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2013 Investing in Innovation Fund: Development Full Application

INSPIRE: Infusing Innovative STEM Practices Into Rigorous Education

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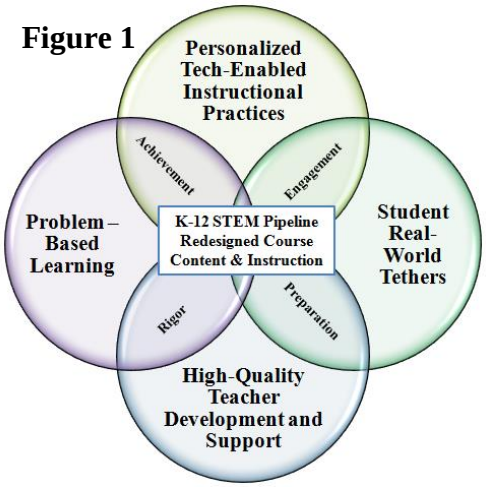
A. SIGNIFICANCE

(1) Project as a novel approach as compared with what has been attempted nationally.

Our proposed i3 project, *INSPIRE, Infusing Innovative STEM Practices Into Rigorous Education*, addresses ***Absolute Priority 3: Improving STEM Education: Subpart (a) Redesigning STEM course content and instructional practices to engage students and increase student achievement.*** *INSPIRE* was designed to advance our model from a promising strong theory to an evidence-based practice through the development and validation of an innovative approach to significantly improve STEM education, student engagement, and achievement. The National Research Council (2011) suggests there is no single pipeline in STEM education and identifying effective course content and instructional practices that are most successful in the STEM disciplines is challenging. Many STEM programs take a silo approach rather than a continuous K-12 focus; however, research shows that early exposure is essential as interest in STEM often begins to flourish in elementary school and influences future career plans (Tai, Liu, Maltese, & Fan, 2006). If students are not engaged in rigorous math and science coursework by 7th grade, they will be ill-equipped for STEM studies in college (Espinosa, 2010). To prepare for college and future STEM careers, students must be capable of thinking across disciplinary boundaries in a real-world context (Asghar, Ellington, Rice, Johnson, & Prime, 2012). While there is a growing body of STEM content knowledge and academic standards, educators are faced with the pressure to cover more material "in a curricular space that has not grown commensurately" (Brown, Lawless, & Boyer, 2013, p. 69). Further, research on STEM inclusive schools often compares students who self-select into such schools with students in non-STEM comparison schools whose motivation for STEM is largely unknown, increasing the likelihood that the results are confounded by selection bias (National Research Council, 2011). To address these widely shared challenges, schools need to transition from addressing each STEM course as a silo to a framework that crosses these boundaries and engages in pedagogical practices that

reflect interdisciplinary, problem-based work. Rather than piecemeal STEM education or a sequence of STEM courses as has been done previously, our proposed project addresses the national need to develop an integrated K-12 STEM pipeline providing a unique opportunity to offer effective solutions and serve as a model for STEM course content and instructional redesign through an integrated approach (Figure 1). Using problem-based learning (PBL) as the core of our curriculum redesign, *INSPIRE* is novel as the approach addresses limitations in STEM education by: 1) providing early, continuous engagement via a STEM pipeline starting in Kindergarten and channeling students into integrated STEM magnet programs at both middle and high school levels; 2) reducing selection bias and student interest factors by intentionally and automatically placing low-income, minority students in elementary STEM magnet schools located in their neighborhood; 3) linking PBL with interdisciplinary STEM course content connected to the Common Core; 4) integrating PBL units across all courses to enable students to explore the same issue in every subject with student real-world tethers (connections beyond the classroom); 5) connecting PBL and digital course content to personalized and tech-enabled instructional practice to impact achievement and engagement; and 6) revolutionizing the teacher role from transmitter to a facilitator of knowledge via substantive transformations in the way curricula, pedagogy, and assessments are conceptualized and implemented (Asghar et al., 2012).

Figure 1



(2) Contribution of project to advancement of theory, knowledge, and practices.

The *INSPIRE* model will be tested and evaluated in Cabarrus County Schools (CCS), which is among the largest school systems in North Carolina, serving nearly 30,000 students in 39 schools. CCS has a history of implementing large initiatives with measurable gains in student outcomes (see Appendix C). The development of our initial K-9 continuum began with the design of a complete STEM magnet elementary school so that every student in the school's

attendance zone was reached. This school holds a Title I status and serves our most ethnically diverse students, traditionally underrepresented in STEM (55% Hispanic or Black) making it an ideal environment to reach underserved students (Public Schools of NC, 2010-2011). These students can automatically continue in our middle and high school STEM magnet schools as long as they score proficient on NC End of Grade tests in Math and Reading. Evidence shows that gaps in academic achievement among low-income and minority students grow as children age (National Science Board, 2010). By beginning STEM engagement at the elementary school and continuing through high school, we will provide students with a solid foundation and ongoing support for STEM learning. Our model is built on existing international and national theory and practice with key *examples* from peer-reviewed journals and research included in Table 1 (see Appendix J for research citations and Appendix D for evidence standards).

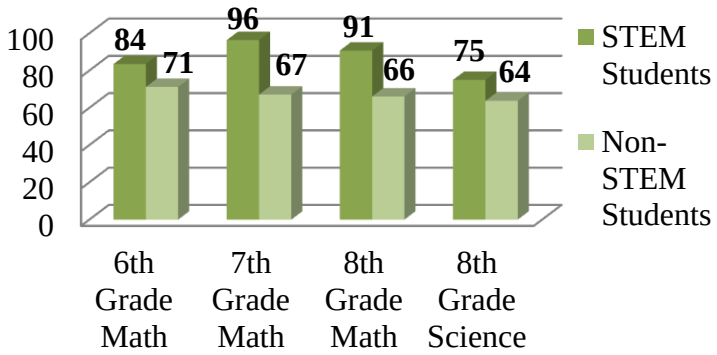
Table 1. *INSPIRE* Strategies Reflect Existing Theory and Practices	
K-12 STEM Pipeline	• Empirical studies of integrative approaches to STEM learning have found positive effects of integration on achievement; meta-analysis of 28 such studies on integration of combinations of two to four STEM subjects showed a large (between .5 and .8) or very large (>.8) effect size for 10 of the studies (Becker & Park, 2011). • Students in "inclusive" STEM schools in Texas score higher on state math and science tests, have fewer absences, and take more advanced courses than students in comparison schools in a quasi-experimental design (QED) (National Research Council, 2011). • PBL in STEM education shows promise as an organizing framework for K-12 initiatives as essential learning experiences in STEM are similar to underlying PBL principles (Asghar et al., 2012). • When science inquiry is experienced at multiple grade levels, project-based units have an independent and cumulative effect on distal student achievement scores; repeated experiences with standards-based instruction sustained by highly specified and developed curriculum leads to further learning gains (Geier, et al., 2008).
Learning Theory	• PBL is grounded in learning theories which include situated learning, constructivism, information processing, metacognition, self-directed learning, and cooperative learning (Kwan, 2009). • Inquiry-based pedagogy is theoretically rooted in constructivism and in the developmental learning theories of John Dewey and Jean Piaget (Memory, Yoder, Bolinger, & Wilson, 2004).

Student Achievement	• Examining the impact of a summer training institute and use of 5 PBL curriculum modules (7,000 12th grade students, 76 teachers, 66 schools), a federally funded, randomized control trial approved by What Works Clearinghouse in high school economics found evidence for the efficacy of PBL through student performance, problem-solving and teacher satisfaction (Finkelstein, Hanson, Huang, Hirschman, & Huang, 2010). • Compared to traditional instruction, PBL raises long-term retention of content, helps students perform as well or better than traditional learners in high-stakes tests, and improves problem-solving and attitudes towards learning (Strobel & van Barneveld, 2009; Walker & Leary, 2009). • Research finds that PBL students show positive results for retention of content, problem-solving skills, higher order thinking, self-directed learning, and confidence (Hung, Jonassen, & Liu, 2008). • Taiwanese high school seniors engaging in STEM PBL activities showed better performance and attitudes on STEM subjects compared to a control group with traditional instruction (Lou, Shih, Diez, & Tseng, 2011). • High school biology students in Turkey that experienced PBL instruction showed stronger intrinsic goal orientation, task value, use of elaboration learning strategies, critical thinking, and metacognitive self-regulation compared with control-group students (Sungur & Tekkaya, 2006).
Student and Minority Engagement	• A QED of predominately Hispanic and African-American elementary students showed the PBL group had higher growth in content knowledge, problem-solving strategies, and collateral learning (Drake & Long, 2009). • Evidence from a QED shows that PBL was more effective than a traditional style with students of average or low verbal ability and those who were most and least confident in their ability to solve problems (Mergendoller, Maxwell, & Bellisimo, 2006). • Findings reveal that PBL has been implemented effectively in a wide variety of schools (urban, suburban, and rural) and student populations (e.g., gifted, average, low income) (Hung, et al., 2008). • A study looking at the relationship between problem quality and student group functioning in a PBL environment found that problem quality directly affected group functioning, which contributed to positive effects on student achievement (Van Berkel & Dolmans, 2006). • Learning is more motivating and engaging for students in PBL classrooms; the PBL environment attracts reluctant learners by bringing out more observable academic behaviors such as active research, making comparisons, and drawing inferences (Gallagher & Gallagher, 2013).
Personalized Learning and Technology Integration	• Meaningful technology integration with curriculum enables students to investigate deeper into the content-area, spend more engaged time on task, and progress beyond knowledge and comprehension to application and analysis of information (Brown, et al., 2013).

	• 1:1 tablet use increases student engagement, enables collaborative learning, allows productivity and efficiency, and improves technology competency (Bayer Corporation, 2010). • A PBL environment that combines online, virtual activities with face-to-face instruction shows a positive impact on the science interest and self-efficacy of middle-grade students (Brown, et al., 2013).
Professional Development and Coaching	• A multifaceted scaling reform in urban middle schools focused on project-based inquiry science units supported by aligned professional development and learning technologies found improvements in science content understanding and process skills compared to peers, lowering the achievement gap between urban African-American boys and their peers (Geier, et al., 2008).

The model is also built on the preliminary results highlighted in Figure 2 from our own K-9 implementation experiences and promising practices (Discovery Education, 2012-13). STEM students who are prepared in elementary school and along the continuum score significantly higher than non-STEM students in our district using benchmark data. We also continue to improve the rate at which students are remaining in the pipeline from elementary to middle school, and we now have a waiting list for the high school program, showing increased student engagement. Through *INSPIRE,* we will study the effects of an integrated K-12 STEM pipeline that will be tested over four years through a target population of 2,200 students at four schools. Our first study will examine the impact of STEM on elementary school students through a longitudinal *quasi-experimental design*. Our second and third studies will examine the impact of our integrated STEM practices on middle and high school students through *randomized control trials* (see Quality of the Project Evaluation). The set of findings from these studies will provide data to advance theory, knowledge, and practice and serve as an exemplar in STEM education by contributing the following: 1) Evidence of the

Figure 2. Students Scoring Proficient on Benchmarks in 2012



impact a district has when STEM curriculum and instructional redesign are made a key priority starting with the dramatic expansion of STEM at the elementary level and providing the opportunity to continue through high school; 2) Validation of findings in relation to a broader range of students by reducing selection bias and student interest factors by intentionally and automatically placing low-income, minority students in a STEM magnet school; 3) Refined and tested PBL K-12 curriculum units and digital content to support the redesign of STEM course content integrated across all subjects with a defined design process for other districts to develop units based on their needs; 4) Collection of teacher development trainings, curriculum design modules, and student real-world tethers to support practice; 5) Sustainable teacher development approach to address pedagogical and content knowledge development as well as the effect of larger systemic factors on practice (Asghar, et al., 2012); 6) STEM Attribute Implementation Rubric in collaboration with the NC Department of Public Instruction for LEAs across the nation to evaluate STEM course content and instructional strategies at each stage of development; 7) Evidence of the effectiveness of a K-12 pipeline on student achievement and engagement paving the way for replication via dissemination through NC STEM Network, VIF and World View; and 8) Data on the characteristics of integrated STEM curriculum and instructional practices associated with positive student engagement/achievement and college or career pursuits via the development of a longitudinal student tracking mechanism to assist in replication.

(3) Project will substantially improve on outcomes achieved by other practices.

The project will substantially improve upon outcomes achieved by other practices in STEM course content and instructional methods through an integrated K-12 STEM pipeline. The studies highlighted in Table 1 have revealed promising findings. However, we propose that *INSPIRE* will produce better student outcomes and accelerated results based on the following factors: **1) Integrative Approach:** Research shows positive results in each of our individual proposed four core areas: problem-based learning, personalized, tech-enabled instructional practices, teacher development, and student real-world tethers. However, we hypothesize that the integration of

these will substantially improve student outcomes. **2) Additive Impact:** These integrated components interfaced with a K-12 continuum provide an additive impact that we predict will help accelerate student growth. Further, we expect that repeated experiences with standards-based instruction sustained by highly specified and developed PBL curriculum units in STEM across courses and grade levels will lead to further learning gains (Geier, et al., 2008). **3) High-Need Students:** Studies reveal that 44% of low-income students who are high achieving in 1st grade are no longer in this status by 5th grade (Wyner, Bridgeland, & Dijulio, 2007). Similar findings also reveal this trend in elementary and middle schools with a decrease in the number of high achievers in low-income groups over five years (Theaker, Xiang, Dahlin, Cronin, & Durant, 2011). Scholars suggest low-income, potential high achievers experience curriculum that is fact oriented, simplistic, closely aligned to accountability tests, and lacks challenge (Gallagher & Gallagher, 2013). Our project improves on these student outcomes and will accelerate results by starting with Kindergarten students at a Title I STEM school serving ethnically diverse students, traditionally underrepresented in STEM. **4) Improvements in Program Limitations:** In addition to these approaches, *INSPIRE* will improve upon outcome limitations noted in Table 2.

Table 2. *INSPIRE* Improvement on Outcomes in STEM Education

Program and Research Limitations	***INSPIRE* Improvements**
Limited number of QED, RCT, and correlational studies that examine STEM subjects and PBL	Three impact studies to examine the effects on elementary (QED) and middle and high school students (RCT)
Most research on PBL instruction focused on other subjects besides STEM and only one grade (e.g., medical, macroeconomics)	Examination of the link between PBL instruction and STEM courses across the K-12 continuum
Professional development activities in PBL are mostly limited to a few day trainings or institutes	Intensive, sustained teacher development approach via trainings, professional learning communities, on-site STEM coaches
Teacher development in content areas has traditionally been highly discipline specific (Asghar, et al., 2012)	Transform teacher preparation from discipline specific to an interdisciplinary approach to learning using common PBL curriculum
Students engage in PBL units for one subject lacking integration with other classes	Integration and student study of each PBL unit across all subjects at the same time
Limited research on younger learner characteristics and PBL (Hung, et al., 2008)	QED study of elementary students in 2 STEM inclusive schools starting in Kindergarten

Student learning is examined on time-limited PBL curricula unit(s) of a few days or weeks	Additive impact of multiple STEM curricula units to help students form deeper knowledge and analysis skills (Mergendoller, et al., 2006)
Limited context of PBL use with individual teachers or classes (Ravitz, 2009)	Part of larger school wide reform on a K-12 continuum
Technology use in instruction replicates traditional curriculum (Brown, et al., 2013)	Use of technology to transform course content and classroom pedagogy (Brown, et al., 2013)

INSPIRE provides the unique opportunity to advance practice and improve upon these outcomes through the following strategies on a K-12 continuum: 1) High-quality PBL curriculum units to support STEM course content connected across all subjects; 2) STEM instructional practices that connect PBL and digital content to tech-enabled personalized learning strategies; 3) A sustained teacher development approach to support STEM curricula and instructional practices; and 4) Connection of real-world student tethers to STEM course content and instructional practices. If successful, *INSPIRE* will advance STEM student achievement, engagement, preparation, and rigor to help meet a growing national demand for workers in STEM careers. A recent national report on student interest in STEM and job outlooks revealed a variety of findings (Munce & Fraser, 2013): The US STEM workforce surpassed 7.4 million workers in 2012 and is projected to increase to 8.64 million by 2018. Science and engineering jobs are predicted to grow at more than double the rate (20%) of the overall US labor force (10%). Unfortunately, while nearly 28% or 1 million high school freshman declare interest in a STEM field, over 57% will lose interest by the time they graduate and African-American interest in STEM careers has dropped nearly 30% since 2000. Companies across the nation continue to demand workers with specialized skills for STEM jobs, many of which require degrees in STEM fields, yet many of these jobs are unfilled because workers lack the necessary degrees. If just 80% of the expected 600 students participating in the high school STEM magnet pursue a STEM career, *INSPIRE* will have a significant socio-economic impact statewide. At an estimated average cost per student per year of just $340, *INSPIRE* offers a cost-effective and lasting investment in future STEM workers. If successful, *INSPIRE's* impact can be scaled up nationally to meet these critical economic needs.

B. QUALITY OF THE PROJECT DESIGN

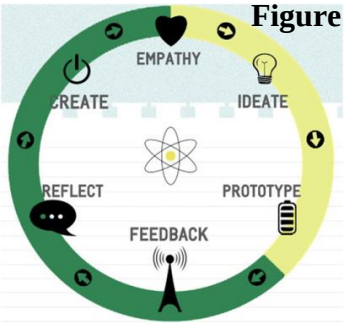
(1) Project addressed the absolute priority the applicant is seeking to meet.

Our project will address ***Absolute Priority 3: Improving STEM Education: Subpart (a) Redesigning STEM course content and instructional practices to engage students and increase student achievement*** by redesigning STEM course content and instructional practices on a K-12 pipeline. We will test our redesign model at four CCS schools: Coltrane-Webb Elementary (full STEM magnet, Title I school), Patriots Elementary (full STEM magnet), J.N. Fries Middle (STEM magnet), and Central Cabarrus High (STEM magnet in 9th grade with other grades added as students move through the pipeline). As students progress through the STEM continuum, we will serve a significant and growing number of students and teachers as detailed in Table 3. The following provides an overview of our integrated strategy areas previously highlighted in Figure 1. **1) Problem-Based Learning Content and Instruction:** Our conceptual framework is based on six common characteristics identified in successful PBL environments: student centered, ill-structured contextualized problems to encourage student-directed problem solving, multidisciplinary focus, self-regulation and collaboration, reflection and evaluation, and closing analyses (Nelson, 2010). Across our current K-9 pipeline, at least 60% of lessons are PBL with a minimum of 40% being interdisciplinary. These PBL units are vertically and horizontally aligned (e.g., forces/motion, organisms/ecosystems, life choices, recycling/energy). Through *INSPIRE*, we will refine current PBL units, integrate digital content, and test additional units to support STEM course content redesign. Our curriculum design cycle in Figure 3 is driven by teacher development, student interest obtained via student

Table 3: *INSPIRE* Participants

	Year 1	Year 2	Year 3	Year 4
Students	959	2,060	2,200	2,200
Teachers	50	103	110	110
Total	1,009	2,163	2,310	2,310

Figure 3



surveys, relevance to national and global issues, and fit to the Common Core. Our teachers are trained in PBL curriculum development by Wake Forest University and in the research-based curriculum framework, Understanding by Design (ASCD, 2013), which supports the importance of learning with understanding, and other tools such as Engineering is Elementary (Museum of Science, Boston, 2013) and Engineering by Design (International Technology and Engineering Association, 2013) by the Center for Teaching and Learning at Clemson University in conjunction with the International Technology and Engineering Educator's Association. Providing student synergy and engagement, PBL units are integrated across courses so students explore the same problem in every subject area. For example, in an energy conservation unit, students address the following in each course: *"Since Central Cabarrus High is the number one user of energy in the district, what can we do to offset these consumption concerns that relate to the sustainability of our school?"* To address the problem, science class conducts an energy audit; math class compares energy bills of all schools; history class examines how other cultures address energy consumption; and English class writes detailed instructions for building solar panels based on sketches provided by art class. At end of the project, students engage in hands-on learning with community partners to address the problem (e.g., build solar panels for the school in collaboration with county energy managers). To ensure rigor, each unit will be designed with the following components shown to lead to project success: a realistic problem (aligned to student skills and interest with clearly defined content); structured group work (students with diverse skill level, interdependent roles, and individual accountability based on student growth); and multi-faceted assessment (opportunities to receive feedback and revise work, multiple learning outcomes, and presentations that encourage participation and have social value) (Barron & Darling-Hammond, 2008; Hung, 2008). **2) Personalized, Tech-Enabled Instructional Practices:** Research finds that technology integration with PBL enhances the inquiry process by bringing elements of authenticity and relevance to student work (Park & Ertmer, 2008). Moving to a learner-centered approach driven by technology, *INSPIRE* will allow

us to study the effect of layering our PBL course content with personalized instructional practices. We have initial success with this approach through our current 1:1 student to tablet ratio at Central Cabarrus High which has impacted how our STEM course content and PBL units are taught. The proposed project will enable us to study the impact of moving to a learner-centered approach driven by technology across the K-12 STEM pipeline and extend the 1:1 student to tablet ratio to cover grades four through eight. Multiple modalities and deep learning experiences will be essential to the design of our instructional practices and will come from a blended delivery using technology (to provide diverse content), digital content (simulations aligned to Common Core and integrated with PBL units), and instruction (teachers as a guide rather than controller of learning) (Digital Learning Now, 2010). Our instructional redesign builds on empirical research (Education Elements, 2012; Public Impact, 2012; Wolf, 2010) to employ the following elements: student driven with autonomy to plan STEM learning path; competency-based progression to work at own pace to master standard; flexible, hands-on learning from a range of experts and technologies; age-appropriate digital STEM learning using adaptive content aligned to standards; face-to-face teaching time for higher-order learning, differentiation, and personalized follow up; technology leveraged to individualize student needs in real time through feedback loops; instruction based on review of student data from digital assessments; and real-time teacher and student access to meaningful data to develop necessary interventions. **3) Teacher Development and Support:** Research shows there are essential pieces that must be present for teachers to ensure high-quality implementation of the redesigned course content and instructional practices (Bradley-Levine, et al., 2010). These components include: initial transition support to PBL, collaboration (internal/external), ongoing support structures, and professional development. We have already provided initial training and support in PBL for our teachers, and we will deepen this support as follows: *Collaboration:* Professional learning communities (PLC) have been an essential tool in the development of our approach to support the design of STEM course content and instructional practices. PLCs meet at least weekly to

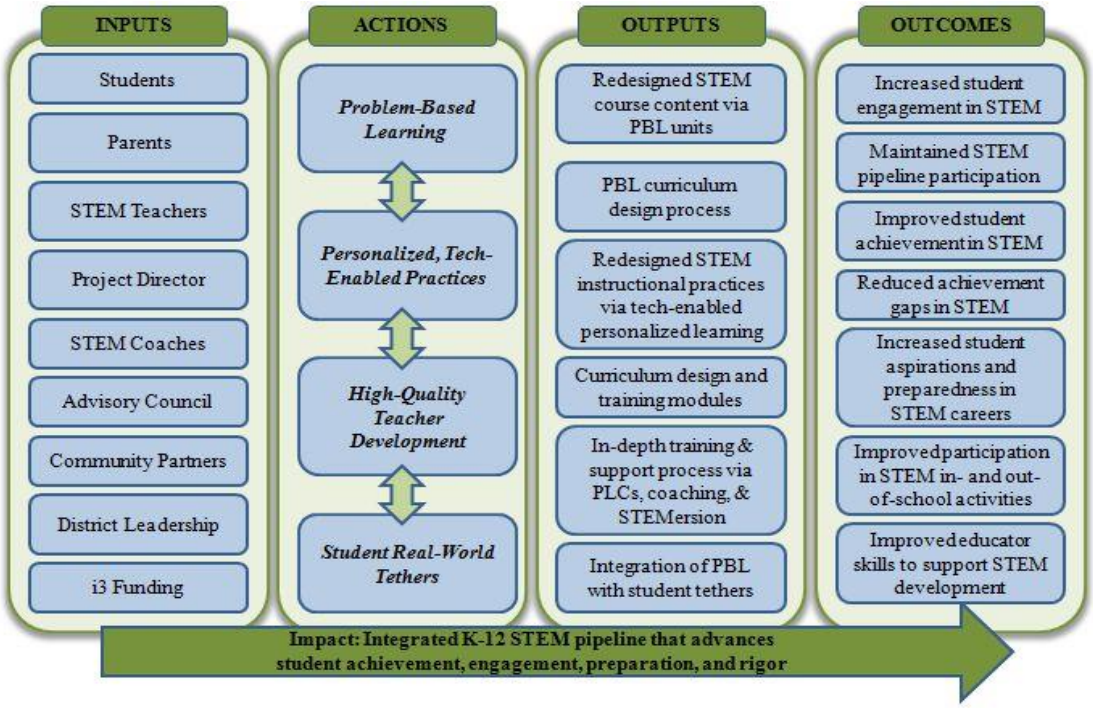
provide adequate time to refine PBL units and instructional practices, ensure horizontal and vertical alignment, and integrate with the Common Core. Through *INSPIRE*, we will expand this approach to study the impact of more in-depth design, interdisciplinary collaboration, and tech-enabled instruction. This process includes training during school in-service days and an annual four day curriculum review week to connect the K-12 continuum. *Ongoing Support:* Since PBL requires a shift in pedagogical thinking for teachers, STEM Coaches, with the assistance of university partners, will be crucial to the success of this project. Central to this support is transforming the teacher role from a transmitter to a facilitator of knowledge (Asghar, et al., 2012). Through the direction and support of the STEM Coordinator, two STEM Coaches will: guide PLCs in the development of STEM course content, ensure practices are integrated along the K-12 pipeline, support teachers to develop competency with interdisciplinary approaches via in-class coaching, and assist with alignment of results from common formative assessments with PBL units. *Professional Development:* We will host a semi-annual Innovation Showcase for teachers to share their STEM PBL best practices across the district to expand knowledge within and beyond our target pipeline. Our annual five-day summer "STEMersion" approach will immerse teachers in business environments to assess the practical use of formulas, theories, and concepts used in the classroom. All of our STEM teachers will have the opportunity to build partnerships with businesses, develop hands-on ways to engage students using real-world examples, generate PBL strategies, and identify student learning opportunities by the end of the program period. **4) Student Real-World Tethers:** We have developed a variety of successful extensions beyond the classroom to support student engagement and achievement. Through *INSPIRE*, we will study the impact of integrating these tethers with our STEM course content. This extension of PBL into the community will result in a real-world connection to the process of STEM-based problem solving. Authentic assessment and exhibition of STEM skills will be provided through opportunities aligned to PBL units such as: student competitions (Odyssey of the Mind, Science Olympiad, Robotics), Senior Capstone Projects (culminating PBL research

project), alignment of STEM content to annual field trips (colleges/industries/Bio-Tech campus), use of digital content outside of school, quarterly STEM events, and hands-on experiences at the high school's planetarium. We will also study the effect of integrating PBL units by expanding STEM learning in the summer (e.g., two-week NASA summer camp held on our campus), a time when many high-need students disengage from STEM pathways (Afterschool Alliance, 2011).

(2) Clarity and coherence of project goals with explicit plan or actions to achieve goals.

Our vision is to create an integrated K-12 STEM pipeline that advances student achievement, engagement, preparation, and rigor through **four integrated goals**: 1) Develop rigorous PBL curriculum units to support STEM course content connected across all subjects; 2) Design STEM instructional practices that connect PBL and digital course content to tech-enabled personalized learning strategies; 3) Create a high-quality teacher development and support process to sustain innovative STEM course content and instructional practices; and 4) Amalgamate real-world student tethers with STEM course content and instructional practices. Figure 4 provides a summary of our logic model which articulates the action plan to achieve our goals. The detailed logic model (Appendix J) illustrates strategies, actions, outputs, outcomes, and long-term impact.

Figure 4: Summary of Logic Model



(3) Coherence of project goals with activities and strategies to mitigate risks.

Table 4 below delineates the specific goals and measurable objectives for each project activity.

Table 4: INSPIRE Goals, Activities, and Objectives
Goal 1: Develop rigorous PBL curriculum units to support STEM course content connected across all subjects
1.1 Increase the number of newly developed interdisciplinary PBL units at each level (ES, MS, HS) by at least 5 percentage points in Years 1-2 and 10% in Year 3-4 or until no fewer than 75% of all developed PBL units are interdisciplinary. *Measure: Administrative records*.
1.2 At least 75% of new curricular units in Year 1 will be judged to contain at least five of the following six criteria for PBL quality: 1) have a realistic problem; 2) incorporate structured group work; 3) use multi-faceted assessments, 4) link to the common core, 5) integrate across subjects, and 6) vertical and horizontal alignment, increasing to 90% of all new units by the end of Years 2-4. *Measure*: *Evaluator-developed four-point scoring rubric.*
1.3 By the end of Year 1, each STEM school will score no less than 75% on the STEM Attribute Implementation Rubric, increasing by 5% each year, or until all schools score 85%. *Measure*: *STEM Attribute Implementation Rubric (Elementary, Middle, and High).*
1.4 Increase 3rd grade STEM students NC EOG Math standard scores by an average of 2 points in Year 1, and 3 points in Years 2-3 (overall effect size of .33 over baseline) or until the average scaled score reaches 348. *Measure: NC EOG Math, 3rd grade*. [Please note: student achievement is also measured via our three impact studies (see Quality of Project Evaluation)]
Goal 2: Design STEM instructional practices that connect PBL and digital course content to tech-enabled personalized learning strategies
2.1 By the end of Year 1, 70% of targeted STEM students will report utilizing digital STEM learning with adaptive content at least twice per week, increasing 5 percentage points annually or until 85% report such use. *Measure: Year-end student survey of grades 5, 7, 9.*
2.2 By the end of Year 1, 80% of targeted STEM teachers will report using student-level digital assessment data to inform instruction, increasing 5 percentage points annually or until 85% report such technology use. *Measure: Year-end teacher survey of grades 5, 7, 9.*
Goal 3: Create a high-quality teacher development and support process to sustain innovative STEM course content and instructional practices
3.1 At least 50% of STEM teachers will demonstrate proficiency in linking professional growth to PLC-related professional development goals by the end of Year 1; 70% in Year 2; 80% in Year 3; and 95% in Year 4. *Measure: NC Teaching Rubric.*
3.2 By end of Year 1, 50% of STEM teachers will report utilizing the on-site STEM coach at least twice per month, increasing by 5% in each of Years 2-4, or until 75% of all teachers utilize the STEM coach on a bi-weekly basis. *Measure: Year-end teacher survey.*
3.3 No fewer than 80% of targeted teachers will participate in at least 10 STEM-related training hours each program year. *Measure*: *Administrative attendance records.*

3.4 By the end of Year 1, 75% of STEM teachers will meet with their PLC at least 4 times/month, increasing by 5% in each of Years 2-4, or until 90% of all teachers meet 4 times/month in PLCs for curriculum refinement and teacher development. *Measure: PLC meeting records.*
Goal 4: Amalgamate real-world student tethers with STEM course content and instructional practices
4.1 At least 60% of middle school and 70% of high school students will aspire to a STEM-related career by the end of Year 1, increasing 2 percentage points annually or until 80% of MS and HS students report such aspirations. *Measure: Annual year-end student survey.*
4.2 By the end of Year 1, at least 70% of students will be retained in the STEM pipeline at each transition point (ES to MS and MS to HS), increasing by 2 percentage points per year, or until 80% of all students are retained in the pipeline, per year. *Measure: Enrollment records.*
4.3 Each year, STEM schools will showcase their finished student STEM-related products at no fewer than 4 public events outside of school per year (1 per school). *Measure: Event tracking.*
4.4 At least 50% of elementary, 70% of middle, and 90% of high school students will participate in at least 2 school-sponsored STEM-related community activities, per year. *Measure: School records (e.g., field trips, competitive teams, planetarium, senior capstone experience).*

Based on research and our own previous implementation experience, we identified potential risks to project success and strategies to mitigate these risks in Table 5. To monitor these risks, we developed procedures for ensuring continuous improvement (see Quality of Management Plan) and equitable access to and participation in our program (see GEPA statement).

Table 5. Strategies to Address Potential Risks

Potential Risks	*INSPIRE* Strategies
Minority or low-income students are overlooked for participation in STEM educational activities	Pipeline begins at STEM elementary school (Title I, diverse students) so that every student in the school's attendance zone is reached
Students continuing in the pipeline to middle or high school, are not zoned for transportation	Transportation is provided to high-need students outside the school attendance zone
Students are used to traditional lecture style and may be hesitant of PBL approach (Bradley-Levine, et al., 2010)	Extensions beyond the classroom to support student engagement and achievement; layering PBL content with personalized instruction
Schedules are not coordinated to create interdisciplinary connections across STEM subjects (Asghar, et al., 2012)	Opportunities for collaborations via weekly PLCs, curriculum review weeks, and summer institutes with the support of a STEM Coach
PBL units may be labor intensive for teacher planning; struggles with redefined teacher role (Bradley-Levine, et al., 2010)	Units developed through PLCs; digital content integration to assist with PBL units by refining results by subject, language, format, or student
Lack of administrator support to fully implement PBL	Redesigned STEM curriculum is a key district priority; CCS has invested in STEM magnets

C. QUALITY OF THE MANAGEMENT PLAN

(1) Responsibilities, timelines, and milestones for completion of major project activities.

Serving as the fiscal agent for the proposed project, Cabarrus County Schools designed *INSPIRE* with a variety of management structures to monitor activities and ensure the project is achieving its goals: 1) The Deputy Superintendent (DS) will lead the *INSPIRE* Advisory Council and guide strategic project direction with a focus on framework development for nationwide replication. 2) Meeting quarterly, the Advisory Council will use evaluation reports to make strategic decisions for successful implementation, identify best practices for national replication, and develop a sustainability plan. Members include the Project Director (PD), K-12 STEM Coordinator, Technology Director (TD), Principals from each target school, Assistant Principal (AP) at Patriots STEM Elementary, and partners. 3) The PD will coordinate day-to-day activities including curriculum alignment, professional development, progress monitoring with evaluators, and cultivation of partners. 4) Principals, with the support of APs, will provide project leadership including integration of program strategies and curriculum alignment. 5) STEM Coaches (SC) will provide guidance for STEM course content and instructional redesign at the schools and support teachers on an ongoing basis. Table 6 provides timelines and milestones for completion of major project activities for each goal area. Specific, well-defined project objectives and annual performance targets to monitor goal attainment were previously highlighted in Table 4 above.

Table 6. *INSPIRE* Management Plan		
Goal 1: Develop rigorous PBL curriculum units to support STEM course content connected across all subjects		
Objectives: *1.1 New Units; 1.2 Units Structure; 1.3 STEM Rubric; 1.4 Student Achievement*		
Metrics: *Additional PBL curricula units created, existing PBL units refined, rubric & test scores*		
Milestones	**Timeline**	**Responsibility**
Refine current and develop new PBL units	Begin 1/14, weekly	PD, Teachers, SC
Ensure vertical and horizontal alignment of units	2/14, monthly	SC, PD, Teachers
Test and implement PBL units	Begin 3/14, monthly	Teachers, SC
Employ curriculum review week to connect K-12	Begin 7/14, annually	PD

Modify and formalize curriculum design cycle	Begin 8/14, ongoing	PD, SC
Review units for fidelity via school committee	Begin 9/14, monthly	SC, Lead Teachers
Goal 2: Design STEM instructional practices that connect PBL and digital course content to tech-enabled personalized learning strategies		
Objectives: *2.1 Student Technology Usage; 2.2 Teacher Technology Usage*		
Metrics: *Number and/or percentage of students utilizing digital STEM learning with adaptive content and teachers utilizing student digital assessment data*		
Assess technology to plan for PBL unit integration	Begin 2/14, quarterly	DS, PD, TD
Procure tablets and digital content integration	Begin 2/14, ongoing	PD, TD
Prepare for/extend 1:1 tablet ratio to grades 6-8	Begin 2/14	PD, Principal, TD
Layer PBL content with personalized practices	Begin 8/14, quarterly	Teachers
Review student data from digital assessments	Begin 8/14, weekly	SC, Teachers
Develop data-led student interventions/enrichment	Begin 9/14, weekly	SC, Teachers
Prepare for/extend 1:1 tablet ratio to grade 5	Begin 2/15	PD, Principal, TD
Prepare for/extend 1:1 tablet ratio to grade 4	Begin 2/16	PD, Principal, TD
Goal 3: Create a high-quality teacher development and support process to sustain innovative STEM course content and instructional practices		
Objectives: *3.1 PD Goals; 3.2 Coaching; 3.3 Training; 3.4 PLCs*		
Metrics: *Number and/or percentage of trainings offered, attendance and completion of training, teachers utilizing STEM Coaches, participation in STEM PLCs, participation in STEMersion*		
Recruit and hire high-quality STEM Coaches	1/14-6/14	DS, PD
Begin training STEM Coaches	7/14-8/14	PD, Principal, AP
Design PLCs with PBL and interdisciplinary focus	Begin 7/14, ongoing	PD, AP
Implement 5-day STEMersion experience	Begin 8/14, annually	PD, Partners
Support PLCs in curriculum redesign	Begin 9/14, monthly	SC
Provide in-class coaching and modeling	Begin 10/14, weekly	SC
Provide onsite training on digital PBL content	Begin 10/14, ongoing	PD, SC
Host innovation showcase for district	11/14, semi-annually	PD, Teachers
Goal 4: Amalgamate real-world student tethers with STEM course content and instructional practices		
Objectives: *4.1 Career Aspirations; 4.2 STEM pipeline; 4.3- 4.4 STEM Events*		
Metrics: *Career Aspirations; Enrollment; Authentic STEM community exhibitions*		
Develop and confirm community partnerships	Begin 2/14, ongoing	PD, Principals, AP
Design vertical alignment of STEM to field trips	Begin 3/14, ongoing	SC, Teachers
Implement local two-week NASA summer camp	7/14, annually	PD, Teachers
Schedule/conduct college and industry field trips	Begin 9/14, ongoing	PD, Partners
Use STEMersion training to integrate curricula	Begin 9/14, ongoing	SC, Teachers

Organize and hold STEM competitions	Begin 9/14, ongoing	PD, Teachers, AP
Initiate Senior Capstone projects	Begin 9/16, monthly	PD, Partners
Overarching Project Management		
Convene Advisory Council and share findings	Begin 3/14, quarterly	PD, Evaluator
Conduct evaluation (data collection/analysis/tools)	Begin 3/14, ongoing	Evaluator
Develop written sustainability plan	Begin 3/16, quarterly	PD, Contractor
Convene partners for replication and dissemination	Begin 3/16, quarterly	PD, DS

(2) Commitment of partners or evidence of support from stakeholders to long-term success.

The support and commitment from our school district, administrators, teachers, and community partners are critical to *INSPIRE's* long-term success. This commitment is already evidenced by the district's preliminary implementation of STEM reform efforts which include: 1) transforming STEM education to a district priority area; 2) requiring a signed three-year contract from each STEM teacher confirming their commitment to implement PBL and participate in professional development; 3) developing a K-9 STEM continuum beginning with the design of two complete STEM magnet elementary schools so that every student in the school's attendance zone is reached; 4) employing PLCs and other instructional supports to design and implement PBL units; 5) integrating student tethers to assist in making real-world connections; 6) rolling out a 1:1 student to tablet ratio at the high school which has impacted how our STEM course content and PBL units are taught; and 7) employing a full-time district-funded K-12 STEM Coordinator. Appendix G provides a Memorandum of Understanding (MOU) demonstrating the continued commitment of our district administrators and principals to develop the proposed K-12 STEM pipeline. In year three, we will develop a written sustainability plan to assess existing capacity using evaluation results to clarify programmatic elements that should be preserved and solutions to common barriers (e.g., transportation) with a focus on leveraging district and community resources. We also have a variety of community partners, highlighted in Table 7, which are critical to the long-term success of our project. A summary of specific commitments and letters of support are also included in Appendix G.

Table 7. Key Partners	
University of North Carolina Charlotte: Advisory Council, content expertise/alignment	**NC STEM Learning Network:** Statewide dissemination, STEM rubric and PD
Local Foundations: Support for technology	**NASA:** Curriculum support for STEM camp
NC Research Campus - Biotech: Advisory Council, content expertise, field trips	**Howard Lee Institute:** Mentors, outreach efforts, Advisory Council
VIF International Education & World View: National and international dissemination, PD	**Cabarrus County Government:** Refurbish the high school planetarium
Discovery Education: Digital content, professional development	**Knovation:** Digital content integration and alignment

(3) Adequacy of procedures for ensuring feedback and continuous improvement.

To ensure feedback and continuous improvement in project operations, we will use the following procedures. **1) Management Structures:** Our Advisory Council will meet quarterly to monitor project activities. With support of the STEM Coordinator, two STEM Coaches will support teacher development and a STEM PBL leadership committee to review course content and instructional practices. Coaches will also meet monthly to share best practices and address implementation issues. **2) Utilization-Focused Evaluation:** A participatory approach to evaluation will ensure that data is strategically used on a regular basis to provide feedback in an effort to refine implementation and make programmatic changes as needed. Through continuous monitoring, the evaluator will provide periodic feedback to each school and will triangulate the data to provide a synthesis of program-wide, evidence-based data. The evaluation team will effectively communicate results using interim and end-of-year reports, survey briefs, snapshots, and in-person briefings. **3) Logic Model:** The *INSPIRE* logic model (Appendix J) ensures that both continuous quality improvement and program enhancement are guided by evaluation. The model has a built-in feedback loop to provide timely and useful information to stakeholders for informed decision-making relative to needed changes in program activities. Short-term performance indicators will be used to assess progress toward long-term outcomes. Annual benchmarks are established and embedded in our outcomes listed in Table 4 above and will be used to graphically chart actual progress against targeted progress.

D. PERSONNEL

(1) Staffing plan, identification of project director, and how critical work will proceed.

Key project personnel are ready to move on the critical work in the first year to ensure a smooth start and transition to the K-12 pipeline based on the following factors: 1) Our district-funded K-12 STEM Coordinator in collaboration with our Deputy Superintendent will begin this important work upon award while the Project Director is being identified and hired by April 1. 2) Our implementation plan uses the first six months of the project for initial curricula development and redesign with in-class coaching beginning at the start of the school year in August. As a result, with a hire date of July 1, this process gives us several months to recruit, interview, and train highly qualified and experienced STEM Coaches. 3) All key personnel have previous experience with initiatives to improve STEM education and direct experience in our K-9 STEM continuum. 4) Principals, assistant principals, and teachers at the implementation sites have experience using PLCs to develop PBL units ensuring a smooth transition. Table 8 highlights our staffing plan to ensure high-quality implementation (see Appendix F for resumes and job descriptions).

Table 8. Key Personnel Responsibilities (R) and Qualifications (Q)	
Dr. Jason Van Heukelum, Deputy Superintendent	
R:	Provide oversight and strategic direction for *INSPIRE* and develop dissemination plans
Q:	Doctorate from Vanderbilt University with over 10 years of school leadership experience leading large district-wide initiatives; establishing a K-9 STEM magnet pipeline; directing the development of 3 IB programs; leading initial SACS accreditation for an international school; leadership brought positive results to schools: nomination as Blue Ribbon School; one of five schools in NC with 100% proficiency and high growth
INSPIRE Project Director	
R:	Oversee i3 program, coordinate day-to-day implementation, provide fiscal management and accountability, lead community outreach efforts, cultivate community partners, coordinate professional development, and work collaboratively with independent evaluators
Q:	Master's degree with at least 10 years of experience in the education field and at least 5 of these years in STEM; prior experience managing large projects with multiple schools, staff, and community partners; skills in managing multiple deadlines and priorities, budgets, professional development coordination and delivery, mentoring, and community outreach
Bridget Jones, K-12 STEM Coordinator	
R:	Coordinate STEM curriculum development and alignment and support STEM Coaches

Q:	Master's in Educational Leadership with nearly 10 years of education experience; served as high school STEM Coordinator; designed and implemented STEM training, assisted with STEM PBL curriculum development incorporating technology and hands-on learning
Julie Barbee, Principal, Coltrane-Webb Elementary	
R:	Provide project leadership at the high-need STEM elementary school in collaboration with the STEM Coach including integration of key program strategies and curriculum alignment
Q:	Masters in Educational Administration; over 16 years of experience in education serving as a teacher and administrator; facilitated the implementation of the district's first magnet school; Cabarrus Educators Association President; designed training modules
Phil Hull, Principal, Patriots Elementary	
R:	Provide project leadership at the new STEM elementary school in collaboration with the STEM Coach including integration of key program strategies and curriculum alignment
Q:	Masters in School Administration; over 27 years experience in education; led opening of new elementary school and first year of new STEM magnet program
Dr. Kecia Coln, Principal, J.N. Fries Middle	
R:	Provide project leadership at the STEM middle school in collaboration with the STEM Coach including integration of key program strategies and curriculum alignment
Q:	PhD in Curriculum and Instruction with an urban education focus; 17 years of experience in education; responsible for the school conversion to a magnet school and implementation including budgets, processes, accountability, personnel, and data analysis for decisions
Lynn Rhymer, Principal, Central Cabarrus High	
R:	Provide project leadership at the STEM high school in collaboration with the STEM Coach including integration of key program strategies and curriculum alignment
Q:	Master of Administration; 2012-13 Cabarrus County Principal of the Year; Region 6 Principal of the Year, and North Carolina High School Principal of the Year; over 18 years experience in education serving as a high school administrator and math teacher
Two STEM Coaches (1 at the elementary schools and 1 at the middle and high schools)	
R:	Guide STEM course content and instructional redesign; provide one-on-one assistance to teachers to facilitate STEM PBL units; support PBL interdisciplinary integration
Q:	Master's level professional with Math or Science Teaching Certification and at least five years of teaching experience in a STEM subject area, professional development on coaching techniques, and prior experience working with high-need populations
Dr. Joel Philp and Dr. Karyl Askew, Evaluators, The Evaluation Group	
R:	Lead 3 impact studies including a longitudinal quasi-experimental design and 2 randomized control trials including data collection, tools, analysis, and reporting
Q:	Identified through an open procurement process, TEG has over 20 years of experience, including three i3 evaluations, experience conducting RCT and QED studies, experience leading evaluations of science-education supported by grants from NASA, NSF, ED, IES
Steven Bookhart, INSPIRE Advisory Council Member and Assistant Principal of Instruction	
R:	Provide leadership on the Advisory Council; assist in sharing and replicating best practices via the NC STEM Learning Network, UNCC, NC Research Campus, and other resources
Q:	Master's degree in School Administration; over 17 years experience; helped design STEM elementary and middle school; serves on state committee to develop the STEM Rubric

E. QUALITY OF PROJECT EVALUATION

(1) Key questions to be addressed by project evaluation and appropriateness of methods.

Our evaluation will address three primary questions examining what is the effect of *INSPIRE* on: 1) 2nd grade math achievement for *INSPIRE*-zoned elementary school students after 3 program years? 2) 7th grade math achievement for middle school magnet students after 2 program years? 3) 10th grade math and science achievement for high school magnet students after 2 program years? Accordingly, we propose three evaluations to assess the impact of *INSPIRE* at each critical entry point in the STEM pipeline. Selection bias is controlled by design, either through matching (Study 1) or through randomization of interested magnet students to treatment and control groups (Studies 2 and 3). The studies use recognized assessments with proven reliability and validity, including NC End-of-Grade (EOG) and End-of-Course (EOC) tests, Discovery Education's (DE) Common Core Math Assessment and the ACT-PLAN, EXPLORE, and ACT college readiness assessment. The following summarizes the appropriateness of the methods used to answer each question. ***Impact Study 1:*** We will use a three-year longitudinal *quasi-experimental design* (QED) to assess the impact of *INSPIRE* on math achievement at the end of 2nd grade. Each year, approximately 100 of the 200 students entering Kindergarten at our two STEM elementary schools are low-income minority students zoned for each school, making their enrollment compulsory and largely due to circumstance rather than choice. We will compare the outcomes of *INSPIRE*-zoned students with similar students from four comparison elementary schools not offering a STEM program (R.B. McAlister; Beverly Hills; Pitt School Road; Charles Bogor). Propensity-score matching using a 1:1 greedy match without replacement will be used to minimize selection bias and ensure *INSPIRE*-zoned students and comparison students are equated on key background and demographic variables, ***including a baseline pretest measure*** of math ability in Kindergarten (DE Common Core Math Assessment), age, ethnicity, gender, and free/reduced lunch status. Matching is the preferred method when there is a large pool of

comparison subjects and can be done prior to data collection. Math achievement will be assessed at the end of 2nd grade using DE Math Assessment. By serving all magnet students, a suitable control group cannot be constructed from overflow. Nevertheless, a secondary (exploratory) analysis will compare outcomes of *INSPIRE* magnet students, *INSPIRE*-zoned students, and comparative students. ***Impact Study 2*:** We will use a multiple-cohort individual-level longitudinal *randomized control trial* (RCT) to assess the effects of *INSPIRE* on 7th grade math achievement. At J.N. Fries Middle, we expect to receive 200 applications for only 150 open 6th grade slots. In each of two successive years, beginning in SY2014-15, we will use a carefully orchestrated lottery process to randomly assign eligible 6th grade applicants to either *INSPIRE* at J.N. Fries or to a non-*INSPIRE* control group in the middle school for which the student is zoned. Use of a RCT design effectively minimizes selection bias and ensures that the program and control groups are equitable at baseline in terms of background, demographic, and pre-program factors such as motivation. Data from the two cohorts will be pooled to increase statistical power (*INSPIRE*=300, control=100, total n=400), and between-group comparisons will be made on state standardized test scores in math administered at the end of 7th grade. Additional exploratory analyses will be conducted on subsamples by exposure, cohort number and outcome. ***Impact Study 3:*** We will use a multiple-cohort longitudinal individual-level RCT to assess the effects of *INSPIRE* on 10th grade ACT-PLAN math and science scores. In SY2014-15, we expect to receive 150 applications for just 100 9th grade slots at Central Cabarrus High. In each of two successive years, beginning in SY2014-15, we will use a carefully orchestrated lottery process to randomly assign eligible 9th grade applicants to either *INSPIRE* at Central Cabarrus or to a non-*INSPIRE* control group in the high school for which the student is zoned, thus negating spillover effects (Coalition for Evidence-based Policy, 2005). Data will be pooled across cohorts to increase statistical power (*INSPIRE*=200, control=100, total n=300). Additional exploratory analyses will be performed on subsamples by exposure, cohorts, and outcomes. Table 9 provides a summary with * indicating a primary analysis and all others representing exploratory analyses.

Table 9. Impact Analysis by Study and School Year			
Impact Analysis	**Year 1 (2014-15)**	**Year 2 (2015-16)**	**Year 3 (2016-17)**
Study 1: Effect on cohort 1	One year effect on K Math	Two year effect on Grade 1 Math	*Three year effect on Grade 2 Math
Study 2: Effect on cohort 1	One year effect on 6th grade EOG Math	Two year effect on 7th grade EOG Math	Three year effect on EXPLORE and 8th grade Math & Science EOGs
Effect on cohort 2		One year effect on 6th grade EOG Math	Two year effect on 7th grade EOG Math
Pooled effect across cohorts (C1+C2)		Pooled one year effect on 6th grade EOG Math	*Pooled two year effect on 7th grade EOG Math
Study 3: Effect on cohort 1	One year effect on 9th grade EOC Math	Two year effect on 10th grade PLAN Math and Science	Three year effect on 11th grade ACT-Math & Science & EOG Science
Effect on cohort 2		One year effect on 9th grade EOC Math	Two year effect on 10th grade PLAN Math & Science
Pooled effect across cohorts (C1 +C2)		Pooled one year effect on Math	*Pooled two year effect on 10th grade PLAN Math & Science

(2) Evaluation plan includes clear and credible analysis plan.

Each study will follow an intent-to-treat analysis model on a stable sample of students (no in-movers) and assumes fixed-effects. The Benjamini-Hochberg (Thissen, et.al, 2002) procedure will be used where applicable to adjust for multiple comparisons in academic outcomes. The longitudinal design provides confidence in reaching Minimal Detectable Effect Size estimates and to avoid a Type II error. Studies 2 and 3 will use standardized tests with proven validity/ reliability. All studies will use OLS regression and include individual and contextual covariates.

Table 10. Summary of Design Parameters by Study			
Parameters	**Study 1 QED**	**Study 2 RCT**	**Study 3 RCT**
School level	Elementary	Middle	High
# Cohorts/year/ grade at entry	1 cohort/School Year 2014/K	2 cohorts/School Year 2014 & 2015/6th	2 cohorts/School Year 2014 & 2015/9th
Sample Size	200	400	300
Primary Outcomes(s)	Discovery ED 2nd grade Math scores	NC EOG 7th grade Math	ACT-PLAN Math and Science, 10th grade

Exploratory Outcome(s)	Discovery ED, 1st grade Math scores	NC EOG 6th grade Math and 8th grade Science; ACT-EXPLORE	NC Physical Science EOC, 11th grade ACT-Math, ACT Science
Covariates	Individual: age, gender, FR/L, ethnicity, pretreatment 1st quarter K math score; Contextual: % AMOs met	Individual: age, gender, FR/L, ethnicity, pretreatment 5th grade EOG math & science; Contextual: EVAAS score, % AMOs met	Individual: age, gender, FR/L, ethnicity, pretreatment 8th grade EOG math & science; Contextual: EVAAS score, % AMOs met
MDES*	.44	.37	.38
**Each MDES assumes a Type 1 error rate of .05 at a power of 80% and accounts for unbiased sample attrition and unbalanced groups. For description of the power analysis, see Appendix J.*			

(3) Evaluation plan articulates key components and measurable threshold.

Our key components are depicted in the logic model (Appendix J) with the underlying theory: training teachers to implement STEM-based PBL supported by personalized, tech-enabled instruction and connected to real-world tethers, will significantly increase student interest and engagement in STEM, leading to higher achievement in math and science. The extent to which any program achieves its desired outcomes is linked to maintaining fidelity to the program model and measurable thresholds for acceptable implementation. A priori established thresholds are presented in Appendix J and will be revisited in subsequent years with the expectation that they increase incrementally as the program matures. Implementation data obtained from multiple sources (surveys, STEM rubric, lesson plans, administrative records, interviews, focus groups) will be used to compute fidelity scores. Fidelity scores will be summed across all components to compute an *Annual Fidelity Index* to assess the overall extent of implementation each year based on: 1) *Reach* or extent to which individuals participate; 2) *Dosage* or how much of the component was delivered; 3) *Quality* or how well each component was delivered; and 4) *Responsiveness* or extent to which participants are engaged (Durlak & Dupre, 2008; Mowbry, et.al, 2003). The evaluator will provide periodic feedback to each school and will triangulate the data to provide a synthesis of program-wide evidence-based data to the district. Short-term indicators will assess progress toward long-term program goals and inform replication efforts.