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Significance / Absolute Priorities

Introduction

Knox County Schools (KCS) is located in East Tennessee, where the 526 square miles and estimated 451,324 residents of Knox County, and its county seat, Knoxville, are nestled in the foothills of the Appalachian Mountains. The system is large and diverse with regards to both demographics and location, ranging from inner city to rural. KCS enrolled over 60,000 students in 2017-2018 and is the region's second largest employer with over 8,500 staff in 90+ locations. KCS has large numbers of high-need elementary-aged students (Appendix H-1) and a dedication to providing high quality Science, Technology, Engineering, and Math (STEM) and Computer Science (CS) education (p. 5) including a dedicated STEM Facilitator. As the sole provider of public education in Knox County, KCS has developed and maintains strong working relationships with Industry Partners and has evidence of support (Letters of Support, Appendix C). KCS will act as the lead grantee and will contract with WestEd for evaluation.

KCS and WestEd are familiar with relevant literature and current research and understands issues facing students in Knox County and nationwide. In response, KCS proposes a framework of services (p. 9) alongside rigorous research (p. 20) and has plans to disseminate results to education professionals, policymakers and others (p. 18, p. 23) with the potential to impact education locally and across the United States. Knox County Schools, along with evaluator WestEd (p. 13), has experience with large-scale budgets and programs; a project management plan is in place and the team is capable of implementing the project (p. 14).

Absolute Priorities

KCS students, particularly those with high needs, face challenges and KCS recognizes the need for promoting Science, Technology, Engineering, and Math (STEM) and Computer Science Education. KCS will implement **Think About It: SySTEMatiCally Preparing Students for the Workforce (TAI)**, to leverage STEM, Computer Science, and integrated research (p. 20) through the creation, development, implementation, and scale up of field-initiated innovations to improve knowledge of and interest in STEM education and careers for high-need students. Challenges faced by KCS students are not unique. TAI is backed by rationale (Logic Model, Appendix G) and likely to achieve goals and objectives and improve student outcomes (Appendix, H-6). TAI is scalable and an innovative solution with potential to address challenges engaging students in STEM education and careers both across the nation (p. 2) and locally (p. 4). Five target schools (p. 7) will be initially impacted by TAI which Demonstrates a Rationale (Absolute Priority 1) and impacts high-needs students through Field-Initiated Innovations – Promoting Science, Technology, Engineering, or Math (STEM) Education, With a Particular Focus on Computer Science (Absolute Priority 3). Ten elementary schools will implement TAI during the scale-up phase of funding, impacting 570 students.

National Significance of the Proposed Project

Science, Technology, Engineering, and Math (STEM) education continues to grow in importance across the country, particularly when one examines workplace trends. The current demand for STEM-capable workers surpasses the supply of applicants who have trained for those careers. Some 16 of the 20 occupations with the largest projected growth in the next decade are STEM related. Growth in STEM occupations will accelerate 26%

from 2010-2020 (Carnevale, et al., 2013). Further, according to the U.S. Department of Commerce, STEM occupations are growing at 17%; nearly double other occupational fields, which are growing at 9.8% (Engineering for Kids). Only four of the STEM-related occupations with the largest projected growth require an advanced degree. While the rest require specialized training, typically an Associate's or Bachelor's degree is sufficient (T.A. Lacey & Wright, B., 2009). In 2011, STEM workers were found to earn 26% more than their non-STEM counterparts (Langdon, et al 2011). More currently, STEM occupations average salary (\$87,570) is nearly double the national average wage for non-STEM occupations (\$45,700) (U.S. Bureau of Labor Statistics, 2017).

While the case for STEM education and building interest in STEM fields is obvious, the need for computer science specific education is equally compelling. A 2016 report from Burning Glass found that 7 million U.S. jobs representing 20% of "career track" jobs were in occupations that value coding skills. These included information technology (IT) workers, data analysts, artists and designers, engineers, and scientists. The same report found that half the job openings for programmers were in industries outside of technology, most notably in finance, manufacturing, and healthcare.

Studies indicate that building engagement and interest in STEM earlier is paramount. Research recommends that every effort should be made to introduce children to STEM as soon as they enter elementary school and identifies the "elementary years as the period when students form their interest in STEM identities and careers..." (McMurrer, J.). To further the case for early STEM education, STEM is an active learning procedure, and classrooms who engage in active learning have shown a 6% boost in test scores and a 21 point gain on SAT scores. According to the Frameworks

Institute (Levay, Volmert, & Kendall-Taylor, 2018), “Experts explained that, as people learn STEM, they develop skills that are valuable well beyond the four STEM subjects...(Critical thinking and problem solving) are vital for learning other subjects, such as literacy, carrying out everyday activities, securing and maintaining professional success, and participating in and contributing to civic life.”

Unfortunately, minorities continue to be underrepresented among those pursuing STEM-related degrees, including Computer Science. While women received 55% of U.S. bachelor’s degrees in 2015, they accounted for only 16% of the Computer Science bachelor’s degrees. The statistics on underrepresented minorities tell a similar story: in 2015, underrepresented minorities accounted for just 11% of Computer Science degrees reported (New Student Clearinghouse Research Center, 2016).

Local Significance of Project

The Tennessee Department of Labor and Workforce Development (2014) projected 43,000 STEM-related jobs to be added in the state by 2022, accounting for 11% of total job growth in that period. The report continues that 40% of that job growth arises from the Computer and Mathematical occupational group with Computer occupations, specifically computer systems analysts and computer user support specialists, being the largest share of projected core STEM job openings (Rothwell, J., 2014). Reflecting the aforementioned national trends, the median salary of Tennesseans in STEM occupations (\$62,000) is more than twice the median salary for all occupations (\$31,000).

Project as an Alternative Strategy

Knox County Schools elementary school students, including those with high needs, are currently exposed to widely varying levels of STEM education depending largely upon

which of the 51 KCS elementary schools they attend with additional variance based on classroom placement. KCS maintains a dedicated STEM Facilitator whose role is to increase both access to and efficacy of STEM education across KCS. Recent efforts to achieve these goals include: [STEM Cohort](#) designed to unify K-12 STEM teachers; [Math Partnership](#) as KCS strives to assist elementary math educators be more intentional about incorporating real world STEM into math lessons; [Elementary Support](#) to bring together K-5 STEM teachers to discuss starting, maintaining, and challenges around elementary STEM courses as a Related Arts option; [STEM Collective Newsletter](#) updates the STEM Cohort on available grants, local and regional opportunities for teachers and students, successes and needs throughout the district, evidence-based practices, and resources; [STEM Resources Page](#) utilizes Canvas to share resources and lesson plans for STEM-minded teachers; [Taking Tech into the Classroom](#) deploys technology tools including Cubelets and Spheros into classrooms throughout the district; [STEM Certifications](#) as a way to identify best-in-class STEM programming to serve as a model of high-quality STEM learning throughout the district; and [Community Outreach](#) to include ongoing efforts to engage industry partners in Knox County Schools locations including our elementary schools.

As mentioned, KCS elementary STEM education differs across our 51 K-5 campuses: 8 KCS schools have received STEM Certifications; 5 elementary schools (including 3 Certified STEM schools) offer STEM as a Related Arts option; and 12 teachers in 2017-2018 utilized Taking Tech into the Classroom. As evidenced by these activities, KCS is highly engaged in providing access to STEM education; however, many elementary students are not impacted by these initiatives. A district as large as ours

faces challenges engaging students, particularly those with high needs, in STEM education. Further, Computer Science/Technology education also varies greatly across the district. In 2017-2018, 25 (50%) of elementary schools and 12 (86%) of middle schools offered Technology or exploratory Computer Science courses. KCS high schools consistently offer some form of Computer Science or Technology course; 2,259 high schools students enrolled in these courses including Website Development, Web Page Design Foundations, Networking, Computer Science Foundations, Coding, Computer Applications, and Robotic Programming and Design.

The proposed project is a new strategy for KCS. Funding for TAI will allow KCS to recruit and engage approximately **570 high-needs KCS students** to experience Think About It (TAI) including *STEM Institute: Imagine* in July, *STEM Institute: Create* during KCS Winter Break, two *STEM Challenge Days* over Fall and Spring Breaks (generally October and March), and *STEM Institute: Improve* in June (pg. 9, Appendix H-2). *Industry Partners* have been recruited and will, along with KCS high school student *Mentors*, be engaged to work alongside and connect with students through externships, sharing about STEM education and careers, and a TED Talk Capstone project (p. 11). Our goal is that students would complete all components during the yearlong STEM Institute. It is anticipated that not all students will complete the yearlong commitment and that some students may continue participation for more than one year. Student-level attendance will be tracked and available for evaluation purposes.

Target Population

KCS has identified five schools in which TAI will be implemented beginning with *STEM Institute: Imagine* in July 2019 including Ball Camp Elementary, Belle Morris

Elementary, Cedar Bluff Elementary, Green Magnet Academy, and Sarah Moore Greene Magnet Academy (Appendix H-1). These Knox County schools were chosen intentionally to provide sound and objective knowledge that TAI can be implemented and effective in a variety of school settings with diverse communities and populations. These school choices will allow for student-level matched comparison research (p. 20) and scale-up (p. 12) as we strive to implement *Think About It* on a larger scale and build a knowledge base that can influence practice and policy nationwide.

STEM Institute participation will lead to success. Within the target schools, teachers and administrators will refer diverse, high-need students who will then be recruited to participate. The student identification and recruitment process will continue annually in conjunction with TAI staff and school level personnel to fill available spots. Students will be enrolled beginning with fifth graders for the 2019-2020 year and continuing with third, fourth, and fifth graders annually from 2020 through the end of the funding period (Projected Numbers, Appendix H-5).

Exceptional Approach to Priorities

Research indicates “growing evidence that opportunities to learn STEM outside of school directly affect what is possible inside classrooms, just as what happens in classrooms affects out-of-school learning” (National Research Council, 2015). This National Research Council report further outlines that out-of-school STEM programming has been found to contribute to student interest in and understanding of STEM, connect students with caring adults who serve as role models, and reduce the achievement gap between students from high- and low-income families and concludes with findings that programming should be engaging, responsive, and connecting.

TAI, under the auspices of Knox County Schools with evaluation from WestEd, will serve elementary-aged students, including those with high needs (Appendix H-1), through TAI which is supported by rationale (Logic Model, Appendix G) as outlined in Absolute Priority 1. TAI is purposefully designed to ensure that high-need students have increased access to Science, Technology, Engineering, and Math (STEM) and Computer Science education as outlined in Absolute Priority 3 through involvement with a yearlong STEM Institute outside of typical school days. TAI will include programming for an initial pool of five Knox County School elementary schools (p. 7) before scaling up to 10. It is anticipated that TAI will not only prove an exceptional response to the selected Absolute Priorities in Knoxville, Tennessee, but will also be an appropriate and innovative response to these challenges throughout our state, region, and nation. The project design outlines our approach to attaining our goals, objectives, and outcomes.

Quality of the Project Design and Management Plan

Project Design

Through our mission of Excellence for Every Child, KCS strives to provide and enhance school environments where teachers can teach effectively, *all* students can learn and succeed, and our community can thrive. In an effort to make this vision a reality, Knox County Schools proposes **Think About It: SySTEMatiCally Preparing Students for the Workforce (TAI)** which features components chosen with the primary goal to integrate field-initiated innovations promoting Science, Technology, Engineering and Math education and Computer Science education in an effort to support 3rd – 5th grade KCS students, particularly those with high-needs. TAI includes a yearlong STEM Institute (Graphic, Appendix H-2) comprised of three weeklong STEM Institutes, two

two-day STEM Challenge Days, and the inclusion of Industry Partners and Mentors (p. 11) designed to reach and engage high-needs students attending elementary schools throughout Knox County Schools to increase their access to, and interest in, STEM education and careers. 100 5th grade students from five schools (approximately 20 students per location) across the county will complete STEM Institutes in 2019-2020; 200 3rd - 5th grade students from ten schools, including the initial five locations and five additional sites to be determined, will complete the programming annually thereafter. When possible, schools may combine to provide services in one, instead of two, locations. Students may enroll in programming for more than one year; *570 total students will be impacted*. A feasible timeline and logic model are included (Timeline, Appendix H-3 and Logic Model, Appendix G).

Think About It: SySTEMatiCally Preparing Students for the Workforce

(TAI) curriculum will be developed by highly effective teachers recruited from across the district. These educators will spend an estimated 800 hours in Year 1 creating the STEM Institute curricula for grades 3-5. An additional 100 hours of *Curriculum Development* time has been included within the budget to ensure the ability to perform Continuous Quality Improvement and respond to lessons learned and/or standards changes impacting TAI curriculum in Years 2-5.

Prior to the start of student learning, parents and guardians will be invited to take part in a *Parent Institute (PI)* held approximately one week before the STEM Institute begins each year. PI will be held conveniently in the evening when parents are available and will ensure parents have the opportunity to ask questions and receive information about TAI. TAI staff will engage parents who cannot attend PI individually. Parents will

receive a program timeline and be asked to commit their student to yearlong involvement. TAI STEM Institute dates have been strategically selected to impact times when students are out of school, parents are working, and, particularly for high-needs students, access to prohibitively expensive educational camp options are limited. Through strategic timing alongside the inclusion of full day (8am-4pm) programming and leveraging relationships with partner organizations to provide nutritious food options for students, KCS has removed barriers to high-need student participation.

Students will first take part in *STEM Institute (SI): Imagine*, held annually prior to the start of school beginning in July 2019. During this five day institute held at KCS locations, high-needs students will be introduced to the 4 C's (Critical Thinking, Communication, Collaboration, and Creativity) and STEM habits, complete an introductory level Engineering Design Challenge, participate in two Learning Expeditions, complete an Interest Inventory and be grouped with like minded students, receive an Introduction to TED Talks, and set up Portfolios with an emphasis on STEM Competencies (Appendix H-4).

Two-day *STEM Challenge Days* will be held during Fall and Spring Breaks, generally October and March. During these institutes, students will work with Industry Partners and high school Mentors to design their TED Talk Capstone project. The shortened experiences will also review and build upon the content introduced during the weeklong Institutes.

STEM Institute: Create, held during Knox County Schools' Winter Break, will allow students to complete a one day Externship along with two Learning Expeditions.

Further, students will work on TED Talk Collaborative Creation with Industry Partners along with Industry STEM Challenges.

The students' yearlong involvement will culminate with *STEM Institute: Improve* in June annually. Students will revisit the Introductory Design Challenge and make improvements to their initial project. Additionally, students will work alongside their Industry Partners for TED Talk Collaborative Planning culminating in the TED Talk Capstone project. Finally, students will invite families and friends along with Industry Partners and Mentors for a Portfolio Showcase and STEM Awards for student achievements within *STEM Competencies (SC)*. Classroom teachers will assess TAI student progress using SC (Appendix H-4) to include attendance, tardies, office referrals, grades, behavior, and social skills such as participation, perseverance, creativity, and engagement.

TAI incorporates *Industry Partners (IP)* who have provided Letters of Support (Appendix C) including Cirrus Insight, Harrison's Construction, Knoxville Entrepreneur Center, Right Click Design, Threds, Inc. and URS CH2M Oak Ridge LLC (UCOR). Additional partners will be recruited. Industry Partners will attend a Partner Institute in July, prior to the beginning of the STEM Institute. Further, IP will support and interact with TAI in a myriad of ways including providing student tours in their facilities; allowing students to interview one or more of their STEM and/or CS professionals; provide a guest speaker for students during the STEM Institute; work with Knox County Schools to create a job shadow/internship experience for small groups of students; and/or attend an achievement day during SI: Improve where students show off their learning about the engineering design process and STEM career awareness. IP time will be

tracked; while in-kind estimates are not included within the budget, IP will be invaluable to the success of TAI and their impact will be available for reporting and dissemination.

Mentors will be recruited from Knox County Schools high school STEM programs to work with students during the STEM Institutes. Mentors will work with students, providing another connection to future STEM possibilities for these high-needs students. While Mentors are volunteering, they will receive community service hours towards their graduation requirements and have the opportunity to receive a Technology Stipend towards the technology of their choice (laptop, Chromebook, iPad, etc.).

The integration of grade-level appropriate curriculum plus Mentors and Industry Partners will lead to STEM Institute students completing programming with not only a great understanding of STEM and Computer Science but also with ideas of real-world educational and occupational opportunities. TAI will answer the oft-asked question, “When will I ever use this?” for our high need student participants.

Scale Up

TAI will, upon funding, begin hiring and final planning with implementation beginning in five elementary (K-5) schools (p. 7) in July 2019. Evaluation will allow for performance feedback and scale-up so that TAI will be implemented in at least 10 schools from July 2020 until funding ends. The final make-up of the minimum 10 schools targeted in Year 3-5 will be dependent upon evaluation results gathered during Phase 1 implementation with the initial five schools. This sample size will allow for matched sample comparisons. KCS has set targets for the number of students to reach each year and through the life of the project (Appendix H-5).

Goals, Objectives, and Outcomes

KCS has worked to develop goals, objectives, and outcomes (Appendix H-6) that are specified, measurable, achievable, realistic, and which center around the TAI logic model (Appendix G) and a defined timeline (Appendix H-3). Goals, objectives, and outcomes will be evaluated (p. 20) and results disseminated (p. 18, p. 23) in various local, regional, and national venues and publications as well as in required reporting.

Management Plan

Achieving Objectives On Time and Within Budget

A management system is in place to achieve TAI objectives on time and within budget including defined responsibilities, timelines, and milestones for successful project completion. KCS has a history of strong fiscal management and academic performance, being named one of twelve 2015 Exemplary Districts in TN. Knox County Schools has experience serving students and families. KCS has a history of large-scale project management including a \$471,146,000 FY2018 budget and has dedicated administrative resources (p. 14) that serve as matching resources for TAI. Beyond the named individuals, KCS maintains an array of supports to which TAI will have access including Informational Technology, Finance, and Human Resources.

WestEd conducts research studies using a full range of experimental and quasi-experimental designs to meet the requirements of a particular client, stage of program development, and context of implementation. Often, we start by helping a client develop a logic model that makes more explicit the assumptions about the program and the key variables that need to be in place to produce the desired outcomes. The logic model then guides the design of a research study to understand both the extent and quality of

implementation of the program and the immediate and longer-term outcomes. WestEd has conducted randomized controlled trials (RCTs) funded by IES as well as other federal agencies and foundations. Under the Regional Educational Laboratory West (REL West), six RCTs were completed and published in 2010 to 2012, after thorough review by IES peer reviewers. Three additional RCTs were completed in REL West by 2016, including one that was conducted in under a year, through partnership with local school districts and the Silicon Valley Education Foundation, after several years of refinement of their summer math program, Elevate.

Proposed Project Staff with Defined Responsibilities

KCS and WestEd have experience and identified staff with defined responsibilities (Resumes, Appendix B and Timeline, Appendix H-3).

- KCS: D. Odom, Executive Director Office of Innovation, 20 years experience, 10% for TAI administrative oversight; C. Robison, Innovation Specialist, 13 years experience, 20% for direct supervision of TAI Facilitator; S. Rudder, Director of Research and Evaluation, 10 years experience, 10% for Data Analyst oversight; Dr. L. Denton, Grant Development Manager, 10 years experience with Federal grant programming, evaluation and reporting, 10% for TAI grant management assistance; and B. Fisher, STEM Facilitator, 12 years experience, 20% for coordination and collaboration with TAI. School level personnel such as Administrators and Classroom Teachers will be involved in identifying, referring, and evaluating students for TAI; these staff are not included within the budget.

These KCS staff members are non-grant funded matching resources.

- Dennis Ciancio will serve as Lead Evaluator. Dr. Ciancio is a Senior Research Associate in the Science, Technology, Engineering, & Math (STEM) program at WestEd. Ciancio is a developmental psychologist who specializes in academic interventions for children from at-risk populations and formative assessments in educational contexts. He has written and scientifically evaluated cognitive, academic, and motivational programs, including those targeting foundational cognitive skills, attention and engagement, numeracy and literacy. Ciancio led an independent evaluation of a middle-school math intervention in Knox County Schools and has an excellent working relationship with project partners. As a Principal Investigator (PI), Ciancio has led research grants from the Institute of Education Sciences to develop and evaluate academic interventions for early primary grade students. He has published nationally and internationally on evaluations on the scientific evaluation of educational and instructional curricula and practices. Ciancio has authored formative assessments of reading, numeracy, and vocabulary. He received a MA and PhD in psychology from the University of Notre Dame and an MA in psychology from George Mason University. Dr. Ciancio will lead the evaluation effort and managing the day-to-day operations of the project at 40% FTE.

Additional staff members will be hired to facilitate TAI. Strong hiring practices ensure staff will be well qualified for the positions and, when possible, existing KCS staff will be recruited for timecard (non full-time) positions. Staff will be trained (p. 17) upon hire.

- KCS: TAI Facilitator (TF) (1 FTE) – will be trained, coordinate day-to-day operations of STEM Institutes, Recruit, engage, and collaborate with Industry

Partners, Recruit Mentors, and Work with School-level Personnel to identify and recruit students, Disseminate results, Assist with training staff/volunteers/KCS personnel and others; Institute Leaders (IL) (10 timecard employees in Year 1, 20 in Years 2-5, approximately 180 hours/IL/year) will be trained, certified teachers, provide day-to-day instruction to student participants, and coordinate partner and mentor activities during Institutes; Curriculum Developers (timecard employees, approximately 80 hours Year 1 and 10 hours Years 2-5) will be trained, certified teachers, develop curriculum specifically for STEM Institute; Data Analyst (.1 FTE) – will collaborate with evaluators to provide de-identified student level data, participate in identifying matching students for comparison; School Security Officers (5 timecard employees in Year 1 and 10 in Years 2-5, approximately 171 hours/officer/year) – Off-duty KCS School Security Officers, will provide on-site security services for STEM Institute locations; and TAI Mentors – (approximately 3 students per Institute location) STEM students from KCS high schools will be recruited and trained, serve as Mentors to participants will earn community service credits towards graduation requirements and technology stipend. These TAI staff persons are included within the budget.

KCS (p. 13) and WestEd (p. 13) are capable to effectively and efficiently manage and evaluate TAI. Proposed staff will be carefully vetted using thorough job descriptions (to be developed upon funding) before hire and provided with comprehensive training in selected models to ensure they are competent to implement TAI as planned.

Training and Implementation

The TAI Facilitator (TF) will be recruited and hired immediately upon funding. Training TF on current district STEM work as well as TAI vision is a crucial component of success and will happen during the first months of funding (Timeline, Appendix H-3).

Institute Leaders will be recruited during the spring semester (approx. Jan-Feb annually) for Institutes beginning in the summer. Institute Leaders will participate in one day of paid training prior to Institutes to ensure consistency across the district sites.

Mentors will be recruited from amongst STEM students at KCS high schools and will attend a portion of the training day with Institute Leaders.

School-level Personnel to include administrators and teachers at targeted schools will be trained on TAI as well as engaged in the process of identifying and recruiting students to attend. Further, district wide staff will receive training on best practices and lessons learned throughout the funding period.

Timeline and Milestones

KCS has developed a feasible and appropriate timeline with milestones and responsible parties (Appendix H-3) around project start-up, implementation, evaluation, and scale-up in conjunction with evaluator, WestEd. Staff (p. 13) is in place to work towards meeting milestones set forth and recruit and engage in high-need students into TAI, thereby increasing their access to, and interest in STEM education and careers.

Performance Feedback and Continuous Improvement

KCS, alongside WestEd, is committed to a process of performance feedback and continuous improvement that begins from the inception of the logic model (Appendix G) with recognized needs, through our planned goals and activities to meet determined needs

and the collection of output and outcome data as measures of effectiveness of the project and work accomplished. As initial development and implementation of TAI will lead to gradual scale-up culminating in possible district-wide adoption, performance feedback and continuous improvement are integral to project success. Once collected, output and outcome data will be shared as feedback and utilized for needed modifications with TAI staff. The evaluation team will meet with KCS staff regularly for two-way communication. Further, KCS and WestEd will refine and build upon an existing feedback loop process to ensure parents, staff, partners, and community stakeholders have opportunities for input (see Timeline, Appendix H-3).

Stakeholder input is invaluable to this process. Shortly after each Institute, TAI staff will meet with KCS school level personnel as well as Industry Partners and Mentors when possible for a review of challenges, barriers, and lessons learned. Survey tools will be developed and utilized with Industry Partners and Mentors to track progress. Students and parents will be invited to complete a survey at the culmination of each Institute to provide feedback and input. Additionally, classroom teachers of Institute attendees will provide feedback on student progress beginning with the semester in which students are recruited, before students enter the Institute. These conversations and survey results will inform changes or adjustments for the upcoming Institute.

Dissemination

TAI will be initially implemented in five elementary schools (p. 7) and scaled up to a minimum of ten elementary schools (p. 12) in Knox County, TN. TAI includes thoughtfully chosen goals and objectives (Appendix H-6) and a rigorous research study (p. 20) that will lead to results with implications for educational practice. These results,

as well as the practices which led to them, will be disseminated to a variety of audiences. Semi-annual and final programmatic, along with quarterly financial, reports will be submitted to ensure progress is documented and shared with funders throughout the project.

Planned Scholarly Products

KCS will work alongside WestEd (p. 13) to develop proposals to peer-review journals. Further, both programmatic and evaluation staff will search out opportunities for book chapters that will contribute to the field of knowledge.

Plan for Dissemination to Broader Audiences

TAI and WestEd staff members have identified venues through which summary information from the project can be made available to broad audiences. Funds are included in the project budget to allow for staff travel to disseminate project information and findings to audiences including researchers, practitioners and policymakers.

Education practitioners, administrators and researchers will be presented with information from this project. Best practices and results will be disseminated to administrators and education practitioners at the additional Knox County schools that have not been targeted for TAI through training (Timeline, Appendix H-3) during thrice yearly District Learning Days or six annual Teaching and Learning Days. Additionally, staff will propose presentations and workshops to reach education practitioners and evaluators from neighboring school districts, including other large districts throughout Tennessee such as Shelby County, Metropolitan Nashville, and Hamilton County, as well as districts across the nation. Tennessee is introducing new Science standards in 2018-2019; we anticipate multiple venues where TAI results would be welcomed including

National Conference of Teachers of Mathematics (NCTM) and Tennessee STEM Innovation Network (TSIN) Summit.

Dissemination to practitioners and researchers within the local, regional, statewide, and national educational community as well as policymakers is a priority. Information regarding program design and outcomes will be made available to local and State policymakers on an ongoing basis and all results will be made publically known to any interested parties. It is anticipated that dissemination of project results will continue beyond program funding.

We intend to not only present to audiences but also to publish within nationally recognized publications. We will pursue this and other similar opportunities as they come available during and after the funding cycle.

Independent Project Evaluation

Designed to Meet WWC Evidence Standards With Reservations

WestEd will conduct an independent evaluation of KCS's TAI program over the five project years. The evaluation will examine TAI's impact of the project's activities on the STEM knowledge, interests, and competencies of students in grades 3 to 5. Working collaboratively with KCS during early development, WestEd will actively engage in formative evaluation and providing critical feedback for program development. After the development phase, WestEd will conduct an impact study utilizing a quasi-experimental design (QED) that can receive a rating of *Meets What Works Clearinghouse (WWC) Group Designs Standards with Reservations* – the highest rating for QEDs (U.S. Department of Education, 2014) by creating a comparison group of students using propensity score matching. In addition, WestEd will conduct an implementation study to

measure the implementation of the TAI program and provide context for understanding student impact. The implementation study will provide a rich and contextualized understanding of factors that mediate the program’s ability to affect its targeted outcomes. Through these studies, program stakeholders will better understand the link between TAI implementation and program impact by examining the associations between implementation measures and the outcomes of interest.

Research Questions

The following research questions will drive the evaluation of program impact:

- RQ1.** After participation in TAI, do 3–5th grade students demonstrate greater basic STEM knowledge than a matched sample of peers?
- RQ2.** After participation in TAI, do 3–5th grade students demonstrate greater awareness of, and intent to enter, STEM careers than a matched sample of peers?
- RQ3.** After participation in TAI, do 3–5th grade students demonstrate greater STEM Institute Competencies than a matched sample of peers?

Additionally, the following research questions will be the focus of evaluating program implementation:

- RQ4.** To what extent is TAI implemented with fidelity in participating schools?
- RQ5.** To what extent do various implementation factors (e.g., participation, dosage, fidelity, teacher characteristics) relate to student outcomes?
- RQ5.** To what extent do district and community support factors (e.g., professional development, community involvement, parent involvement) relate to student outcomes?

Formative Evaluation

During the first two years of the evaluation, WestEd will address formative evaluation questions that will help refine and improve KCS's approach (Patton, 2008), such as: What are the strengths and weaknesses of TAI? What types of implementation problems are occurring and how can they be corrected? What do TAI participants want to change about the program? To answer these and other formative questions, WestEd will conduct semi-structured interviews with project staff, teachers and students; will survey teachers, students, and parents; and review project documents. WestEd's findings will be included in short formative reports that will be prepared twice each year.

Evaluation of Impact

WestEd will utilize a QED to study the impact of KCS' TAI program on student outcomes. The study will include the 570 participating students from 10 schools. A comparison sample will be created using the best available matching strategy depending on the data available. While propensity score matching is frequently employed, Euclidean distance matching and Mahalanobis distance matching offer some advantages under certain conditions, such as when the number of treatment units is small (Guo & Fraser, 2010; Stuart, 2010). WestEd will work with KCS' robust data department to determine the best variables and data to include in the matching process.

Baseline equivalency

WestEd will work with KCS on identifying suitable baseline measures (for example, prior year TN Ready scores) to assess equivalency. WestEd will employ hierarchical linear models (HLM) to conduct baseline equivalency testing by comparing mean scores of the treatment and comparison groups prior to the intervention with treatment status as

the sole predictor of the baseline measure. To meet WWC standard with reservations, treatment and comparison groups need to be equivalent, within +/- .25 standard deviations, on baseline measures (i.e., Meets WWC Group Design Standards with Reservations; U.S. Department of Education, 2014). WestEd will calculate effect sizes indexing the differences between the groups using the estimated mean differences from the HLM models divided by the pooled standard deviations.

Impact Analysis

WestEd will use HLM for impact analyses. Intervention effects on student outcomes will be estimated with two-level models, with students nested within schools. Following WWC standards, the analytic sample will include participants from treatment and comparison groups with both pretest and outcome scores. The HLM analyses will determine if the group differences are statistically significant, to what degree by calculating effect sizes (e.g., Hedges' g ; Hedges & Olkin, 1985), and using appropriate multiple comparison corrections (Benjamini & Hochberg, 1995).

Guidance About Strategies Suitable for Replication or Testing

WestEd will share performance feedback through regular memos and reports of ongoing evaluation activities. During the first two project years, formative evaluation activities (described above) will provide critical information for KCS to refine their approach and meet project goals. We will include primary and exploratory outcome survey results in annual reports. The Evaluation team will construct a regular meeting schedule suitable for project goals (e.g., monthly or quarterly) to provide continuous feedback as well as bidirectional sharing of information regarding program implementation.

Collaboration and Dissemination

In addition to regular reporting, collaboration on dissemination activities will inform replication or scale-up activities. WestEd staff are adept at conveying complex evaluation information to a wide array of audiences, including researchers, practitioners, policy makers, and funders. WestEd staff frequently present evaluation and research findings at educational conferences for researchers (e.g., American Educational Research Association conferences), evaluators (e.g., American Evaluation Association conferences), and practitioners (e.g., Association for Science Teacher Education). We also have successfully published about our work in peer-reviewed journals and book chapters. We will work closely with KCS to create opportunities to share program highlights regionally and nationally.

Valid and Reliable Performance Data on Relevant Outcomes

Student Outcomes

Student outcomes will be measured using scale scores from TNReady assessment. TNReady is a state administered standardized test aligned to Tennessee’s college- and career-ready state standards. TNReady is administered at the end of the school year to all students, beginning in third grade. Testing sections for grades 3-5 include ELA, Math, Science, and Social Studies. Scale scores from relevant sections (i.e., Math and Science) will be used to determine STEM knowledge. In addition, KCS proposes to create program specific measures of STEM knowledge and STEM Institute Competencies. TNReady, STEM knowledge, and STEM Institute Competency data will be provided to the evaluation team by KCS’ data team.

Student awareness of and interest in STEM careers will be measured using a student survey developed for this project. WestEd has an established track-record surveying students' interest in STEM. Members of the evaluation team, including the lead evaluator have played vital roles in WestEd's Study of Qualified Students Applying to Selective STEM-Specialty Schools, a 5-year project supported by the National Science Foundation. We will build project specific student and teacher surveys incorporating lessons learned from prior work.

Key Program Components, Mediators, Outcomes, and Implementation Thresholds

Implementation Fidelity

Evaluation of the TAI program's fidelity will examine the extent to which various program component activities are delivered as designed. WestEd will develop a fidelity of implementation matrix for each of the programs based on its working program logic model (Century, Rudnick, and Freeman, 2010). A fidelity of implementation matrix specifies key components of the program, indicators for each key component, the operational definition of each indicator, data source for each indicator, and the criteria to determine the implementation scores of each indicator and each key component. Fidelity data will be collected via regular observations conducted by the evaluation team.

Evaluation of implementation fidelity will focus on types of variation across implementation settings. WestEd will use implementation thresholds and survey data on program features in correlational and mediational analyses seeking to identify relationships of program implementation and program features with the outcomes of interest.