Enhancing Teacher Effectiveness in Rural Missouri and Kansas

May 2018

eMINTS
INSPIRED TEACHERS | INSPIRED STUDENTS

eMINTS National Center
University of Missouri
College of Education

Table of Contents

Project Introduction

Rural America plays an important role in the U.S. economy. Agriculture and related industries account for 5.5 percent of the U.S. gross domestic product (Economic Research Service, 2016). Despite their important role, rural communities are suffering. Rural economies have rebounded at a rate far slower than their urban counterparts, with only 1.6 percent growth since 2000 compared to 9.1 percent in cities. Fewer jobs translates to poorer communities. In 2000 one in five rural communities had 20 percent or higher poverty rate; by 2015 it was one in three (National Conference of State Legislatures [NCSL], 2018). Rural schools often lack funding, adequate staffing, and access to professional development (PD) compared to urban and suburban schools (Rosenberg, Christian, & Angus, 2015; Showalter, Klein, & Hartman, 2017).

A 2001 Kansas City Federal Reserve report argues education innovation is a key strategy for bettering the quality of life for rural Americans (Stauber, 2001). Correlations between education and economic outcomes support this. Low educational attainment in rural counties is linked with unemployment, poverty, child poverty, and population drain (ERS, 2017). Of the 467 U.S. counties identified as "low-education," 75 percent are rural (ERS, 2017). Rural schools educate one in five of U.S. students (National Center for Education Statistics [NCES], n.d.a) and represent nearly 28 percent of U.S. schools (NCES, n.d.b) and 53 percent of U.S. school districts (NCES, n.d.c). Rural schools are at the heart of rural communities and are their hope for a place in this modern economy. However, challenges facing rural schools provide significant obstacles in creating environments that prepare students for a changing future. eMINTS develops teachers who improve student achievement and prepare students for the demands of a modern economy.

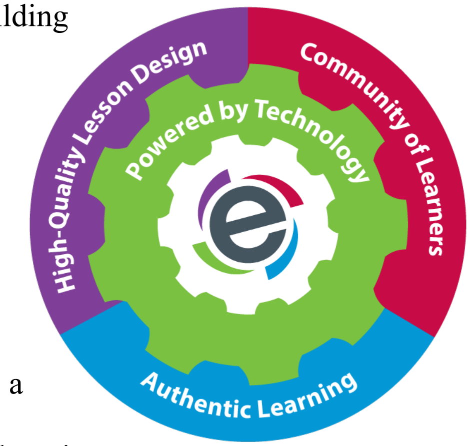
We propose **Innovation in the Heartland: Enhancing Teacher Effectiveness in Rural Missouri and Kansas** to build upon eMINTS' strong history of improving rural teacher effectiveness and student achievement by extending our PD program. We will enhance teacher effectiveness in **58 rural** (designated with locale codes 32, 33, 41, 42, or 43) **middle schools** (a variety of population combinations that incorporate grades 7 and 8). We will reach about **406 teachers and 26,796 students** over the five years of the project.

We address **Absolute Priority 1 - Supporting Effective Teachers** by providing a school-based program of Evidence-Based PD; **Competitive Priority 2 - Promoting STEM Education** by helping teachers integrate authentic engineering design tasks across core subject areas as students solve problems in their rural communities; and **Invitational Priority - Micro-credentialing** using a system of electronic badges for eMINTS district affiliate trainers as they implement effective adult facilitation strategies. Our project will increase academic performance while increasing problem-solving ability, self-regulation skills, and academic and STEM mindset for rural 7th and 8th grade students. The middle school experience largely determines if a student will graduate from high school (Balfanz, 2009) and provides opportunities for exploration and development of the soft skills needed to become college and career ready (Messia, 2017). ACT researchers found the academic level a student reaches by 8th grade is a bigger indicator of college and career readiness than anything that happens in high school (Fleming, 2011).

A. Quality of the Project Design

Exceptional Approach to Priorities

We address Absolute Priority 1: Supporting Effective Teachers by providing eMINTS comprehensive school-based program of **sustained, intense, evidence-based PD** for teachers, district trainers, and principals. The **eMINTS Instructional Model** addresses all aspects of effective instruction required to prepare students for the 21st century. It is based upon constructivist learning theory and contains four pillars: **Authentic Learning** - involving students



in real-world, relevant inquiry; **Community of Learners** - building a positive classroom environment where students feel safe to collaborate with others; **High Quality Lesson Design** - enhancing teacher capacity to design standards-based lessons that engage students in rigorous problems found in their own environments; **Powered by Technology** - using technology as a fundamental tool for high-level and transformative classroom learning.

eMINTS teaching strategies promote the 4Cs: critical thinking, creativity, communication, and collaboration – skills identified as most crucial for employees (American Management Association, 2012). Students work together to ask questions, solve problems, and present solutions. In diverse experiences – such as eighth graders designing and re-creating a destroyed river wetland in collaboration with the state conservation department, and seventh graders creating virtual tours of their communities using Google Earth – eMINTS teachers design lessons that immerse students in real-life scenarios and promote achievement. Teaching is moved from textbook-driven instruction to practices where teachers facilitate rather than lecture and students are active participants in their learning (Freeman et al., 2014; Michael, 2006). Achievement data and formative assessments inform teacher and student decision-making (Fisher & Frey, 2015; Wiliam, 2011). Students gain non-cognitive skills essential for college and career readiness, such as adaptability, self-direction, social skills, productivity, accountability, and leadership (Partnership for 21st Century Schools, 2009; Nagaoka et al., 2013). The approach is grounded in research around what works in problem-based learning (Hung, Jonassen, & Liu, 2008), and leads to increased retention of content (Dochy, Segers, van den Bossche, & Gijbels, 2003), enhanced problem-solving (Hung, et al., 2008), higher-order thinking skills (Shepherd, 1998), increased self-direction and lifelong learning (Chrispeels & Martin,1998). Jeremy King, Educational Technology Coordinator for Baldwin County Schools in Alabama says, “I’ve been an eMINTS trainer for ten years and the manager of the program in our district for six of those years. In all that time I have never seen a program that connects teachers and students in the way eMINTS does. It as a culture transforming program. Teachers come out changed in how they see both instruction and their students. It’s a game changer like no other.”

eMINTS promotes deeper learning. A key component of eMINTS is helping teachers learn to develop high-quality standards-based lessons. Emerging evidence suggests teachers are challenged to provide learning experiences that help students participate in complex, higher-order thinking tasks derived from the Common Core State Standards (CCSS) (Kane & Staiger, 2012). eMINTS encourages teachers to deepen students’ thinking and to have high expectations for student work, an attitude especially critical in high poverty schools where educators sometimes practice the “soft bigotry of low expectations” (Welner & Weitzman, 2005).

eMINTS-trained teachers break down standards into knowledge, understandings and skills that students must know, understand, and implement to successfully master a standard; develop formative assessments “for, as, and of” learning (Earl & Katz, 2006); and design authentic tasks to engage students. Our approach has been successful in a range of settings with a variety of local and state standards (Meyers & Brandt, 2010; Meyers et al., 2015). Instruction is designed addressing the CCSS major shifts for English/language arts (ELA) and math standards that require students to closely read and analyze complex text, back up claims and inferences with data, marshal an argument both in writing and orally, apply mathematics to solve real problems, and focus on conceptual understanding and problem solving. eMINTS is well aligned to the CCSS for technology integration and information literacy. Teachers learn to incorporate these standards into learning where students use 21st century skills in real-life situations.

eMINTS has a strong history of helping schools improve achievement for high-needs students. Since its inception in 1999, annual external evaluations have determined the effects of eMINTS PD on teacher and student outcomes in high needs schools. Qualitative research and formative evaluations have contributed to a better understanding of best practices for school and classroom implementation of eMINTS. Early quasi-experimental studies of eMINTS PD from 2002 - 2005 comparing students in elementary eMINTS classrooms to those in non-eMINTS classrooms consistently showed positive and significant achievement gains in mathematics, language arts and science (OSEDA, 2002; 2003a; 2004, 2005). In these early studies, teachers reported improvements in inquiry-based teaching and technology integration (OSEDA 2001a). Observations showed that after one year of eMINTS implementation, teachers transitioned from teacher-centered models to hybrid or student-centered models (OSEDA, 2001b). A 2004 study demonstrated that eMINTS teachers' instruction became increasingly student-centered and their classroom became increasingly linked to effect behavior management strategies (Tharp, 2004).

Education Development Center (EDC) evaluations in 2006-2009 substantiated these results (Strother, Martin & Dechaume, 2006; Martin, Strogher, Weatherhoff & Dechaum, 2008; Martin, Strother & Reitzes, 2009). With sample sizes of 6,000-7,000 students in 35 to 40 schools, these studies found higher proficiency and advanced levels in all grades (3-6) in ELA and mathematics with significant results at the 0.01 level. In all studies from 2002-2009, for all subjects, the achievement gap between eMINTS and non-eMINTS students by group (special education status, frpl, and race/ethnicity) was statistically significant and grew over time (OSEDA, 2004; Martin, et al, 2008; Strother, et al., 2006). "The fact that the effects were most dramatic among the highest-need students suggests that the kind of environments eMINTS teachers create in their classroom may be particularly effective for these students" (Strother, et al., 2006, p.7).

eMINTS has a track record of specifically improving achievement in the rural context. Our 2010-2015 i^3 grant with 60 high-needs middle schools in rural Missouri found significant changes in teacher practice and student achievement in mathematics on state assessments. Teachers participating in eMINTS PD demonstrated increased skills in the domains of positive community of learners (effect size of .24), inquiry-based learning (effect size of .73), high-quality lesson design (.37), and technology integration (effect size 1.43) compared to non-eMINTS control group teachers (Meyers et al., 2015). Average student achievement differences in mathematics were notable, with effect sizes of 0.13 (eMINTS) standard deviations (Meyers et al., 2015). The program was implemented with a high degree of fidelity for 1,503 rural teachers and 15,036 students. These results meet the Strong Level of Effectiveness required. **The eMINTS Model is one of the few programs for all core subjects in the middle grades with *What Works Clearinghouse* evidence leading to positive impacts on student achievement.**

A current study of 56 rural middle schools and 24,500 students in Alabama, Arkansas, Missouri and Utah adds to our growing body of evidence, showing changes in teacher practice with significant improvements at the $p < 0.001$ level for teacher emotional support (effect size 0.88), classroom organization (0.77), instructional support (0.95), student engagement (0.82) and technology integration (1.22) (Wan, Gerdeman & Swanlund, 2018). The **overlap of both high-needs rural context and middle school student population** between our previous studies and the target population for this project **indicates that similarly significant results are likely**.

These studies have informed our work with high-needs, rural middle schools – positioning us to meet the unique needs of the rural schools in this proposal.

Competitive Preference Priority - Promoting STEM Education. STEM education in rural schools is critical to create a qualified workforce for manufacturing, agriculture and energy jobs emerging in rural America (White House Rural Council, 2011). However, rural schools are challenged to provide quality instruction due to limited funds and shortages of well-trained STEM teachers (Avery, 2013). Additionally, models for implementing STEM in K-12 schools are under-conceptualized (Breiner, Harkness, Johnson & Koehler, 2012) and education does not reflect the interconnectedness of the four STEM areas (Roehrig, Moore, Wang, & Park, 2012). At the same time, teachers across the nation are struggling to navigate new science standards based upon the Next Generation Science Standards (NGSS). Engineering is well-represented in the NGSS but is underrepresented in most school curricula (National Research Council, 2009). The NGSS, written to emphasize STEM literacy for all and aligned to ELA common core standards, call for an interdisciplinary approach to science education (NGSS Lead States, 2013). Kansas and Missouri have adopted science standards based on the NGSS.

The eMINTS Model is well-suited to interdisciplinary and integrated STEM. Effective STEM education engages students in collaborative problem-solving, builds 21st century skills and involves students with their communities (Lesseig, Nelson, Slavit, & Seidel, 2016). Interdisciplinary approaches apply content from two or more disciplines; integrated STEM incorporates two or more aspects of science, technology, engineering and mathematics (Becker & Park, 2011). We will help teachers create interdisciplinary/integrated lessons that use engineering design processes to solve problems identified for the students' rural communities. Pedagogy that integrates mathematics and science has a positive impact on students' attitudes

(Bragow, Grow, & Smith, 1995), motivation to learn (Gutherie, Wigfield, & VonSecker, 2000) and achievement (Hurley, 2001). Rural schools with smaller class and staff sizes are well-positioned to implement these approaches (Showalter, Johnson, Klein, & Hartman; 2017).

We will help teachers build connections between engineering design and core subjects in an interdisciplinary approach. Currently, during eMINTS PD, teachers engage in design tasks, reflect on those experiences, and develop design-based lessons that meet curricular standards. In this project, we will use a flipped approach. Face-to-face sessions will involve all teachers in interdisciplinary lesson development and online sessions will address pedagogical content knowledge. Dr. Johannes Strobel, an expert in K-12 engineering education, will guide the development of online modules for math and science that help teachers integrate the three dimensions of the NGSS: science and engineering practices, disciplinary core ideas, and cross-cutting concepts (Strobel, Wang, Weber & Dyhause, 2013; Jonassen, Strobel & Lee, 2006; Liu, Carr & Strobel, 2009). Online learning for ELA teachers will make learning connections to ELA CCSS inherent to design-based lessons. Social studies online learning will incorporate the idea of place and tying history, geography and government standards to solving local community issues.

Schools will consider their unique situations to implement interdisciplinary approaches. The possibility is open for experiences where all subjects are working together on one problem, supporting the project in each of their subject areas with cross-cutting concepts. Teachers who do not share the same students may choose to integrate in just one or two courses. The goal is for all teachers to implement at least one interdisciplinary design unit in year 1 and two in year 2.

We will take advantage of the strong relationships between rural schools and the communities they serve (Avery, 2013). Many static curricula exist for implementing design, including Engineering is Elementary (Cunningham, 2009), IMaST (Satchwell & Loepp, 2002), and Project Lead the Way (Tai, 2012). In contrast, this project focuses on the design process to identify and solve problems students experience in their own communities (Smith, 2017). Students become citizen scientists and learn to see STEM connections in their lives. The Rural Schools Collaborative promotes the focus on community (place-based education) as an effective learning strategy for rural students (2018). Our approach aligns with Department of Education's *Vision for STEM Education in 2026* that describes student interdisciplinary experiences to solve grand challenges (Tanenbaum, 2016).

Invitational Priority. We use a **system of Micro-credential**s for certification of our district affiliate trainers. Affiliates create electronic portfolios that demonstrate competency of outcomes organized around the four pillars of our eMINTS Facilitation Model: High Quality PD, Collaborating and Networking, Coaching and Mentoring, and Enriching with Technology (See Appendix F.6). One badge per quadrant of the eMINTS Facilitator Model is issued as each participant demonstrates (through reflection and artifacts) that he/she is routinely putting those skills into practice. Trainers may earn additional badges for various accomplishments (e.g., supporting teachers in a variety of ways or winning Top Tech Tool in a "March Madness" Tournament). A final certification badge is awarded when trainers complete the program with a successful portfolio, meet 80% attendance requirement, and deliver eMINTS PD with fidelity.

eMINTS is an exceptional approach to the challenges facing rural schools. The attributes of many rural communities (i.e., isolation, a low tax base, an aging population, and higher poverty levels) contribute to a scarcity of qualified teachers for rural schools (Monk, 2007; Sipple & Brent, 2008). Shortages are especially acute for math, science and technology specializations (Aragon, 2016). The workforce in rural schools tends to be homegrown arising from geographic areas close to schools (Miller, 2012; Fowles, Butler, Cowen, Streams & Toma, 2014). In close-knit rural communities a level of distrust of outsiders can place barriers for new teachers imported from other communities (Owens, Richerson, Murphy, Jageleweski, & Rossi, 2007). **Improvements in teacher quality in rural areas should center around developing the effectiveness of teachers already dedicated to those schools** (Barrett, Cowen, Toma & Troske 2015). Budget shortages often mean that rural teachers receive significantly less professional learning than their urban and suburban counterparts (Wei, Darling-Hammond, & Adamson, 2010).

eMINTS is one of the few programs with data to support the chain of evidence from delivery of a specific technology PD program to changing teacher practice and to positive impacts on student achievement (Martin, Strother, Weatherholt, Dechaume, 2008). Studies of outcomes in eMINTS classrooms show that the program makes a difference: Teachers change practices and students achieve at higher levels. eMINTS has been dedicated to the success of rural teachers since its inception, working with over 300 rural districts. We have modified our program to specifically help rural teachers implement practices aligned with the eMINTS Model.

The nature of rural schools with small class sizes and close communities contributes to their success in educating students. Low-income rural students tend to outperform low-income counterparts in urban settings (Redding & Walberg, 2012). However, rural students are less likely to attend college and when they do, are less likely to choose a 4-year college than urban and suburban students (Buffington, 2017; Mader, 2014). eMINTS builds students' 21st century college- and career-ready skills. We specifically address essential problem-solving ability and noncognitive skills such as persistence, grit and academic mindset. eMINTS develops independent thinkers that can apply and extend knowledge. Most PD programs attempt to improve aspects of effective teaching, such as standards-based lesson design, inquiry-based instruction, collaborative learning structures, and technology integration; few incorporate a comprehensive approach to 21st century skill development to the extent that the eMINTS program does (Meyers, et al., 2015).

Poverty is a large factor in college selection; however, the connection between social-economic status and college attendance is weaker for rural students than their urban/suburban counterparts (Koricich, 2014). The reason may be in large part due to the isolation of rural communities. Rural students are not exposed to a wide variety of career opportunities, including STEM opportunities. Many rural families do not perceive educational attainment as a means of advancement (Provasnik, et al., 2017). By engaging students with real-world STEM content and problems that are relevant to their rural context, this project will increase students' interest in pursuing STEM degrees and careers. Technology will bring the world to rural students. Students in eMINTS classrooms learn to connect virtually with experts in a variety of STEM fields, gaining insights into potential opportunities that other rural students lack. Each classroom will receive virtual meeting software (Zoom) so that University of Missouri science education undergraduate students can connect with rural middle schoolers around STEM problems. MU students will provide a connection to a large university for isolated rural kids. Students see first-hand what it is like to attend a university, that college might be a possibility for them and what skills they need to develop in high school to be ready.

Rural students do not have access to STEM experiences available in urban areas such as museums and afterschool programs (Buffington, 2017). Rural educators also tend not to value some STEM related subjects as highly as educators in urban schools (Showalter, et al., 2017).

Teachers in this project learn to provide students with rich opportunities to engage in challenging math and science problem-solving right in their own backyards. Farms, agricultural industries, forests, and prairies can provide the resources for rich STEM experiences. By using a variety of innovative but inexpensive technologies, rural students can propose solutions to important engineering problems and communicate their thinking to the world.

Project Design Ensures PD is High Quality, Sustained and Intense.

Our project is designed for rural middle schools with three goals: 1) Increase the number of rural teachers using highly effective teaching strategies; 2) Increase academic achievement in mathematics, language arts and science for 7th & 8th grade students in high-needs rural schools; and 3) Implement a multi-level support system for an efficient and effective model of eMINTS.

Fifty-eight rural middle schools have provided letters of intent expressing their need and desire to participate. All schools have no sanctions or are not Level 1 or 2 of School Improvement status and are from rural districts in Missouri and Kansas. Because eMINTS is a school-wide program, all seventh and eighth grade core subject ELA, science, mathematics and/or social studies teachers, including special education teachers, will participate. All principals from each school participate in the administrator program. eMINTS will assist schools in choosing 1-2 district trainers based upon our experience. From award of the grant to May of 2019, project staff time will be spent in implementation planning, randomization, preparing schools for participation and content-specific materials development.

Goal 1. Increase the number of rural teachers using highly effective teaching strategies. eMINTS uses research-based PD that is intense and sustained to move teachers to high quality instruction (Garet, Porter, Desimone, Birman, & Yoon, 2001; Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009). Teacher PD for treatment schools extends from Fall 2019 to Spring 2021 with 40 sessions totaling 140 contact hours involving a combination of face-to-face PD and "flipped" online PD, and 14 in-class coaching visits with their district trainer. Teachers attend about one full day of PD each month from August through May. The online sessions contain pedagogical content-specific materials while the face-to-face sessions apply to all subject areas. Online learning allows for content differentiation and connects isolated rural content area teachers with similar teachers from other schools. Face-to-face sessions allow teachers to collaborate to develop interdisciplinary lessons. District trainers and eMINTS staff will lead a one-day statewide kick-off orientation to build enthusiasm for the project and set expectations.

During PD sessions, teachers actively experience the strategies they will transfer into the classroom, use technology in the context of classroom activities (Rogers & Abell, 2008; Rushton, Lotter, & Singer, 2011), and develop instructional materials (Garet et al., 2001). The PD is centered on technology-infused teaching and learning, rather than on a technology tool (Learning Forward, 2011). Collegial interaction during PD sessions encourages teachers to make sense of their learning, interpret their experiences, and share ideas (Mezirow, 1997; Darling-Hammond et al., 2009) (See Appendix F.3 Project Timeline).

Traditional methods leave teachers to work alone to transfer new learning into their teaching practices; **eMINTS trainers provide in-class mentoring and coaching** to help teachers reflect on their practice and become self-sustaining decision makers (Fletcher & Mullen, 2012). Each teacher will receive at least seven in-class site visits of at least one-hour duration each year. Studies have found combining PD and in-classroom coaching to be effective in changing teacher practice and increasing technology integration into classes (Glazer, Hannafin, Song, 2005; May, 2000; Swan & Dixon, 2006). The International Society for Technology in

Education (ISTE) recognized eMINTS PD as an effective program that successfully uses coaching to improve student outcomes in technology-rich classrooms (Beglau et al., 2011).

Teachers earn eMINTS certification by attending at least 80% of PD hours and successfully completing a reflective portfolio (Tucker, Stronge, &; Gareis, 2013; Oner & Adadan, 2011). Teachers examine their belief systems about how students learn, and record their change and growth throughout the program. They provide sample teaching materials and student artifacts to support their reflections. Teachers present their portfolio to their peers at the end of the year and receive collegial and trainer feedback.

Goal 2. Increase academic achievement in mathematics, ELA and science for 7th & 8th grade students in high-needs rural schools. eMINTS positively affects achievement in these high-needs schools by developing students who are problem solvers, who ask questions, put forth solutions, and defend points of view with arguments supported by complex text and data. Students learn to delve deeply into content, develop their own questions, communicate their thinking, and take responsibility for their learning. For example, students in one class using the eMINTS Instructional Model learned that a young person's lifestyle can put them at risk for heart disease and were inspired to create a heart-healthy school. The teacher helped students turn a complex and somewhat overwhelming problem into one that was achievable. Students worked collaboratively to research the problem, analyze potential solutions, and target the best solution. They created and tested prototypes before presenting and defending their solutions to the school board. Based upon student recommendations, the board chose an active playground design to inform new construction.

Students in eMINTS classrooms use digital tools to organize their thinking, create content for a variety of audiences, and collaborate with others inside and outside their classroom

(Sheng & Fui-Hoon Nah, 2010). They are able to locate and critically examine information. In this study, each student, teacher and district trainer will be given a Chromebook device. Each school will be given additional equipment to promote STEM design projects such as 3D laser cutters, probeware, GoPro cameras, 3D video production, and Google Expeditions.

Students in eMINTS classrooms are also given specific strategies to develop non-cognitive academic skills required for college and career success, such as time management, social skills, self-regulation, and perseverance (Farrington, et al., 2012; Nagaoka et al., 2013). As students work collaboratively to tackle problems they learn to develop action plans that identify tasks and break them down into concrete actions. They must come to consensus, examine their work for flaws and learn to think about failure as an opportunity to improve their solutions.

Goal 3. Implement a tiered support system for an efficient/effective eMINTS Model. We have developed a multi-level support system to ensure success and build district capacity to sustain and grow the program with consistent results. The system includes school-based implementation, district trainers, administrator PD, and an online community. In this project, we will partner with regional professional development centers to extend the eMINTS supports.

eMINTS uses a blended train-the-trainer program to prepare district trainers. We prepare two district trainers at each treatment school and one at each control school. Treatment districts receive two district trainers to reduce risk of attrition. District trainer PD for treatment schools begins in June 2019 with a kick-off event and ends in May 2021 with a celebration event. Training for control schools will begin in June of 2021 after data collection is complete. Training consists of nine days of face-to-face PD (58.5 hours), 12 virtual sessions (36 hours), and monthly support calls. eMINTS staff perform two on-site visits to observe, consult, and collaborate with affiliates. In addition, district trainers complete four virtual coaching and reflection sessions with eMINTS staff using video of themselves facilitating PD sessions or conducting classroom visits. District trainers watch and reflect on their delivery; they meet virtually with eMINTS to engage in reflective conversations. The eMINTS coaching model involves reflection and building of self-efficacy rather than a more consultant-based, evaluative model where teachers are given direct feedback (Knight, 2017).

During PD, trainers develop skills in adult facilitation and coaching. Trainers understand how the Instructional Model works in a classroom and how to facilitate eMINTS PD sessions. Trainers learn to conceptualize and adapt training for their context. District trainer PD is built on the same research-based tenets as teacher PD in which eMINTS trainers model strategies for effective facilitation. Our job-embedded model has been positively rated in feedback surveys. eMINTS staff mentor district trainers as they plan PD sessions together. Trainers deliver sessions with teachers in the next month, then meet back with their eMINTS mentor to reflect on practice. Trainers complete a professional portfolio of artifacts and reflections highlighting how their work meets expected competencies They earn digital badges as outcomes are met. The portfolio, videos, site visits, and a minimum attendance of 80% will determine district trainer certification (See Appendix F.6 Affiliate Program).

Train-the-trainer models have been successful when providing teacher PD for technology integration (Clarke and Dede, 2009; Kanaya, Light and Culp, 2015). Research findings of the eMINTS train-the-trainer program point to strong fidelity outcomes and suggest the potential for student achievement gains regardless of whether affiliate trainers or eMINTS trainers deliver eMINTS PD (Martin et al., 2008). A current study validating our train-the-trainer model is showing preliminary evidence of positive impacts with teachers showing significant changes at the $p < 0.001$ level for teacher emotional support (effect size 0.88), classroom organization (0.77), instructional support (0.95), student engagement (0.82) and technology integration (1.22) with classroom observations (Wan, Gerdeman & Swanlund, 2018).

We leverage existing local infrastructure to support small schools. In our experience the smallest rural schools struggle to identify staff with the time and capacity to become a district trainer. They choose a teacher or principal with many other responsibilities to serve this role. We will train staff members at Missouri and Kansas regional PD centers to support eMINTS affiliate trainers. Regional center staff who are familiar with the schools in the project will support district trainers by helping them plan and deliver PD and in-class visits. They will provide on-site consulting when issues arise and continue to support project schools beyond the grant period.

Administrators learn to lead innovation. School principals are members of the school and building implementation teams; they receive PD, site visits and phone support by eMINTS staff. In the planning year we will meet virtually to plan for technology infrastructure, onboarding of staff, and integration of eMINTS into existing programs. PD includes annual face-to-face meetings, six virtual meetings and annual building walkthroughs with eMINTS staff. We help principals understand how the eMINTS Model shapes teacher practice. Principals learn to lead instructional change, remove barriers to innovation, and connect eMINTS with existing programs. During site visits they learn to conduct classroom walkthroughs (Cervone & Martinez-Miller, 2007; Ginsberg & Murphy, 2002) with look-fors designed around eMINTS competencies (See Appendix F.4 eMINTS Competencies). Principals learn to support teacher growth using coaching conversations. They connect with their peers in other districts to share best practices in face-to-face sessions and an online community of practice.

District Involvement. We work with schools to ensure key groups are represented in all stages of implementation. In April 2019 at a statewide kick-off meeting treatment schools will review implementation and data collection plans. Implementation teams include the building administrator, tech coordinator, district trainer, a teacher, and a project point of contact. Implementation teams participate in a video conference with eMINTS staff three times each year. The team oversees project launch, implementation, and sustainability planning. They create a plan for incorporating the eMINTS Model and professional learning practices into the structure of their school. We will hold an online video conference with control schools to plan for student data collection in April 2019. In April 2021 control schools begin with a statewide kickoff.

Online Community of Practice as support for trainers, teachers and administrators. Our community of practice (CoP) is facilitated through a Google + Community and is designed to: 1) happen naturally, 2) support sociability and participation, 3) attract diverse membership, 4) provide for different roles, 5) use technology, and 6) use a blended approach (Lai, Pratt, Anderson, Stigter, 2006). Three participant roles support the CoP: leadership (eMINTS staff), core members (experienced eMINTS participants) and community members (project participants) (Fontaine 2001). The community facilitates sharing, discussion, and peer support.

eMINTS provides extensive materials and resources. District trainers are provided with facilitator agendas that are editable and flexible, providing options for group size, content and grade level. Free online technology tools for a variety of devices are incorporated. Teachers have access to web-based participant guides. Competencies for eMINTS teachers describe expectations and classroom behaviors for both teachers and students that align with the eMINTS Instructional Model, and are used as a guide for teacher portfolio development.

Collaboration of Partners

eMINTS National Center at the University of Missouri has over 18 years of experience helping teachers combine technological, pedagogical, and content knowledge to improve classroom instruction. In 2005, eMINTS was the first PD program in the world to demonstrate full alignment with ISTE Educator Standards. Edutopia's *Schools that Work* series featured eMINTS Classrooms (George Lucas Foundation, 2012), and we earned recognition as a PD Affiliate of the Partnership for 21st Century Skills in 2009. eMINTS has managed more than $37 million in grants and contracts, including a five-year $12.5 million federal i3 validation grant awarded in 2010 and a second i3 validation award in 2015. We have trained more than 420 affiliate trainers across 10 states and Australia who are certified to train teachers on behalf of the center. Resumes for experienced eMINTS PD staff and leadership can be found in Appendix A.

LEAs: Fifty-eight rural schools in 58 districts have expressed their desire and commitment to the eMINTS program. Letters of commitment are located in Appendix D.

American Institutes for Research (AIR) has 65 years of experience in evaluating education implementations of schools and districts, the U.S. Department of Education, many state education agencies, and private sector nonprofit and for-profit entities. Our past partnership with AIR on a successful i3 validation of our traditional program has been upheld as a model for collaboration between practitioners and researchers (Kaplan, Terry, & Beglau, 2014). Resumes for AIR staff can be found in Appendix A.

University of Missouri Information Science and Learning Technologies Professor: Dr. Johannes Strobel serves as Assistant Director for the project (See Appendix A for resume). Dr. Strobel brings extensive experience in STEM teacher professional learning particularly in the area of engineering design. He will lead the development of STEM pedagogical content materials, math and science resources and lesson examples. Dr. Strobel will supervise MU undergraduate students who will connect virtually with eMINTS classrooms (see p. 11) and assist in designing model STEM lessons.

Regional PD Centers and Rural School Consortia in Missouri and Kansas will support nearby project schools. (See page 17 for more details).

Missouri State University Agency for Teaching, Leading and Learning provides high quality PD and consulting on a wide scope of educational topics for 94 school districts in Southwest Missouri. **Greenbush Southeast Kansas Education Service Center** reaches schools through consortiums of districts offering cooperative purchasing, PD and technical support. **Southwest Plains Regional Service Center** was formed in 1989 to provide consulting and PD for professionals at all levels of education across the state of Kansas. Each of these centers will provide two staff members to attend eMINTS training and support their local schools.

Rural school consortia in Missouri will provide local assistance in understanding the context and cultures of participating districts. They will assist us with logistics as we implement projects and provide avenues for collaboration among schools during and after the project. The **Southern Ozark Alliance for Rural Development (SOAR) consortium** representing 46 rural schools in southern Missouri, and the **Greater Ozarks Cooperating School Districts** representing 56 schools in central and south-central Missouri have signed letters of commitment.

The **Missouri and Kansas Departments of Education** will advocate for the program at a state level. **Kansas City Audio Visual**, one of our match partners, will secure discounts for project technology and provide technical support and training for participating schools. See Appendix D for these letters of support.

Focused on Those with Greatest Need and Addresses the Needs of Rural Schools.

Schools in this project are some of the most poverty-challenged in Kansas and Missouri. We are recruiting high needs schools across Missouri with the highest concentration in the southwest and south-central areas of the state, and in the southeast region of Kansas and the area surrounding Lawrence. We have letters of commitment from 58 schools with rural codes 31, 32, 41, 42 or 43. Eighty-eight percent of these schools qualify for the Small Rural School Achievement Program (SRSA) or the Rural Low-Income Program (RLIP) and 46% are classified as remote. We will continue to recruit schools from September to January in the first grant year with randomization occurring in January and PD beginning in the 2019 – 2020 school year. We will choose from recruited schools those with the highest levels of poverty, poor performance and those that are most remote. Unlike an urban proposal that can target one large high needs district, working with rural schools greatly increases the variability in demographics and needs. One school may have very poor students but achievement in-line with state averages while another school with average achievement may have low educational attainment. (See Appendix F.8 School Data).

With the collapse of the coal industry and Kansas tax policies that have caused a growing economic divide, southeast Kansas has been coined the Appalachia of the Midwest (Swanson & Ehrenfreund, 2017). As rural incomes have failed and child poverty rates reach 23% - 31% in the region (Fox, 2017), tax cuts have led to cuts in education and health care (Solomon, 2017). In 2014, Kansas saw the largest education funding cut in its history. South central Missouri represents some of the poorest counties in Missouri. Schools in our project represent four of the poorest 10 counties in Missouri - Texas #2, Oregon #3, Wright #4 and Shannon #6 (Index Mundi, 2018). Half of the project schools in both Missouri and Kansas reside in counties listed in Kids Counts as at highest risk for students in terms of health, education and poverty (Missouri Kids Count Data Book, 2018) and **67% of students in project schools qualify for free and reduced price lunch.**

eMINTS is an effective approach to improve outcomes for high-needs students. Our research shows that eMINTS is successful in high-needs rural schools and can decrease the achievement gap for Title I and frpl students (see page 5-6). Teachers in our program report that active, student-centered learning integrated with technology provides opportunities for their often marginalized high-needs students to showcase talents that might not be valued in traditional classrooms.

Schools in rural areas are particularly challenged to recruit and retain highly qualified teachers. Teachers in small schools are often challenged to teach multiple grades and/or subject areas, often out of their expertise (Barley, 2009). Eighty percent of schools in this project report it is difficult or extremely difficult (4-5 on a 1-5 Likert scale) for them to recruit high quality science teachers, 79% for mathematics teachers and 55% for teachers overall. The majority (71%) report five or fewer hours of PD around implementing standards and 66% reported five or fewer hours around technology integration for their staff in the past year. With their challenges for recruiting teachers and providing PD, the schools in this study need an intense, sustained program that has the ability to positively affect student outcomes. This project will bring much needed resources to poor rural schools, specifically for investments in technology and intense, effective PD that is currently not available. (**See pages 9-12: eMINTS is an exceptional approach for rural schools.)**

Student Achievement. Over half of all students in these schools achieve at below basic – level 1 or basic – level 2 in 7th and 8th grade language arts, math, and science; as students move from 7th to 8th grade, performance in all tested areas worsens. In math, a content area where eMINTS has shown strongest results, 62% of students are at basic or below at 7th grade and 71.5% are at basic or below in 8th grade.

Table 1: % of students in Below Basic and Basic Achievement Levels in MO and KS

	ELA	Math	Science
7th Grade	51.1	62.2	Not tested
8th Grade	53.6	71.5	57.3

By creating classrooms that implement the eMINTS Instructional Model, this project will increase achievement, technology skills, information literacy and essential noncognitive skills to prepare middle school students to move into high school and begin to think about their futures We will examine impact on student achievement as well as problem-solving ability, academic mindset, and self-regulation. With an emphasis on locally-relevant interdisciplinary design problems, we will increase students' interest and awareness of STEM in their communities and help them discover the potential of STEM careers. Students will develop STEM skills crucial for rural students and rural economies (Carnegie Science Center, 2014). With small class sizes and close-knit communities, rural schools provide many advantages for poor children not found in urban areas. What gains might rural schools and low–income rural students make if they have the advantages given to their wealthier counterparts? Rural students have their "own stories, struggles, and dreams. They should matter to our country." (Showalter, Johnson, Klein, & Hartman, 2017).

These rural schools are seeking eMINTS PD. SOAR consortium members have seen eMINTS in action in two rural schools in their group. They reached out to the eMINTS National Center in 2016 to examine potential impacts of the program and have asked us to partner with them to make this a reality. The Kansas Research and Education Network met with eMINTS leadership in 2017 to discuss establishing a partnership to bring eMINTS to their state. We have

22 letters of commitment from Kansas schools for this project. eMINTS works for rural schools and the rural districts in this study have been waiting for the opportunity to bring the program to their schools.

B. Significance

Magnitude of Results Likely to be Obtained.

Every principal, teacher, and student in eMINTS schools will benefit from this comprehensive and systemic approach to innovation. Principals learn to effectively lead and support school-wide transformation. District trainers work closely with building teachers as mentors and coaches. Teachers in turn create cooperative classroom environments and influence school-wide culture. Project activities and research will directly serve about 58 administrators, 406 teachers, and 26,796 students in 58 rural middle schools during its five-year duration.

We expect eMINTS to change the practice of teachers in this study to those that align with the eMINTS Instructional Model. We expect these practices will lead to increased integration of technology in instruction and positive classroom interactions in the four domains of emotional supports, classroom organization, instructional supports, and student engagement as measured by observation protocol with an effect size of 0.33. Estimated effect sizes are based on a previous study of eMINTS that observed teacher-level effects in the range of 0.24 to 1.55 standard deviations (Meyers et al., 2016). In this project we will further examine the impact of eMINTS on teacher development of integrated design-based lessons.

We expect these changes in teacher practice will result in corresponding student gains in problem solving, ability to self-regulate, increased self-efficacy and academic and STEM mindset as measured by student survey with expected effect sizes of 0.33 and increased student achievement with a minimum detectable effect size of 0.126 in math and language arts, and

0.142 in science. We will add an interdisciplinary science and engineering design focus to our problem-based learning PD to strengthen academic gains and lead to increased awareness and interest in STEM fields. This study serves to inform the practice of integrating engineering across subject areas, especially in rural areas where STEM education has particular challenges.

Contributions to the Field. Researchers have mostly overlooked rural schools (Jimerson, 2005), despite recognition that they face unique struggles to improve student achievement and increase access to high-quality STEM instruction (Redding & Walberg, 2012). This is especially true in comparison to the large body of scholarship focused on urban areas (Lankford. Loeb, & Wykoff, 2002). Advocates and scholars express frustration that ignorance of the rural context has led to federal policies that are biased against rural schools (Walker, 2017). This study will contribute knowledge about how to strategically invest in and support rural school success.

Findings will guide our work with colleges of education. The eMINTS National Center is part of the College of Education at the University of Missouri. Our work is central to the mission of the college and we provide PD to both faculty and pre-service teachers. We work with five additional Missouri universities and colleges that integrate eMINTS into their teacher pre-service curriculum. This project will inform our work with colleges of education, increasing the magnitude of results far beyond the teachers directly affected in this implementation.

Reasonableness of Costs

Our train-the-trainer program substantially reduces implementation costs compared to eMINTS staff training all teachers while increasing district capacity to sustain the project. Technology is used to increase our efficiency. Distance technologies are used to reduce face-to-face PD hours required for district trainers by 50%. We capture video of teachers' PD sessions and use virtual meetings to engage district trainers in reflective conversations.

In 2011, Odden and Picus recommended an annualized PD investment for average schools of $445 per student to achieve a basic level and intensity of PD and coaching (60 hours per year) to change instructional practices and improve student performance. They also recommended an annualized technology and materials investment of $510 per student to provide the infrastructure to support research-based instructional practices (Odden & Picus, 2011). When adjusted for inflation to reflect the value of the dollar in 2018, the total recommended annualized investment for PD and technology increases to $1,060 per student per year.

Costs for this project are well below the total recommended by Odden and Picus. Teachers will receive more than twice the PD hours cited by Odden and Picus, along with instructional coaching. Project costs also provide PD and support for district trainers, administrators and technology coordinators, a feature not included in many PD programs or in Odden and Picus estimates. An estimated per student costs for this project of **$547 per student reflects the total project costs including the randomized control trial study**, a feature that is not part of the Odden and Picus comparison. When cost of the contract with AIR, our evaluation partner is removed, the cost per student is lowered to $472 per student.

Incorporation of Project Purposes and Benefits into Ongoing Work.

Project benefits and activities will be incorporated into the ongoing work of eMINTS with k-12 schools. eMINTS will extend our network of rural district trainers, establishing critical and ongoing partnerships between eMINTS and regional training centers. The lessons learned will guide the replication of eMINTS in similar populations and contexts. This project will strengthen our STEM focus, and result in materials that will be incorporated into the program.

Train-the-trainer program increases school capacity for providing PD. In the past, eMINTS staff delivered PD to one or two isolated teachers. Later, we improved by delivering a school-wide program for core teachers. Today we understand the importance of developing staff who can modify and deliver a school-wide program. Embedded district trainers are best able to adapt eMINTS to integrate with existing programs and meet the needs of their school community. They have established relationships with the teachers they train which aids with buy-in. This is particularly important in rural communities where a distrust of "outsiders" often places barriers to collaboration (Owens, et al., 2014).

At the end of the project, districts will have 1-2 certified eMINTS trainers to sustain the project and provide customized training and support. Trainers become effective instructional leaders, coaches, program designers and facilitators. They support teachers and expand the program beyond the project-funded years. eMINTS teachers and trainers often become school and state leaders who advocate for program expansion. eMINTS will support district trainers after PD is completed via e-mail, phone calls, webinars and online communities of practice.

Building administrators focus on sustainability. We will work with principals and the implementation teams to plan for sustainability. They will create a strategic plan to expand eMINTS training to additional teachers and classrooms, handle teacher turnover and identify synergistic efforts and resources. We will connect leaders with rural principals who creatively fund ongoing initiatives through sources such as re-prioritizing budgets, eRate dollars, state funding sources, and foundations that support connectivity for high needs schools and students.

A partnership with existing state regional training centers will create a local support network. Regional centers in each state have committed to participating in Affiliate Trainer PD to 1) support districts as they expand project activities after grant-funded years, and 2) provide program continuity in cases of Affiliate Trainer attrition. Additionally, by the end of the project, the training centers will be prepared to expand the project into new districts.

Dissemination.

eMINTS research results and practices have been published in professional journals (Meyers, et al., 2016), featured in a book chapter (Kaplan, et al., 2014), and included in an ISTE white paper (Beglau, et al., 2011). We are featured in practitioner journals such as Edutopia (George Lucas Foundation, 2012), the Missouri STEM Coalition publication (Chaffin & Terry, 2015) and the ISTE magazine (Foster, 2018). The MU College of Education will disseminate results. Research results will be submitted to national professional and practitioner journals, and regional and statewide publications. We will target publications dedicated to issues of rural education. The eMINTS website will feature project milestones, results, and best practices, and provide a portal for open access to project materials.

eMINTS staff are regular contributors at both regional and national conferences. We present yearly at the ISTE Conference, and have presented at SEDTA, AERA, AACTE, the National Science Teachers Association STEM Forum Expo and iNACOL. We present annually at the MOREnet and METC technology conferences, and the Missouri Staff Development Council. We will continue presenting at multiple conferences.

The @emintsnc Twitter handle and #emints hashtag are active and informative. eMINTS maintains a Facebook page and group, a LinkedIn site, Google + page and communities, and a Pinterest page. We use social media to promote our projects and disseminate grant findings.

C. Quality of the Management Plan

Specific and Measurable Goals, Objectives and Outcomes.

This eMINTS PD project will accomplish three major goals: 1) Increase the number of teachers using teaching strategies that are highly effective; 2) Increase academic achievement in mathematics, language arts and science for 7th & 8th grade students in high-needs rural schools; and 3) Implement a multiple level system of support for an efficient and effective model of eMINTS. See Appendix F.9 for a detailed table of Goals, Objectives and Outcomes. Our logic model is found in Appendix F.1.

Goal 1 – Increase the number of rural teachers using teaching strategies that are highly effective. (Research Questions: RQ3, RQ4, RQ8)

Goal 1 Outcomes:

- eMINTS teachers will demonstrate increased use of instructional practices aligned to the eMINTS Instructional Model by a statistically significant effect size of .33 standard deviations as measured by teacher surveys and classroom observations.
- Increase in positive classroom interactions by a statistically significant effect size of 0.33 standard deviations as measured by classroom observations.
- Teachers create effective lessons that integrate the three dimensions of NGSS in instruction and assessment as measured by lesson evaluation rubric.
- Teachers create interdisciplinary lessons that integrate science standards and the CCSS as recommended in the NGSS by lesson evaluation rubric.

Goal 1 Objectives

- By July, 2021, 90% of treatment teachers will receive eMINTS certification as measured by attendance records and portfolio scoring.
- By July, 2023, 90% of control teachers will receive eMINTS certification as measured by attendance records and portfolio scoring.

Goal 2 – Increase academic achievement for high-needs seventh and eighth grade students (Research Questions: RQ1, RQ2, RQ6)

Goal 2 Outcomes:

- Students in treatment schools will exhibit higher levels of non-cognitive skills (problem-solving, self-regulated learning, academic mindset and STEM mindset) than control schools indicated by a statistically significant effect size of .33 standard deviations or more using student surveys.
- Students in treatment schools will show higher achievement in math and ELA than control schools on state standardized assessments indicated by a statistically significant effect size of .126 and science with 0.142 or more on state standardized assessments.

Goal 2 Objectives

- By July, 2021, treatment classrooms will use technology to solve problems identified in their communities, organize and analyze information, create products, communicate and collaborate more than control classrooms indicated by a statistically significant effect size difference of 0.33 measured by teacher surveys and classroom observations.

Goal 3 – Implement multiple level system of support for an efficient and effective model of eMINTS that integrates STEM across subjects (Research Questions: RQ5, RQ7 RQ9).

Goal 3 Outcomes

- By 2021, 80% of teachers will rate their school context as supportive or highly supportive for implementation of the eMINTS Instructional Model and STEM integration as measured by teacher surveys.

Goal 3 Objectives

- By July, 2021, 90% of 58 treatment trainers will receive eMINTS certification as measured by attendance records and trainer portfolios.
- By July, 2021, 90% of treatment school implementation teams will have attended 80% of implementation team meetings as measured by attendance records.
- By July, 2023, 90% of 58 control trainers will receive eMINTS certification as measured by attendance records and trainer portfolios.
- By July, 2021, 90% of 29 treatment building administrators will participate in at least 80% of administrator PD as measured by attendance records.
- By July, 2023, 90% of 29 control building administrators will participate at least 80% of administrator PD as measured by attendance records.
- By July, 2023, 90% of control school implementation teams will have attended 80% of implementation team meetings as measured by attendance records.
- By July, 2023, eMINTS staff will complete creation, implementation and refinement of 60 hours of online materials for STEM subject area pedagogical content knowledge training and resources as observed in the online portal.

A Clearly Defined Management Plan to Achieve Objectives

A detailed management plan table and timeline with key activities demonstrating the study's longitudinal nature are in Appendix F.2 and F.3. See the Quality of Evaluation section for an activity timeline. The management plan addresses five sets of key activities: 1) prepare for a successful project study, 2) prepare districts and schools for successful project implementation, 3) implement intervention programs with fidelity, 4) implement a system of internal feedback and continuous revision, and 5) disseminate project information and file timely reports. Each activity lists the major components with begin and end dates and the persons responsible.

From September 2018 to May 2019 we complete seven activities for preparing a successful project study, have the measures and systems in place for collecting project data, and complete seven major activities for preparing participant LEAs and buildings for intervention. The milestones accomplished relate to project instrumentation, site recruitment and preparation, development of online communities and training for baseline data.

From fall 2019 to fall 2021, we will implement the intervention programs with fidelity, collect and analyze data, disseminate project information, and complete reports. Affiliate trainers begin their train-the-trainer intervention in spring 2019 and begin delivering the program to teachers in fall 2019. Both are extensive, two-year programs that will continue through spring 2021. Control group schools continue business as usual.

In Year 3, researchers continue data collection and eMINTS staff continue district supports. eMINTS will improve and codify materials and practices based on formative data collection during the project. We will also collect video and stories of best practices for dissemination. In summer 2021, control schools will begin implementation, finishing teacher PD in May 2023. Final data analysis and reporting occur in Years 4-5, 2021-2023.

Ensuring Feedback and Continuous Improvement.

We use a formal program of internal evaluation and continuous improvement. Our dedication to improving student learning means that we are never satisfied with the status quo. eMINTS program materials and processes are developed using an agile approach with SCRUM project management – implementing short development cycles that focus on continuous improvement. Work is guided by stories created from a users' perspective to ensure we meet the diverse needs of every school. During short working sprints our staff follow a Plan, Do, Review and Revise process. We determine a "Definition of Done" to identify parameters for quality development.

Data to inform decision-making is taken from many sources. eMINTS training staff is in constant contact with our schools. Teachers, trainers and principals are surveyed biannually gathering feedback about PD sessions, staff interactions, and program goals. Yearly focus groups are held with a variety of district stakeholders. The virtual implementation team meetings give us feedback on each district's particular needs. Formative assessments administered during PD sessions also inform decision-making. Our research partner, AIR, will collect formative assessment data in the form of surveys and interviews. Case studies will inform successful approaches and identify local implementation challenges in rural schools.

Using this vast array of feedback, eMINTS staff make ongoing adjustments. We work closely as a cohesive team to develop processes, materials and implement the program. In bi-weekly staff meetings we review data and engage in collaborative decision-making. Twice yearly we meet for several days to review goals and benchmarks and make program revisions. Our grant management team will hold monthly calls – with AIR to plan data collection and review formative data, and with regional development centers to coordinate their work with districts.

D. Quality of the Project Evaluation

AIR will conduct an external formative and summative evaluation. The summative component examines student and teacher outcomes, employing a design that meets WWC standards without reservations. The formative component provides eMINTS with timely performance data and evidence to strengthen implementation and generate a deeper understanding of how the program works in the contexts of rural schools, with an emphasis on

STEM integration and interdisciplinary design-based instruction. AIR is committed to sharing results with the public and will disseminate results through a report, web-based highlights, national conference presentations, and publication in a peer-reviewed journal.

Impact Evaluation

The primary aim of the impact evaluation is to generate evidence on the impacts of the eMINTS PD and supports on student and teacher outcomes, aligned to project goals 1 and 2, in the first year (2019-20) and second year (2020-21) of program implementation (see Table 2).

Table 2. Summary of Impact Evaluation Questions and Data Sources

Research Questions	Data Sources
RQ 1: What is the impact of the eMINTS PD on student achievement?	Kansas and Missouri state assessments in ELA, mathematics, and science for Grade 7 and Grade 8 students (2019-20 and 2020-21)
RQ 2: What is the impact of the eMINTS PD on student mindsets and learning strategies?	Student surveys with measures of academic and STEM mind-set, problem solving, and self-regulated learning (spring 2020 and spring 2021)
RQ 3: What is the impact of the eMINTS PD on the effectiveness of classroom instruction and integration of technology in instruction?	Classroom observations of teachers using CLASS-S and an observation protocol for technology integration (spring 2020 and spring 2021)
RQ 4: What is the impact of the eMINTS PD on teachers' self-reported instructional practices?	Surveys of teachers' instructional practices aligned to the eMINTS model (fall 2019, spring 2020, and spring 2021)

The impact evaluation employs a randomized controlled trial design to produce evidence

about program effectiveness that meets WWC standards without reservations.

The evaluation will focus on 58 rural schools from Kansas and Missouri. Using a cluster randomized controlled trial design, AIR will randomize schools to either receive the eMINTS PD program or conduct business as usual (control condition) during the study years 2019-20 and 2020-21. Control schools will participate in the program after the study years. This design has several advantages: 1) The study will meet **WWC evidence standards without reservations** for student achievement outcomes, and it will produce rigorous impact estimates for other student and teacher outcomes; 2) A school-level design fits the eMINTS program, aimed at improving instruction across core subject teachers in a school; 3) There is a minimal risk of contamination because teachers in control schools will not have access to the eMINTS PD; 4) Teacher attrition during the study period will not result in schools being dropped from analysis.

The impact evaluation uses objective performance measures aligned to the intended outcomes for students and teachers.

The evaluation will examine teacher and student outcomes aligned to the eMINTS logic model, using a set of validated and objective measures.

RQ 1. Student academic achievement will be measured with scores in ELA, mathematics, and science on the Missouri Assessment Program and Kansas Assessment Program standardized tests. The evaluation will use ELA and math scores for Grade 7-8 students and science scores for Grade 8 students. Scores will be standardized within grade, subject, and state.

RQ 2. Students' mindsets and learning strategies will be measured using survey scales drawn from validated and reliable[1] instruments. *Academic mindset* will be measured using a

[1] See supplemental information on reliability of survey scales in Appendix F.10

scale adapted from the Growth Mindset Scale (Blackwell, Trzesniewski, & Dweck, 2007) and the Becoming Effective Learners Survey (Farrington, Levenstein, & Nagaoka, 2013; Farrington et al., 2012). *STEM mindset* will be measured using a scale adapted from the Middle and High School Student Attitudes Toward STEM Survey, with constructs including engagement, confidence, and interests in STEM (Friday Institute for Educational Innovation, 2012). *Approaches to problem solving* will be measured using an unpublished 27-item scale developed by AIR that measures students' openness and approaches to problem solving and opportunities for problem solving in the classroom. *Self-regulated learning* will be measured using the Self-Efficacy for Self-Regulated Learning Scale (Bandura, 1989, 2006).

RQ 3. Teacher instructional practice will be measured using the Classroom Assessment Scoring System Secondary (CLASS-S) (Allen, Pianta, Gregory, Mikami, & Lun, 2011). CLASS-S measures classroom interactions in four domains: emotional supports, classroom organization, instructional supports, and student engagement. The CLASS-S is widely used in research and is predictive of student learning gains in middle school (Gill et al., 2016). Integration of technology in instruction will be measured with an observation protocol developed by AIR for the in-progress evaluation of eMINTS (currently being tested in the field). Observers will conduct in-person classroom observations in treatment and control schools. Observers will be certified on the CLASS-S protocol and will receive training on the technology protocol.

RQ 4. AIR will use validated teacher survey measures of instructional practices aligned to the eMINTS Instructional Model, including high-quality lesson plans, authentic learning, community of learners, and integration of technology (Meyers, Molefe, Brandt, Zhu, & Dhillon, 2016). The survey will complement the observations with teacher self-reported data on intermediate instructional outcomes, using a low-burden data collection mechanism. To align with the eMINTS focus on STEM integration and design-based instruction, AIR will incorporate an additional measure for teacher knowledge and use of design-based learning, adapting from existing survey items such as the Teaching Engineering Self-Efficacy Scale (Yoon, Evans, & Strobel, 2014) and the Teaching Design, Engineering, and Technology Survey (Yasar, Baker, Robinson-Kurpius, Krause, & Roberts, 2006).

The impact evaluation will provide valid and reliable performance data about impacts on student achievement, student learning strategies and mindsets, and teacher instruction.

The evaluation will include 29 treatment and 29 control schools, with an average of seven teachers per school (six core content teachers and one special education teacher). All Grade 7 and Grade 8 students – an estimated average of 25 students per grade per school – will be eligible for inclusion in the analysis. Mathematics and ELA assessments and student survey data will be available for students in Grades 7-8, with an estimated average sample of 50 students per school. Science assessment scores will be available for Grade 8, with an estimated average sample of 25 students per school. Based on empirical estimates for studies in rural schools (see Appendix F.10), this sample will provide an estimated minimum detectable effect size (MDES) for reading and mathematics achievement of 0.129 standard deviations and an MDES of 0.145 standard deviations for science (allowing for 10% school attrition during the study period).

For teacher outcomes, the sample will allow an estimated MDES of 0.33 standard deviations for survey measures and 0.46 standard deviations for observational measures, based on a random subsample of two or three teachers to observe per school (average of 2.5 per school). These estimated effect sizes are generally consistent with recent research reporting an average effect size of 0.49 standard deviations for instruction outcomes in studies of teacher PD (Kraft & Blazar, 2016) and a previous study of eMINTS that observed teacher-level effects in the range of 0.24 to 1.55 standard deviations (Meyers et al., 2016).

AIR will estimate the program impacts, which are defined as differences in mean outcomes between treatment and control group students and teachers, using multilevel modeling to account for nesting of students and teachers within schools. For student achievement, the analyses will estimate the treatment effect for each outcome (ELA, mathematics, and science), overall and by grade level, controlling for student demographics, prior achievement, and school-level characteristics. Achievement from the second year of implementation (2020-21) will serve as the primary summative outcome; achievement in the first year of implementation (2019-20) will provide interim evidence. AIR will use similar analyses to estimate impacts on other outcomes, controlling for available student-level and school-level characteristics (student survey outcome measures) or teacher-level and school-level characteristics (teacher observation and survey outcome measures). See Appendix F. 10 for more information on the analytic model.

Formative Evaluation

The formative evaluation will provide timely feedback (aligned to project goals 1 and 3) about progress and challenges in implementing the PD and Instructional Model in the treatment schools, with an emphasis on STEM integration and design-based instruction.

The evaluation will provide performance feedback and periodic assessment of progress toward achieving intended outcomes.

AIR will incorporate quantitative and qualitative methods to generate evidence about the extent to which participants (affiliate trainers, principals, and teachers) are being prepared as expected and how participants are experiencing and learning through the eMINTS program (Table 3). The findings will help eMINTS learn from successful approaches in rural schools and identify common or localized problems of implementation that may need intervention. AIR will conduct analyses at multiple points in time, provide interim briefs with key findings (including available impact findings), and jointly interpret the evidence with eMINTS to support the continuous improvement processes (see Feedback and Continuous Improvement).

Table 3. Formative Evaluation Questions and Data Sources

Research Questions	Data Sources
RQ 5: To what extent is PD provided for affiliate trainers, principals, and teachers as planned? RQ 6: To what extent are affiliate trainers, principals, and teachers prepared to implement the eMINTS Instructional Model with an integrated approach to STEM? RQ 7: How does implementation fidelity and participant preparedness vary across schools?	eMINTS program records on PD delivery and participation (2019-20 and 2020-21) eMINTS biannual surveys of participating affiliate trainers, principals, and teachers (2019-20 and 2020-21) AIR surveys of treatment teachers (fall 2019, spring 2020, and spring 2021)
RQ 8: How are teachers learning and developing with respect to the eMINTS Instructional Model?	AIR interviews with affiliate trainers, principals, and teachers (spring 2020, 2021) Review of lesson plans (spring 2021)
RQ 9: What key strategies may improve implementation and sustainability of the eMINTS Instructional Model and integrated STEM instruction in rural schools?	School case studies (fall 2021)

Implementation of PD for Affiliate Trainers, Principals, and Teachers

AIR will assess the extent to which the eMINTS PD is implemented as planned, assess participant preparedness for implementing the Instructional Model, and examine how implementation and preparedness vary across schools.

RQ 5. Prior to the first year of implementation, AIR will identify quantifiable implementation indicators for the key PD activities in the logic model and project objectives. Implementation indicators will focus on delivery of and participation in PD for affiliate trainers, principals, and teachers. AIR will work with the eMINTS team to establish predetermined threshold for satisfactory implementation for each indicator, such as 80% participation in PD sessions or timely submission of all virtual coaching and reflection activities for affiliate trainers. This process will help operationalize the logic model and ground the formative evaluation activities in a common understanding of program expectations.

Indicators will be applied at the individual levels (e.g., teacher or affiliate trainer participation in PD sessions) or school levels (e.g., eMINTS staff holding monthly calls) as appropriate, with a score assigned for each indicator based on whether the predetermined thresholds were met. From these indicators, AIR will calculate indices of the level of implementation of PD for teachers, affiliate trainers, and principals for each treatment school in both years of program implementation (fall 2019, spring 2020, fall 2020, spring 2021). The indices will provide evidence of the extent to which expected PD activities are implemented at each school and overall across schools (e.g., see Gerdeman et al., 2017).

RQ 6. AIR will create multicomponent indices for degree of preparation of affiliate trainers, principals, and teacher with respect to the eMINTS Model. The measures will draw from self-reported items on surveys (e.g., competency in the Model, self-efficacy for providing PD to teachers, engagement in the PD) as well as indicators of progress and completion of PD activities. The indices will provide evidence on the extent to which participants have the preparation and competencies to train, support, and implement the eMINTS Instructional Model in their schools, for each year of implementation (calculated in spring 2020 and spring 2021).

RQ 7. Using the indicators and findings from RQs 5 and 6, AIR will employ descriptive statistics and regression methods to quantify how fidelity and participant preparedness vary across the treatment schools and to identify relationships between implementation fidelity and level of participant preparation. The eMINTS PD program is multifaceted by design – involving complementary players, processes, and tools that interact with one another – and can confront a range of local contextual and organizational conditions that may affect implementation. These analyses will help eMINTS identify schools making more and less progress in the program and understand how variation in implementation across schools correlates with teacher and trainer preparedness. The findings will help eMINTS determine potential levers for improvement in implementation and will also inform the selection of sites for more in-depth inquiry (see RQ 9).

Participant Experiences and Learning in the eMINTS Program

RQ 8. AIR will use qualitative methods to generate a deeper understanding of teacher learning and development. AIR will randomly select six treatment schools and interview program participants in these schools, including the principal, an affiliate trainer, and three teachers. In the first year of implementation (spring 2020), protocols will explore how teachers are learning and developing through the eMINTS PD experience as well as how local factors enable or impede uptake. In the second year (spring 2021), the protocols will focus more explicitly on whether and how teachers are incorporating the eMINTS Model, STEM integration, and design-based instruction in practice. To ground this work, AIR will review and code teacher lesson plans and coaching reflections from the affiliate trainers for evidence about practice, with a focus on interdisciplinary design-based lessons. The artifact review will draw from rubrics previously developed to review instructional materials from eMINTS teachers and will employ a tool used to analyze teachers' plans for design-based instruction (Capobianco & Rupp, 2014). AIR will analyze the data for themes about progress and challenges in adopting instructional practices, to inform where and how the program can be improved.

RQ 9. In fall 2021, following the main period of study, AIR will conduct a set of case studies in approximately four original treatment schools that have exhibited particular progress related to interdisciplinary integration of STEM or design-based learning. Case studies allow researchers to study programs in a bounded and integrated context and to generate or challenge hypotheses about the program design or implementation (Stake, 1995). Selection criteria and case study foci will be determined in collaboration with eMINTS, informed by evaluation findings and the perspectives of eMINTS staff. AIR will collect data through site visits and interviews, supplemented by a review of materials about local PD structures and activities. Respondents will include school administrators, technology coordinators, teachers, affiliate trainers and other teacher leaders, and eMINTS staff. The protocols will gather data about promising or successful strategies for teacher learning, support, and PD aligned with the eMINTS Instructional Model. AIR will analyze data using a cross-case approach, exploring common experiences and strategies across schools that may improve implementation and sustainability of the eMINTS Instructional Model in rural schools. Findings will highlight approaches that can be shared or adapted in control schools that begin the program in 2021-22.

References

Aragon, S. (2016). Teacher shortages: What we know. *Teacher Shortage Series*. Education Commission of the States.

Avery, L. M. (2013). Rural science education: Valuing local knowledge. *Theory Into Practice, 52*(1), 28-35.

Balfanz, R. (2009). Putting middle grades students on the graduation path. Policy and practice brief.

Bandura, A. (1989). Perceived self-efficacy in the exercise of personal agency. *The Psychologist: Bulletin of the British Psychological Society, 2,* 411–424.

Bandura, A. (2006). Guide for constructing self-efficacy scales. In F. Pajares & T. Urdan (Eds.). *Self-efficacy beliefs of adolescents,5, 307–337.* Greenwich, CT: Information Age Publishing.

Barley, Z. A. (2009). Preparing teachers for rural appointments: Lessons from the mid-continent. *The Rural Educator, 30*(3).

Barrett, N., Cowen, J., Toma, E., & Troske, S. (2015). Working with what they have: Professional development as a reform strategy in rural schools. *Journal of Research in Rural Education, 30*(10), 1.

Becker, K., & Park, K. (2011). Effects of integrative approaches among science, technology, engineering, and mathematics (STEM) subjects on students' learning: A preliminary meta-analysis. *Journal of STEM Education: Innovations and Research, 12*(5/6), 23.

Beglau, M., Hare, J. C., Foltos, L., Gann, K., Jobe, H., Knight, J., et al. (2011). Technology, coaching, and community: Power partners for improved professional development in primary and secondary education. Washington, DC: International Society for Technology in Education.

Bragow, D., Grow, K.A., & Smith, E. (1995). Back to the future: Toward curriculum integration. *Middle School Journal, 27, 39–46.*

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics, 112*(1), 3-11.

Brown, E. (2015, March 12). In 23 states, richer school districts get more local funding than poorer districts. *The Wall Street Journal.* Retrieved from https://www.washingtonpost.com/news/local/wp/2015/03/12/in-23-states-richer-school-districts-get-more-local-funding-than-poorer-districts/?utm_term=.5ac08f890fd6

Buffington P., (2017, May 3). Closing Stem Opportunity Gaps for Rural Students. Retrieved from http://ltd.edc.org/closing-STEM-education-opportunity-gaps-rural

Carnegie Science Center. (2014). Work to do. Closing the gap in STEM education in improving the Tri-State Area workforce. Retrieved from http://www.carnegiesciencecenter.org/csc_content/stemcenter/pdf/Work_to_Do_The_Role_of_STEM_Education_in_Improving_the_Tri-State_Regions_Workforce.pdf

Cervone, L., & Martinez-Miller, P. (2007, Summer). Classroom walkthroughs as a catalyst for school improvement. *Leadership Compass, 4*(4), 1–4. Retrieved from http://www.naesp.org/resources/2/Leadership_Compass/2007/LC2007v4n4a2.pdf.

Chaffin, Carla & Terry, Christie. (2015). Coding in the classroom – eMINTS enhances educator's abilities to connect*. STEM Connect*. Retrieved from: https://mostemconnection.wordpress.com/2015/01/27/coding-in-the-classroom-emints-enhances-educators-abilities-to-connect/

Chrispeels, J. H. and Martin, K. J. (1998). Becoming problem-solvers: the case of three future administrators. *Journal of School Leadership, 8,* 303–331.

Clarke, J., & Dede, C. (2009). Design for scalability: A case study of the River City curriculum. *Journal of Science Education and Technology, 18*(4), 353-365.

Cunningham, C. M. (2009). Engineering is elementary. *The Bridge, 30*(3), 11-17.

Darling-Hammond, L., Wei, R. C., Andree, A., Richardson, N., & Orphanos, S. (2009). Professional learning in the learning profession. Washington, DC: National Staff Development Council.

Dochy, F., Segers, M., van den Bossche, P., and Gijbels, D. (2003). Effects of problem-based learning: a meta-analysis*. Learning and Instruction*, *13*, 533–568.

Earl, L., & Katz, S. (2006). Rethinking classroom assessment with purpose in mind. Winnipeg, Manitoba: Western Northern Canadian Protocol.

Economic Research Service (2017, October 14). What is agriculture's share of the overall U.S. economy? [chart]. United States Department of Agriculture. Retrieved from https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=58270

Economic Research Service (2016, April). Rural education at a glance, 2017 edition. United States Department of Agriculture. Retrieved from https://www.ers.usda.gov/webdocs/publications/83078/eib-171.pdf?v=42830

Farrington, C. A., Roderick, M., Allensworth, E., Nagaoka, J., Keyes, T. S., Johnson, D.W., & Beechum, N. O. (2012). Teaching adolescents to become learners: The role of noncognitive factors in shaping school performance--A critical literature review. Consortium on Chicago School Research. 1313 East 60th Street, Chicago, IL 60637.

Fisher, D., & Frey, N. (2015). Checking for understanding: Formative assessment techniques for your classroom. ASCD.

Fleming, N. (2011, November 29). Middle schoolers get prepped for college. Retrieved from https://www.edweek.org/ew/articles/2011/11/29/13middle_ep.h31.html

Fletcher, S., & Mullen, C. A. (Eds.). (2012). Sage handbook of mentoring and coaching in education. Sage.

Empowered Learner. 1

Fowles, J., Butler, J. S., Cowen, J. M., Streams, M. E., & Toma, E. F. (2014). Public employee quality in a geographic context a study of rural teachers. *The American Review of Public Administration, 44*, 503- 521.

Fox, M. (2017, November 6). Kids count report shows steady drop in Kansas childhood poverty rate. Retrieved from http://kcur.org/post/kids-count-report-shows-steady-drop-kansas-childhood-poverty-rate#stream/0

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410-8415.

Friday Institute for Educational Innovation. (2012). *Student attitudes toward STEM survey—*

Fontaine, M. (2001). Keeping communities of practice afloat. *Knowledge Management Review, 4*(4), 16-21.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915–945. Retrieved from http://aer.sagepub.com/content/38/4/915.full.pdf.

George Lucas Educational Foundation. July 25, 2012. Investing in professional development for technology and inquiry-based learning. Edutopia: What Works in Education. Retrieved from http://www.edutopia.org/stw-tech-integration-professional-development-video

George Lucas Educational Foundation. September 17, 2015. Instructional Coaching: Seeding District-Wide Innovation. Retrieved from https://www.edutopia.org/practice/instructional-coaching-seeding-district-wide-innovation

Ginsberg, M. B., & Murphy, D. (2002). How walkthroughs open doors. *Educational Leadership*, 34–36.

Glazer, E., Hannafin, M. J., & Song, L. (2005). Promoting technology integration through collaborative apprenticeship. Educational *Technology Research and Development, 53*(4), 57-67.

Guthrie, J. T., Wigfield, A., & VonSecker, C. (2000). Effects of integrated instruction on motivation and strategy use in reading. *Journal of Educational Psychology, 92*(2), 331

Hung, W., Jonassen, D.H. and Liu, R. (2008). "Problem-based learning." *Handbook of research on educational communications and technology, 3*, 485-506.

Hurley, M. M. (2001). Reviewing integrated science and mathematics: The search for evidence and definitions from new perspectives. *School Science and Mathematics, 101*(5), 259-268.

Index Mundi, 2108. Missouri poverty rate by county. Retrieved May 1, 2018, from https://www.indexmundi.com/facts/united-states/quick-facts/missouri/percent-of-people-of-all-ages-in-poverty#chart

Jimerson, L. (2005). "Placism in NCLB—How rural children are left behind." *Equity & Excellence in Education, 38*(3), 211–219. doi:10.1080/10665680591002588

Jonassen, D., Strobel, J., & Lee, C. B. (2006). Everyday problem solving in engineering: Lessons for engineering educators. *Journal of engineering education, 95*(2), 139-151.

Kane, T. J., & Staiger, D. O. (2012). Gathering feedback for teaching: Combining high-quality observations with student surveys and achievement gains. Seattle, WA: Bill and Melinda Gates Foundation. Retrieved from http://www.metproject.org/downloads/MET_Gathering_Feedback_Research_Paper.pdf

Kanaya, T., Light, D., & Culp, K. (2005) Factors influencing outcomes from a technology-focused professional development. program, *Journal of Research on Technology in Education, 37(*3), 313-329.

Kaplan, L. K., Terry, C. E, Beglau, M. B. (2014). The eMINTS professional development program and the journey toward greater program fidelity (pp. 86 - 107). New York, NY: Routledge.

Koricich, A. (2014). The effects of rurality on college access and choice. In AERA annual conference, Philadelphia.

Lai, K. W., Pratt, K., Anderson, M., & Stigter, J. (2006). Literature review and synthesis: Online communities of practice. Ministry of Education, New Zealand. Retrieved March, 4, 2008.

Lankford, H., Loeb, S., & Wyckoff, J. (2002). Teacher sorting and the plight of urban schools: A descriptive analysis. *Educational Evaluation and Policy Analysis, 24*(1), 37–62

Learning Forward. (2011). Standards for professional learning. Dallas, TX: Author.

Lesseig, K., Nelson, T. H., Slavit, D., & Seidel, R. A. (2016). Supporting middle school teachers' implementation of STEM design challenges. School Science and Mathematics, 116(4), 177-188.

Liu, W., Carr, R. L., & Strobel, J. (2009). Extending teacher professional development through an online learning community: A case study. *Journal of Educational Technology Development and Exchange, 2*(1), 7.

Mader J. (2014, October 10). Report: STEM education lacking in rural areas. Retrieved from http://blogs.edweek.org/edweek/rural_education/2014/10/_report_stem_education_lacking_in_rural_areas.html

Martin, W., Strother, S., & Reitzes, T. (2009). eMINTS 2009 Program evaluation Report: An analysis of the persistence of program impact on student achievement. New York: EDC, Center for Children & Technology.

Martin, W., Strother, S., Weatherholt, T., & Dechaume, M. (2008). eMINTS Program Evaluation Report: An Investigation of Program Fidelity and Its Impact on Teacher Mastery and Student Achievement. New York: EDC, Center for Children & Technology.

May, M. K. (2000). Mentoring for technology success. Paper presented at the annual conference of The National Convention of the Association for Educational Communications and Technology, Denver, CO, October.

Mezirow, J. (1997). Transformative learning: Theory to practice. New Directions for Adult and Continuing Education, 1997(74), 5–12.

Messia, R. (2017, March 12). 8 ways middle schools can build college and career readiness. Middleweb. Retrieved from https://www.middleweb.com/34228/ms-8-ways-we-can-build-collegecareer-readiness/

Meyers, C. V., Molefe, A., Brandt, W. C., Zhu, B., & Dhillon, S. (2016). Impact results of the eMINTS professional development validation study. Educational Evaluation and Policy Analysis, 38(3), 455-476.

Meyers, C., Molefe, A, Dhillon, S., & Zhu, B. (2015). The Impact of eMINTS professional development on teacher instruction and student achievement: Year 3 report, Naperville, IL: American Institutes of Research. Retrieved from http://www.emints.org/wp-content/uploads/2015/03/151527_eMINTS_Year3_report_FINAL.pdf

Meyers, C., & Brandt, C. (2015). A summary of external program evaluation findings for the eMINTS (enhancing Missouri's Instructional Networked Teaching Strategies) program from 1999–2015. Naperville, IL: Learning Point Associates. Retrieved from http://www.emints.org/wp-content/uploads/2015/04/eMINTS-Research-Findings-Summary_updated-04.15.2015.pdf

Michael, J. (2006). Where's the evidence that active learning works? *Advances in Physiology Education, 30*(4), 159-167.

Miller, L. (2012). Situating the rural teacher labor market in the broader context: A descriptive analysis of the market dynamics in New York state. *Journal of Research in Rural Education, 27*(13), 1-31. Retrieved from http://jrre.vmhost.psu.edu/wp-content/uploads/2014/02/27-13.pdf

Missouri Kids Count (2018). Missouri kids count data book. Jefferson City, MO. Retrieved fromhttp://mokidscount.org/missouri-kids-count-data-book-release/

Monk, D. (2007). Recruiting and retaining high-quality teachers in rural areas. *The Future of Children, 17*(1), 155–174.

Nagaoka, J., Farrington, C. A., Roderick, M., Allensworth, E., Keyes, T. S., Johnson, D. W., & Beechum, N. O. (2013). Readiness for college: The role of noncognitive factors and context. *Voices in Urban Education, 38*, 45-52.

National Center for Education Statistics (n.d.a) [Table]. Number of public elementary and secondary schools, by urban-centric 12-category locale and state or jurisdiction: 2013–14. Retrieved from https://nces.ed.gov/surveys/ruraled/tables/a.1.a.-2.asp

National Center for Education Statistics (n.d.b) [Table]. Number and percentage distribution of public schools and fall enrollment within school urban-centric 12-category locale, by school size and school level: 2013–14. Retrieved from https://nces.ed.gov/surveys/ruraled/tables/a.1.a.-1.asp

National Center for Education Statistics (n.d.c) [Table]. Number of public school districts, by district urban-centric 12-category locale and state or jurisdiction: 2013–14. Retrieved from https://nces.ed.gov/surveys/ruraled/tables/a.1.a.-1.asp

National Conference of State Legislatures (2018, February). Rural America Still Seeking Recovery.

National Research Council. (2009). Engineering in K-12 education: Understanding the status and improving the prospects. National Academies Press.

NGSS Lead States. 2013. Next Generation Science Standards: For states, by states. Washington, DC: The National Academies Press.

Odden, A., & Picus, L. O. (2011). Improving teaching and learning when budgets are tight. *Phi Delta Kappan, 93*(1), 42-48.

Office of Social and Economic Data Analysis. (2005). Analysis of 2004 MAP Results for eMINTS Students. Columbia, MO: Author.

Office of Social and Economic Data Analysis. (2004). Analysis of 2003 MAP results for eMINTS students. Columbia, MO.

Office of Social and Economic Data Analysis. (2003a). Analysis of 2002 MAP Results for eMINTS Students. Columbia, MO.

Office of Social and Economic Data Analysis. (2002). Analysis of 2001 MAP Results for eMINTS Students. Columbia, MO.

Office of Social and Economic Data Analysis. (2001a). Final Results from the eMINTS Teacher Survey. Columbia, MO.

Office of Social and Economic Data Analysis. (2001b). A General Typology of eMINTS Lessons. Columbia, MO: eMINTS National Center.

Oner, D., & Adadan, E. (2011). Use of web-based portfolios as tools for reflection in preservice teacher education. *Journal of Teacher Education, 62*(5), 477-492.

Owens, J. S., Richerson, L., Murphy, C. E., Jageleweski, A., & Rossi, L. (2007). The parent perspective: Informing the cultural sensitivity of parenting programs in rural communities. *Child and Youth Care Forum, 36*(5-6), 179–194.

Partnership for 21st Century Learning. Framework for 21st Century Learning. Retrieved from http://www.p21.org/our-work/p21-framework.

Provasnik, S., KewalRamani, A., Coleman, M. M., Gilbertson, L., Herring, W., & Xie, Q. (2007). Status of Education in Rural America. NCES 2007-040. National Center for Education Statistics.

Redding, S., & Walberg, H. J. (2012). Promoting Learning in Rural Schools. Academic Development Institute.

Roehrig, G. H., Moore, T. J., Wang, H. H., & Park, M. S. (2012). Is adding the E enough? Investigating the impact of K-12 engineering standards on the implementation of STEM integration. School Science and Mathematics, 112(1), 31-44.

Rogers, M. A., & Abell, S. K. (2008). The design, enactment, and experience of inquiry-based instruction in undergraduate science education: A case study. *Science Education, 92*(4), 591–607.

Rosenberg, L., Christianson, M.D., & Angus, M.H. (2015) Improvement efforts in rural schools: Experiences of nine schools receiving school improvement grants. *Peabody Journal of Education, 90*(2), 194-210.

Rural School Collaborative (2018). Retrieved from: http://ruralschoolscollaborative.org/.

Rushton, G. T., Lotter, C., & Singer, J. (2011). Chemistry teachers' emerging expertise in inquiry teaching: The effect of a professional development model on beliefs and practice. *Journal of Science Teacher Education, 22*(1), 23–52.

Satchwell, R. E., & Loepp, F. L. (2002). Designing and implementing an integrated mathematics, science, and technology curriculum for the middle school. *Journal of Industrial Teacher Education, 39*(3).

Savery, J. R., Duffy, T. M., & Wilson, B. G. (1996). Constructivist learning environments: case studies in instructional design.

Sheng, H., Siau, K., & Nah, F. F. H. (2010). Understanding the values of mobile technology in education: a value-focused thinking approach. *ACM SIGMIS Database: the DATABASE for Advances in Information Systems, 41*(2), 25-44.

Showalter, D., Johnson, J., Klein, R., & Hartman, S. L. (2017). Why rural matters 2015-2016: Understanding the changing landscape. Rural School and Community Trust.

Sipple, J. W., & Brent, B. O. (2008). Challenges and opportunities associated with rural school settings. Handbook of research in education finance and policy, 612-629.

Smith, G. (2017). Place-Based Education. Oxford Research Encyclopedia of Education Retrieved 24 Apr. 2018 from http://education.oxfordre.com/view/10.1093/acrefore/9780190264093.001.0001/acrefore-9780190264093-e-95

Solomon, P., (2017, December 7) Do tax cuts spur growth? What we can learn the Kansas budget crisis. Retrieved from https://www.pbs.org/newshour/show/do-tax-cuts-spur-growth-what-we-can-learn-from-the-kansas-budget-crisis

Stauber, K. N. (2001). Why invest in rural America--and how? A critical public policy question for the 21st century. *Economic Review-Federal Reserve Bank of Kansas City, 86*(2), 57

Strobel, J., Wang, J., Weber, N. R., & Dyehouse, M. (2013). The role of authenticity in design-based learning environments: The case of engineering education. *Computers & Education, 64*, 143-152.

Strother, S., Martin, W., and Dechaume, T. (2006). Analysis of 2006 MAP Results for eMINTS and non-eMINTS Students. New York: EDC, Center for Children & Technology.

Swan, B., & Dixon, J. (2006). The effects of mentor-supported technology professional development on middle school mathematics teachers' attitudes and practice. *Contemporary Issues in Technology and Teacher Education, 6*(1), 67–86.

Swanson, A., & Ehrenfreund, M. (2017, June 14). These are the people who suffered when Kansas' conservative experiment failed. Retrieved from https://www.washingtonpost.com/news/wonk/wp/2017/06/14/these-are-the-people-who-suffered-when-kansas-conservative-experiment-failed/?utm_term=.dd5adb7a9b8d

Tai, Robert H., (2012). An Examination of the Research Literature on Project Lead the Way. Retrieved from: https://www.pltw.org/sites/default/files/PLTW%20DR.TAI%20-%20brochure_pages.pdf.

Tanenbaum, C. (2016, September). STEM 2026: A vision for innovation in STEM education. Office of Innovation and Improvement, US Department of Education, Washington, D.C. Retrieved from http://www.air.org/system/files/downloads/report/STEM-2026-Vision-for-Innovation-September-2016.pdf.

Tharp, S. (2004). Classroom Climate, Instructional Practice and Mentoring Experience in the eMINTS Expansion Classrooms: A Two-Year Study. Columbia, MO: Office of Social and Economic Data Analysis.

Tucker, P., Stronge, J., & Gareis, C. (2013). Handbook on teacher portfolios for evaluation and professional development. Routledge.

Walker, T. (2016, September 12). Who's looking out for rural schools? NEA Today. Retrieved from http://neatoday.org/2017/09/12/whos-looking-out-for-rural-schools/

Wan, Y., Gerdeman, D. & Swanland, A. (2018). Results from year 1 scaling eMINTS project. Unpublished report.

Wei, R. C., Darling-Hammond, L., & Adamson, F. (2010). Professional development in the United States: Trends and challenges. Dallas, TX: National Staff Development Council.

Welner, K. G., & Weitzman, D. Q. (2005). The soft bigotry of low expenditures. Equity & Excellence in Education, 38(3), 242-248.

White House Rural Council. (2011). Feedback from Rural America. Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/whrc_travel.pdf

Wiliam, D. (2011). Embedded formative assessment. Solution Tree Press.