proficiency in science and mathematics?

RQ2. To what extent, if any, does impact vary by gender, race/ethnicity, and socio-economic status?

These two questions focus directly on student proficiency in mathematics and science as measured by standardized statewide assessments. The Kentucky Performance Rating for Education Progress (K-PREP) tests are criterion-referenced tests consisting of multiple choice, extended response, and short-answer items. Mathematics and science K-PREP are administered in grades 4, 7 and 11. Therefore, grade 7 K-PREP mathematics and science proficiency data will be used for MS students in the study, and grade 11 K-PREP mathematics and science proficiency data will be used for HS students. Given that all the achievement measures are standardized tests, the WWC assumes the outcomes meet all of the WWC outcome standards, providing valid and reliable performance data for the impact evaluation.

Study Design. CEPR will conduct a rigorous study of the impact of STEM^{CS} using a quasi-experimental design (QED) that will meet WWC Standards with Reservations. More specifically, CEPR will compare the science and mathematics proficiency of students in rural HS and MS that are implementing STEM^{CS} with a carefully matched sample of similar rural schools.

Matches will be determined using propensity score-matching techniques, and CEPR will identify four comparison schools for each school in the treatment group. In the event that the propensity score matching does not result in baseline equivalence on predictor variables, propensity weighting will be used to ensure baseline equivalence.

CEPR will use a Comparative Interrupted Time Series (CITS) analyses to examine changes in treatment schools' performance using student-level outcomes, and when STEM^{CS} is implemented in each treatment school. These changes in treatment schools will be statistically compared against observed changes for the carefully matched comparison set of schools. CITS takes advantage of having multiple years of achievement data before and after the implementation of STEM^{CS}. Design replication studies have demonstrated that CITS perform well in replicating impact estimates from randomized controlled trials.[23,24]

Sample. The impact study includes 16 treatment schools and 64 comparison schools. The intervention begins school year 2019-20 for Cohort 1, consisting of 8 HS; and the intervention begins school year 2021-22 for Cohort 2, consisting of 8 MS. The impact study and CITS analyses uses the combined sample of schools from Cohorts 1 and 2.

For Cohort 1, CEPR will use five years of student-level data from 2014-15 through 2018-19 as pre-treatment data and five years of post-treatment data (2019-2020 through 2023-2024). For Cohort 2, CEPR will use five years of student-level data (2016-17 through 2020-21) as pre-treatment data and three years of post-treatment data (2021-22 through 2023-2024).

Analyses and Mediators/Moderators. Using hierarchical linear modeling (HLM), analyses of outcomes will be estimated using three–level models (students at level 1, teachers at level 2, and schools at level 3) that account for students clustered within teachers' classrooms, clustered within schools. Student-level variables to be included as moderators at level 1 include gender, race/ethnicity, and socio-economic status (economically disadvantaged or not-economically disadvantaged). Teacher-level variables to be included as moderators at level 2 include teacher years of experience, and teacher highest degree attained. In addition, to the extent that valid and reliable teacher-level data can be gathered on the impact of STEM^{CS} on teachers' knowledge, skills and practices, these data will also be included as level two mediators. At level 3, moderators and mediators include school background characteristics, school type (i.e., MS versus HS) and school-level implementation fidelity.

Power analyses. Power analyses were conducted using the PowerUp![25] MDES calculator for HLM Interrupted Time-Series Design Studies. Assuming 16 treatment schools and 64 comparison schools at Level 2, and an average of 150 students per school at Level 1, yields a Minimum Detectable Effect Size (MDES) of .18 (.80 power; Type 1 error level of .05; ICC =.05; R2 at level 2 =.55; 5 baseline or pre-treatment data years).

Attrition. CEPR does not anticipate potential bias due to attrition. Given low levels of student mobility in these rural schools, where there is only one MS and one HS per district, the overall attrition for study participants is expected to be minimal (less than 10%); and there is no expectation of differential attrition (less than 1%) given the design of the study and the low likelihood of the intervention affecting attrition. The combination of low overall attrition and low differential attrition places the study in low expected bias, even using the conservative WWC attrition standard.

Evaluation of Implementation Fidelity

RQ3. To what extent is STEM^{CS} implemented with fidelity at the treatment sites?

RQ4. Are variations in program implementation systematically associated with differences in program outcomes?

RQ5. What factors appear to facilitate effective implementation of STEM^{CS} and what are the key barriers that need to be addressed to support future replication?

The evaluation of implementation fidelity will serve several purposes. First, data from RQ3 will be used to assign a fidelity of implementation score based on identified factors related to successful implementation. The level of implementation will be assessed based on the extent to which teachers use STEM^{CS} content and instructional techniques. For RQ4, the fidelity of implementation score will be analyzed to determine the extent to which varying levels of implementation correlate with student proficiency in mathematics and science. Finally, qualitative data will be gathered for RQ5 to identify factors and challenges affecting the successful implementation of the initiative. These findings will help to identify best practices for future replication and scaling of the initiative in other MS and HS.

<u>Implementation fidelity matrix</u>. The logic model for STEM^{CS} articulates key components, mediators and outcomes. During the first year of the study, CEPR will collaborate with GRREC to develop appropriate and systematic measures of implementation fidelity. A fidelity matrix will link key components of the intervention to their indicators, the data source(s), and the indicator scoring system. Threshold values will be defined to determine whether the intervention was implemented with fidelity. School-level implementation fidelity will be analyzed by computing scores for each indicator and developing a fidelity measure for each key component.

<u>Data sources</u>. Data sources for implementation fidelity will include participant surveys administered at all treatment schools, as well as focus groups and follow-up interviews with a subset of teachers and school administrators. In addition to gathering data on implementation fidelity, these data will help to identify factors and challenges affecting the successful implementation of the initiative. In addition, site visits including classroom observations will be conducted to examine the extent to which STEM^{CS} has changed teachers' use and implementation of key STEM practices (a key mediator).

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