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Program Narrative

Project Background

The nation needs STEM talents. Early learning is critical. Challenging curriculum and compelling life stories of scientists, engineers, and computer scientists animate young children to imagine STEM worlds, to identify with STEM roles, and to develop their talents. **STEM+C^2** is an innovative project grounded in evidence-based intervention models that produced learning gains in identified gifted students (Robinson, Dailey, Hughes, & Cotabish, 2014; Robinson, Adelson, Kidd, Cash, Navarrete & Cunningham, 2017; Robinson, Adelson, Kidd, Cash, & Cunningham, 2019), general education students (Robinson, Adelson, Kidd, Navarrete, Cash, Cunningham, 2018), and elementary teachers (Cotabish, Dailey, Hughes, & Robinson, 2011; Dailey & Robinson, 2017). The **STEM+C^2** project components are supported by promising evidence as defined by the What Works Clearing House. (See Appendix A for References).

STEM+C^2 will develop new information for delivering innovative gifted and talented services and will evaluate the effectiveness of an intervention model designed to assist schools in the identification of and provision of services to gifted and talented students who may not be identified and served through traditional methods including individuals from low-income, culturally diverse households, English Language Learners, and children with disabilities. **STEM+C^2** meets **Competitive Preference Priorities** 1, 2, and 3: 1) Identification of and Services to Gifted and Talented Students, 2) Promoting STEM and Computer Science Education, and 3) Promoting Access to Effective Instruction.

(A) Project Design

STEM+C^2 takes as its starting point the pathway identified by the National Science and Technology Council (NSTC) to "engage students where disciplines converge." (pp vi). As articulated by the

Council, **STEM+C²** "seeks to make STEM learning more meaningful and inspiring to students by focusing on complex real-world problems and challenges that require initiative and creativity." (pp vi). The project is guided by the premise that challenging curriculum can be used to develop talents in <u>all</u> children <u>and</u> as a framework whereby educators systematically engage in the practice of talent-spotting children from underrepresented groups for subsequent gifted and talented services (Robinson, 2018). <u>**STEM+C²** is an exceptional approach to the progression from universal screening in Grade 1 to talent development through curriculum in Grade 2 to gifted and talented programs and services in Grade 3 for students not traditionally identified and served.</u> Moving from a "convenient clustering" of related disciplines, the project integrates science (**S**), technology (**T**), engineering (**E**), math (**M**), computer science (**C**) and creativity (**C**) (**STEM+C²**). The project is graphically displayed in Figure 1: **STEM+C²**

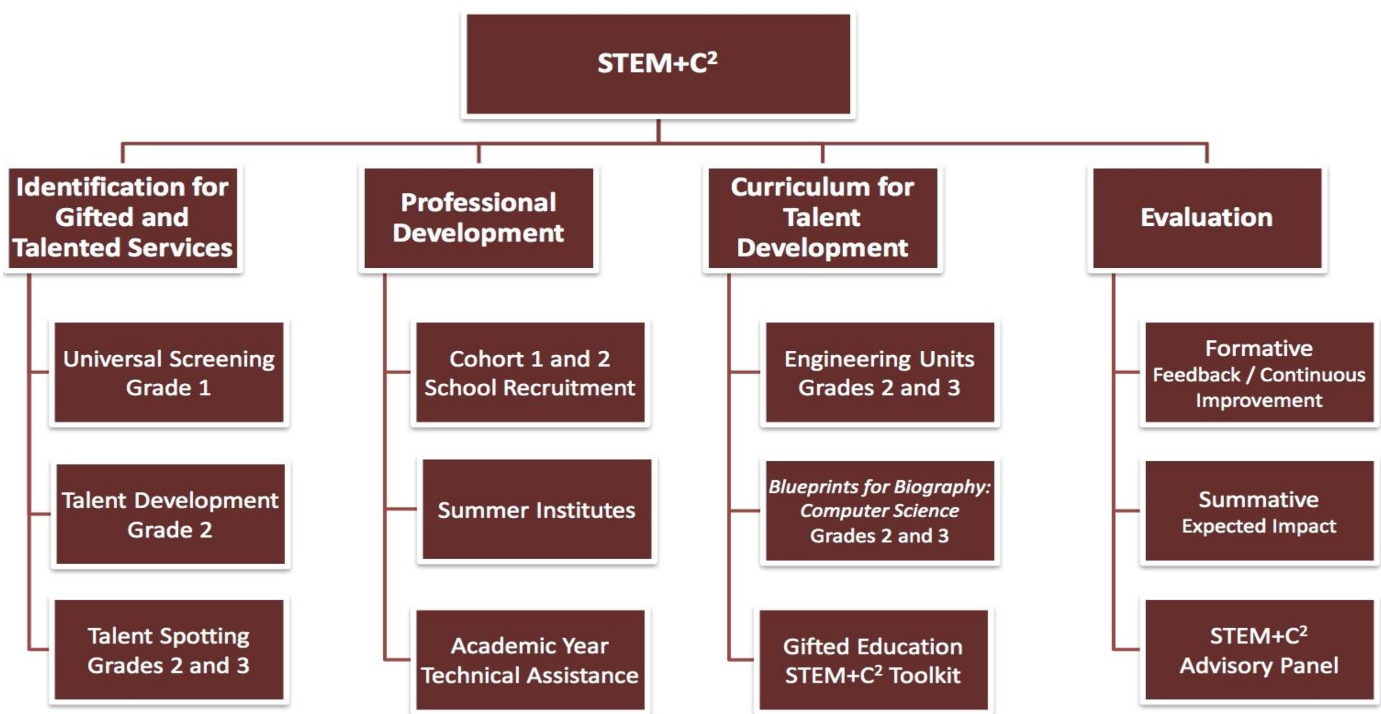


Figure 1. **STEM+C²** Project Design

Project goals, objectives, and outcomes are aligned with the project design. Details about each goal, measurable objectives, and specified outcomes are provided in Table 1, **STEM+C^2** Project Goals, Objectives, and Performance Measures/Outcomes.

Table 1: **STEM+C^2** Project Goals, Objectives, and Performance Measures/Outcomes

Project Goals	Measureable Objectives	Performance Measures/Outcomes
Goal 1: Develop, implement, and disseminate a replicable model linking universal screening, teacher talent-spotting, and innovative elementary gifted and talented services in STEM, including Computer Science.	**Objective 1.1**: Develop and implement a statewide recruitment plan for 132 educators (60 teachers and 12 replacements) 30 gifted and talented teachers, and 30 principals). **Objective 1.2**: Develop and field test project deliverables on universal screening, talent-spotting, and **STEM+C^2** curriculum resources in 90 classrooms. **Objective 1.3**: Implement **STEM+C^2** in 45 treatment and 45 delayed-treatment classrooms. **Objective 1.4**: Disseminate the **STEM+C^2** replicable model at 3 or more professional conferences and online	**132** educators from public, public charter, and private schools with 50% or above poverty rate served in **STEM+C^2**. **STEM+C^2** gifted and talented universal screening/identification documentation developed for **STEM+C^2** Toolkit. 60 classrooms received services. 3 professional conference presentations given, 2 or more manuscripts submitted, online materials posted.
Goal 2: Increase the number of gifted and talented students from underrepresented groups screened, newly identified, and served through gifted and talented services in 30 elementary schools.	**Objective 2.1**: Collect universal screening data from principals and gifted and talented teachers in 30 project schools. **Objective 2.2**: Increase teacher nominations of students from underrepresented groups for gifted and talented services by 50%. **Objective 2.3**: Document, analyze and increase the number of gifted and talented students newly identified and served in **STEM+C^2**.	Students from 60 classrooms were universally screened for districts' gifted and talented identification process. The number of teacher nominations and the number of students identified for districts' gifted and talented identification process were greater in treatment classes than in delayed-treatment classes and greater than in prior years ($p < .05$).
Goal 3: Increase student achievement in science and math through engagement in challenging integrated science, engineering, and	**Objective 3.1**: Increase students' scores on state science and math accountability tests. **Objective 3.2**: Increase students' STEM content knowledge on an above-level test at the $p<.05$ level. **Objective 3.3**: Increase students' awareness of computer science and what	At least 30% of students who participate in **STEM+C^2** move up a level (or remain at the highest level) on science and math accountability tests. Statistically and significantly increased scores on an above-level STEM content test ($p < .05$). Treatment scores relative to delayed-treatment scores were likewise greater ($p < .05$).

computer science curricula.	computer scientists do through biographies and the corresponding *Blueprint*s.	
Goal 4: Increase educator knowledge and skills, thus expanding access to effective teachers in high-poverty and/or isolated rural schools.	**Objective 4.1**: Increase teachers' recognition of gifts and talents in students from underrepresented groups. **Objective 4.2**: Increase teachers' knowledge and skills for teaching STEM content, including computer science. **Objective 4.3**: Increase teachers' knowledge and application of biography in engineering and computer science curricula. **Objective 4.4**: 60 % or more of teachers will initiate National Board for Professional Standards candidacy.	**STEM+C^2** teachers increased their scores on assessments of: 1) their recognition of gifts and talents in students from underrepresented groups, 2) knowledge and skills for teaching STEM, and 3) their scores on an assessment of biography knowledge and application. In above outcomes, **STEM+C^2** teacher posttest scores were statistically and significantly greater ($p < .05$) than the scores of teachers in delayed-treatment.
Goal 5: Evaluate the effects of the **STEM+C^2** model on 30 elementary schools.	**Objective 5.1**: Implement formative feedback 3 times per year to ensure continuous improvement throughout the design and delivery of project services. **Objective 5.2**: Document and analyze student learning gains on STEM assessments at the p<.05 level. **Objective 5.3**: Document and analyze teacher learning gains on **STEM+C^2** assessments at the p<.05. **Objective 5.4**: Disseminate **STEM+C^2** research and evaluation results through conference presentations, publications, and online postings. **Objective 5.5**: Establish Advisory Panel	Administered, analyzed, and reviewed surveys after teacher training, the middle, and end of each implementation year. Collected student STEM pre-tests (beginning of Grade 2), post-tests (end of Grade 2), and post-tests (end of Grade 3). Analyze Cohort 1 treatment vs. delayed Cohort 2 with no treatment and Cohort 2 delayed-treatment vs. Cohort 2 from prior years. Collected and analyzed **STEM+C^2** teacher pre-tests (before summer programming) and post-tests (end of school year). Convened Advisory Panel annually.

Addressing the needs of underrepresented students through universal screening, identification, talent-spotting, and gifted and talented education services. The proposed project, **STEM+C^2** falls on fertile ground; it provides the missing primary classroom component to develop the pipeline of STEM+C talents early (National Science Board, 2010). Although state statistics document a low-income and poorly educated population, gifted and talented education has strong roots in Arkansas. Identification and services are mandated, supported with state policies, and monitored by the Arkansas Department of Education. Public schools are expected to serve promising students, but struggle to do so, especially at the primary grades. Few public charter schools and fewer private schools, particularly denominational private schools identify or serve their promising students (Robinson, Sedivy-Benton, Deitz, & Moreno, 2019). **STEM+C^2** is designed to intervene in 60 grade-level classrooms and 30 gifted education classrooms with 120 educators and 1,380 students in 30 schools with high proportions of children from low-income and culturally diverse households. Table 2: Numbers of Arkansas Public, Public Charter and Private Nonprofit Schools with High-poverty Classrooms demonstrates the extent of poverty and the numbers of schools and classrooms whose students, teachers and principals would be eligible to participate in **STEM+C^2. Our recruitment plan allows for the equitable participation of public, public charter and private nonprofit elementary schools.**

Table 2: Number of Arkansas Public, Public Charter and Private Schools with High-poverty Classrooms

Category	Number of schools	Estimated number of Grade 1 classrooms	Estimated number of Grade 2 classrooms	Estimated number of Grade 3 classrooms
Primary/ elementary public and public charter schools across the state	531[a]	1,593[b]	1,566 [b]	1,593 [b]
Primary/ elementary private schools across the state	143[c]	143	143	143
Primary/ elementary schools across the state with 50% or higher Poverty Rate as determined by meal subsidy status	438[c]	1,218[e]	1,292[e]	1,314[e]

Note. [a]ESEA Accountability Status. (n.d.). Retrieved May 10, 2019, from https://adedata.arkansas.gov/Ark12. [b]Average number of total Grade 1, Grade 2, and Grade 3 students in 1:23 teacher:student ratio. Retrieved May 14, 2019, from myschoolinfo.arkansas.gov. [c]Report (n.d.). Retrieved May 14, 2019, from myschoolinfo.arkansas.gov. [e]Average number of total Grade 1, Grade 2, and Grade 3 students 1:23 teacher:student ratio. Retrieved May 14, 2019, from myschoolinfo.arkansas.gov.

According to the Arkansas Statewide Information System (2018), the state **needs** to increase participation of underrepresented groups of students in gifted programs and services. The most pervasive gap occurs among economically disadvantaged students from low-income households. Statewide, statistics reveal **63.45%** of Arkansas school children are economically disadvantaged as defined by Free and Reduced Lunch criteria; however, only **45.5%** of the state's identified gifted and talented population are from low-income households. The growing Hispanic and Latinx population of Arkansas is **13%**, yet only **5.8%** of Hispanic students are served through gifted and talented programs. They are proportionally underrepresented by over half**.** In an alarming report, Callahan et al. (2013) found Arkansas school districts with an Hispanic population of greater than **71%**, report fewer than **10%** of students identified for gifted programs and services. They are underrepresented by seven-fold. African-Americans comprise **19.97%** of the school population; yet, gifted and talented programs only serve **15.57**%

Given the underrepresentation of children from low-income and culturally diverse households in Arkansas gifted services, **STEM+C^2** will target identification barriers through systematic, statewide recruitment, sustained and differentiated professional development with respect to the effects of poverty and cultural factors on talent development, the implementation of universal screening as part of the state's existing identification practices, and challenging and creatively designed **STEM+C^2** curricula.

With field-tested curriculum and project services focused on universal screening at Grade 1 as well as engineering and computer science instruction at Grades 2 and 3, and STEM+C integrated in gifted and talented services, **STEM+C^2** targets and empowers general elementary classroom teachers and gifted and talented teachers to engage in talent-spotting in domains once considered the province of college students and adult professionals. Specifically, **STEM+C^2**

features engineering curricula, including engineering design challenges, and computer science explorations enriched and extended by biographies of computer scientists to foster identity development in young children. In large-scale quantitative studies, the engineering curricula to be implemented in **STEM+C²** demonstrated increases in student science achievement (Robinson, et al., 2017) and student engineering knowledge (Lachapelle, Oh, & Cunningham, 2017; Oh, Lachapelle, Shams, Hertel, & Cunningham, 2016; Robinson et al., 2017). With respect to the biography component of **STEM+C²**, qualitative studies document the development of science, engineering and computer science identities in elementary children (Capobianco, Yu, & French, 2015; Kelly, Cunningham, & Ricketts, 2017). Through the use of non-fiction narratives (Pantoya, Aguirre-Munoz, & Hunt, 2015) and STEM biography (Deitz, 2012; Deitz & Robinson, 2016) in elementary classrooms, children developed an understanding of what scientists and engineers do and could see themselves in those roles. The *Blueprints for Biography:Computer Science Series* is designed to transfer this evidence-based strategy from science and engineering to computer science.

Addressing the needs of underrepresented students through STEM access. In a national survey of 371 district gifted programs and services, Callahan, Moon, and Oh (2013) reported the plurality of elementary programs focused on language arts as the most well-developed content area in their program (47.2%) while a scant 10.5% of the schools identified science and technology as their primary content area. The emerging content areas of engineering and computer science in the elementary grades, two of the subject matter foci of the proposed **STEM+C²** were not even reported as curricular options. In preliminary findings from the National Research Center for Research on Gifted Education (NCRGE), researchers reported that most gifted and talented services at the elementary level relied more heavily on thinking skills instruction than on advanced content (NCRGE, 2019). Researchers did not specifically investigate gifted education services focused on science, engineering or computer science for students in Grades 3 through 5, although respondents identified grade-level math extensions as part of the gifted education pull-out program services more frequently than math content acceleration (63-66% compared to 41-42%) (NCRGE, 2019). Clearly, there is a strong need for STEM and Computer Science curriculum in the early elementary grades, and this need is currently unfulfilled in gifted education services.

Project Components

The goals, objectives, and outcomes, delineated in Table 1, are supported by the four (4) major components of **STEM+C²**: 1) **Identification for Gifted and Talented Services,** 2) **Professional Development**, 3) **STEM+C² Curriculum for Talent Development,** and 4) **Evaluation**.

First, each major component is described in text. Second, each relevant goal is listed at the end of each component to indicate how project goals and activities are aligned. The project components are presented on page 2 in Figure 1, **STEM+C²** Project Design.

Component 1: Identification for Gifted and Talented Services. Identification is initiated in Grade 1 where the state accountability mathematics test is administered as a part of the state's testing schedule; this test will be used as the **STEM+C²** initial universal screening test. By providing **Technical Assistance** in Year 1 to gifted and talented teachers who are responsible for gathering and organizing school-based data for building committee consideration, a universal screening feature will be added to the state identification practices which currently include multiple criteria, teacher nomination, and committee decision-making. Universal screening (with or without local norms) is not required in Arkansas and is not widely used by individual districts to increase the diversity of students in gifted programs and services (Callahan et al, 2013). Although universal screening has been recommended in gifted education to increase representation of underserved students (Card & Giuliano, 2015; Yaluma & Tyner, 2018), the efficacy and the financial sustainability of universal screening have been debated (Lakin, 2016). To minimize costs and disruption to school testing routines, the **STEM+C²** application of universal screening uses existing test data collected as part of the school accountability plan and the gifted and talented identification assessment practices already in place. The project's innovation in universal screening is developing practitioner-friendly procedures and documents to be included in the **STEM+C²** Toolkit implemented by gifted education teachers responsible for building level identification. The **Identification** component includes two additional features. These are **Talent Development**, exposing all Grade 2 students in the project schools to challenging and engaging instruction, and **Talent Spotting** in Grades 2 and 3, preparing classroom teachers to "spot" behaviors that emerge when young children, particularly those from low-income households are exposed to hands-on engineering. These engaging activities differ dramatically from literacy and numeracy instruction common in primary classrooms (Robinson, et al, 2018).

Component 2: Professional Development. Informed by multiple research studies (Heller, Daehler, Wong, Shinohara, & Miratrix, 2012; Penuel, Gallagher, & Moorthy, 2011; Sandholtz & Ringstaff, 2011), **STEM+C²** actively employs critical elements of evidence-based professional development. Specifically, **STEM+C²**: (a) involves teachers in active learning, (b) occurs over an extended period of time, and (c) utilizes follow-up support through technical assistance. To maximize fidelity of implementation, **STEM+C²** is implemented and evaluated under ideal conditions (Towne, Wise, & Winters, 2005). Following Lachapelle, Oh, and Cunningham

(2017), ideal conditions are defined as: (1) selecting teachers from a pool who choose to participate, (2) providing all materials needed for implementation of services and identification, and (3) providing extensive professional development.

Cohort 1 and 2 School Recruitment. To ensure statewide opportunity and equitable access to project services, **STEM+C²** includes a systematic recruitment plan. Teachers and their principals are recruited through statewide contacts with school administrators in public, public charter, and private schools. Key agencies and groups will collaborate to recruit educators for **STEM+C²**. First, the Commissioner's Office of the Arkansas Department of Education will provide statewide announcements through its digital communications network. The Department of Education also oversees 16 Regional Service Cooperatives located in rural communities. Cooperatives include both gifted education and STEM supervisors who will be key contacts to recruiting high-poverty elementary schools. Second, the Arkansas Association of Educational Administrators (AAEA) will distribute invitations for school teams to apply with links to application packets. Third, the state advocacy organization, Arkansans for Gifted and Talented Education (AGATE) maintains an active website, a newsletter, and a membership listserv where **STEM+C²** will be distributed. (See letters of agreement in Appendix C). Schools who apply are selected with explicit criteria (e.g. 50% poverty rate, a student body which includes culturally diverse individuals, a willingness to implement **STEM+C²** project components) and will be randomly assigned to professional development and technical assistance services in Years 1, 2, and 3 (Cohort 1 Treatment) or in Years 3, 4, and 5 (Cohort 2 Delayed Treatment). New information will be generated by comparing the achievement of students in the classrooms of teachers served through **Summer Institutes and Technical Assistance** with the achievement of students in delayed-treatment classrooms. All Cohort 1 and Cohort 2 schools, teachers, and principals receive the same services and project deliverables over the duration of the 5-year project.

Cohort 1 and Cohort 2 School Recruitment supports Project Goals 1, 2, and 4.

STEM+C² Summer Institutes. Institutes were an effective professional development component in previous evidence-based projects and produced significant learning gains in educators' knowledge and skills (Cotabish et al., 2011; Dailey & Robinson, 2017) and subsequently in student achievement (Robinson et al., 2014; Robinson et al, 2017; Robinson, et al, 2019). In the professional development component of **STEM+C²,** four-day **Summer Institutes** will be held over the duration of the proposed project. The initial institutes will provide training to Cohort 1(Treatment) Grade 2 and Grade 3 classroom teachers as well as gifted and talented teachers, and building principals (***n* = 60**) in Years 1 and 2. As part of a delayed treatment design, the Cohort 2 educators (Delayed Treatment/Comparison) (***n* = 60**) will receive training through **Summer Institutes** in Years 3 and 4. Institutes will be provided regionally depending upon the location of the project schools, but it is anticipated **Summer Institutes** will be held in and have been budgeted for the central Arkansas population center of the state, in the northern region of the state, and in the southern rural region of the state. **Summer Institutes** will provide teachers with: a) content related to the science, engineering, and computer science disciplines, b) information and strategies to assist teachers with the procedures for universal screening, teacher talent spotting, and identification of promising students from underrepresented groups, and c) engineering and computer science-related resources, including *Blueprints for Biography*: *Computer Science Series*, and a **STEM+C²** Toolkit of engineering design challenges and computer science explorations for the gifted and talented teachers. To enhance teacher learning, the institutes will be structured so that teachers take the role of students while expert instructors model effective STEM and gifted education pedagogy. As recommended by VanTassel-Baska, Bass, Ries, Poland, and Avery (1998) and highlighted in the Next Generation Science Standards (National Research Council, 2013), instructional emphasis will be placed on the Next Generation Science Standards (NGSS) cross-cutting concepts, science and engineering practices, and computer science computational thinking. Teacher learning gains will be evaluated through pre-post content knowledge assessments (performance measures/outcomes are found in Table 1, Project Goals, Objectives, and Performance Measures/Outcomes).

Summer Institutes support Project Goals 1, 2, 3, and 4.

Technical Assistance. A unique high-profile feature of the Professional Development Component, **Technical Assistance,** is a suite of services for job-embedded support to Grade 2 and Grade 3 classroom teachers (N= 60) and gifted education teachers (N = 30) in **STEM+C^2.** **Technical Assistance** includes individualized consultation with the Technical Assistance Director throughout the academic year, and short-term intensive online modules with the Principal Investigator, Curriculum Director, and Technical Assistance Director supporting the implementation of **STEM+C^2**. Grade 2 and Grade 3 classroom teachers will enroll and be supported in foundational modules in gifted education focused on understanding the effects of poverty, race, ethnicity, and gender on locating and developing talents in young children and on the implementation of differentiated instruction and curricula. Following the completion of the first module, classroom teachers will enroll in a field experience module aligned to their implementation of the engineering unit and the biography and its companion *Blueprint for Biography: Computer Science Series*. Gifted education teachers and principals will receive **Technical Assistance** on the rationale for and the implementation of universal screening in their schools**.** In addition, gifted education teachers will be provided with support for implementing the engineering design challenges, the computer science explorations, and the comparative biographies and their *Blueprints.*

Finally, **Technical Assistance** includes support for National Board Teacher Certification (NBTC) for project teachers. NBTC is an indicator of observable teacher quality (Cavalluzzo, 2004) and teacher effectiveness with minority and low-income students (Goldhaber & Anthony, 2007). NBTC is designed to impact student learning. Grounded in standards for accomplished teaching, certification is a voluntary process whereby teachers document the application of expertise and engagement in best practices (National Board for Professional Teaching Standards, 2016). Teachers submit classroom-based components to National Board online and take one examination in an approved testing center. **STEM+C^2** Grade 2 and Grade 3 teachers may initiate certification in areas such as: Early Childhood Generalist or Exceptional Needs Specialist (gifted and talented education pathway). **STEM+C^2** teachers will receive Technical Assistance to initiate the National Boards process and to complete and submit one component. If teachers earn a qualifying score, they are eligible to apply to the Arkansas Department of Education for funding to submit the remaining three components as per Arkansas Rules and Regulations.

Technical Assistance supports Project Goals 1, 2, 3, and 4.

Component 3: Curriculum for Talent Development. Students will engage in two types of innovative curriculum units and one **STEM+C^2** Toolkit during the project intervention. These include: 1) Adapted *Engineering is Elementary (EiE*) and *Engineering is Everywhere* units, 2) Trade book biographies supported by the *Blueprints for Biography: Computer Science Series*, and 3) Gifted Education **STEM+C^2** Toolkit which includes engineering design challenges and computer science explorations. Details about each type of curriculum are provided below.

Engineering Unit. The Next Generation Science Standards (NGSS) and the Standards for Technology Literacy (STL) establish engineering as an important new content domain for young children. Evidence-based curricula, *EiE* and *Engineering is Everywhere* have been selected for **STEM+C²** (Lachapelle, Oh, & Cunningham, 2017). The units include a teacher guide, a student storybook with a real-world engineering design challenge, and a refillable kit or a teacher guide, a student email exchange with an embedded real-world engineering design challenge, and a refillable kit. Students engage in engineering activities integrated with science instruction. **STEM+C²** will implement a materials engineering unit in Grade 2 and an aerospace engineering unit in Grade 3.

Blueprints for Biography: Computer Science Series. *Blueprints for Biography* is a model teaching and curriculum guide linked to a specific biography (Robinson, 2006). They include high-level questioning strategies, a persuasive writing activity, primary sources and in the case of STEM-focused biographies also classic science experiments or engineering design challenges. For the **STEM+C²** project, a *Blueprints for Biography: Computer Science Series* will be developed after reviewing the New Generation Science Standards (NGSS), the K-12 Computer Science Framework (2016), and Arkansas Computer Science Standards for Grades K-8 (2016).

The following computer scientists are examples of individuals on whom trade book biographies are available and which link to key science, engineering, and computer science outcomes: (a) Raye Montague, (b), Grace Hopper, and (c) Ada Lovelace. Biographies are selected based on specific criteria which have been found to positively impact student learning and motivation. For example, Lin-Seigler and colleagues (2016) found biographies that portrayed the struggles and challenges individuals had to overcome to reach their goal foster greater motivation to pursue the role portrayed. Owens (2009) provided guidance on the importance of gender stereotypes in STEM biography. Deitz and Robinson (2016) noted that teachers' responses to using biography in the classroom affected how well they thought their students understood scientists and inventors. Biographies are a means of bringing to life the kind of work done by a scientist, engineer, or computer scientist so that students understand the unique and shared experiences of individuals in these disciplines, develop interests, and correct misunderstandings of what a scientist, engineer, or computer scientist does.

The three biographies under consideration for this project represent individuals who struggled to attain their goals, whose biographies include information about their early interests and childhood experiences and whose biographies include information about the kinds of work computer scientists do. Raye Montague, an African-American computer scientist, described by the U. S. Navy as their "hidden figure," developed computer programs to design submarines quickly enough to be built during wartime but was prevented from participating in the launch of her first submarine design because she was a Black woman. Grace Hopper, had the insight to move from binary machine language to using English words and developed the first word-based programming languages in computer science. She worked her way through school and pursued a career in computer science uncommon in the 1940s. Ada Lovelace, a 19^{th} century whiz at mathematics and computational reasoning, anticipated how machines would eventually be programmable through performing repeated tasks sequentially and in a loop, a staple of modern computer science.

Each guide in the *Computer Science Series* concludes with a science investigation or engineering design challenge as well as a computer science exploration created to build the foundation in computational thinking, a critical skill in computer science. Through advanced content and talent development activities, the *Blueprints* for Grade 2 and Grade 3 link to the two engineering curriculum units implemented in **STEM+C²** classrooms. The *Blueprints* for Grade 3 gifted education services links to the engineering design challenges and the computer science explorations in the **STEM+C²** Toolkit.

Gifted Education STEM+C² Toolkit. The Toolkit will be developed to support schools in implementing the **STEM+C²** project. It will contain an overview of the project, the roles and responsibilities of the classroom teacher, the gifted education teacher, and the principal in implementing the services. Key sections of the Toolkit include: 1) the rationale and procedures for universal screening, 2) information on and activities for educators to understand the effects of poverty, language, and culture on the development of talents, 3) children's conceptions of scientists, engineers, and computer scientists and ways educators can encourage more realistic perceptions of who can aspire to join a STEM community, 4) example design challenges and computer science explorations, and suggestions for implementing them. The development of the **STEM+C²** Toolkit will be drafted by project staff, informed by Advisory Panel review, and revised based on teacher and principal feedback.

Curriculum for Talent Development supports Project Goals 1, 3, 4 and 5.

Component 4: Evaluation

The **Evaluation component** includes activities and milestones described in Section D, Project Services to improve the project (formative) and to assess project impact on teaching and learning (summative). Furthermore, the project will utilize an Advisory Panel including individuals such as, the Arkansas Commissioner of Education (See Appendix C for letter of agreement), a member of the business community, educators from participating schools, a member of the computer science community, a member of the Raye Montague family, the Arkansas State Director of Gifted and Advanced Placement Programs, and a member of the

Governor's Advisory Council on Gifted and Talented Education. The Advisory Panel will provide guidance on future directions for the project and will assure that the project is fulfilling its responsibilities to serve teachers and underrepresented gifted learners. The Advisory Panel will examine project procedures, practices, and milestones; review content, curriculum changes, and standards alignment; and examine criteria to ensure fidelity of project implementation.

The **Evaluation** component supports Project Goals 1 and 5.

(B) Project Personnel

A key ingredient for implementing a successful field-based project is the quality of its personnel. The staff and consultant configuration for **STEM+C^{2}** highlights the high value placed on scouting for the best talent available to ensure attainment of the project goals. The project team includes individuals with strong content backgrounds in Gifted and Talented Education, in STEM, and in program evaluation who will devote substantial time and effort to make this project a success. (Part 2, Budget Information summarizes allocations of time and effort of key personnel). (See Appendix B, Vitae, for detailed information on the qualifications of project personnel). Briefly, key project personnel and consultants are:

<u>Principal Investigator (PI).</u> Dr. Ann Robinson, UA- Little Rock, received her doctorate in educational psychology from the Purdue University. Robinson has extensive experience with externally funded projects and has served as Principal Investigator or as key personnel for previous U. S. Department of Education grants under a variety of educational programs. In 2007, she led a grant writing team that secured $13.2 million for the state of Arkansas from the National Math and Science Initiative (NMSI) funded through the Exxon-Mobil Corporation. Robinson is a Past President of the National Association for Gifted Children (NAGC), a former editor of the *Gifted Child Quarterly*, a current Associate Editor of *Gifted and*

Talented International, has authored numerous books and publications including journal publications focused on elementary STEM education, and has developed and implemented online courses in gifted, creative, and talented education as well as educational assessment. She is the initial developer of the *Blueprints for Biography* model. Her experience with teacher professional development and preparation in online contexts, her experience in leading teams in state-wide, school-based project design and implementation, and her experience in serving on and leading advisory boards and panels provide an extensive range of skills critical to project success and sustainability. She will serve as the PI of **STEM+C²** @ 20% for 9 months and 25% during summer annually.

Co-Principal Investigator (C-PI). Dr. Jill L. Adelson, Duke University Talent Identification Program (Duke TIP), has a doctorate in educational psychology with a joint emphasis in Measurement, Evaluation, and Assessment as well as Gifted Education from the University of Connecticut. She holds a Certificate in Quantitative Research Methods in Psychology. Dr. Adelson brings both content expertise (elementary school gifted/mathematics education background) as well as methodological/statistical expertise. Her background as an elementary school teacher of a self-contained gifted program along with her educational background in gifted education and mathematics education is important as the team considers implementation issues related to the elementary grades, to preparing teachers to recognize and work with gifted students, and to implementing a STEM intervention. Her statistical and methodological expertise and skills will allow for stronger inferences to be made about the effectiveness of the project. Her background in assessment as well as her work on a federally funded project, STEM Starters+, developing above-level STEM tests for elementary grades will be critical to the instrumentation work. Her dissertation, *Examining the Effects of Gifted*

Programming in Mathematics and Reading Using the ECLS-K (a *Gifted Child Quarterly* Paper of the Year), is indicative of her extensive experience with large school intervention studies. She is co-author of Teacher Support Materials for Project M^3: Mentoring Mathematical Minds and Project M^2: Mentoring Young Mathematicians and has provided teacher professional development and support on the mathematics units. Adelson will serve as the Co-PI for **STEM+C²** @ 20% for 12 months annually.

Curriculum Director (CD). **Dr. Christine Deitz** is the Associate Director of the Jodie Mahony Center for Gifted Education. Her dissertation study examined teacher perceptions of implementing biography in elementary classrooms. Dr. Deitz received the A. Harry Passow Classroom Teacher Award and as well as the Curriculum Award from the National Association for Gifted Children. She has co-authored teacher guides for the *Blueprints for Biography: STEM Series*. She holds a Master Professional Educator teaching license in multiple areas, including elementary education, and two National Board Teacher certificates in Exceptional Needs: Gifted pathway and Social Studies. Dr. Deitz directs the largest National Board Teacher support site in Arkansas at UA Little Rock. She has over 26 years of teaching experience in metropolitan elementary and middle schools where she also coordinated gifted and talented services in schools with high proportions of students from low-income households. Dr. Deitz will serve as the Curriculum Director of **STEM+C²** @ 50% for 12 months annually in Years 1, 2, and 5 and @ 40% in Years 3 and 4.

Technical Assistance Director (TAD). Kristy A Kidd, UA - Little Rock, currently works with 23 highly diverse schools throughout the state of Arkansas in science and engineering professional development. Ms. Kidd has over 24 years of experience in elementary and middle school public and public charter schools and holds a Master Professional Educator teacher license. She collaborated with the Early Childhood Education teacher preparation program at UA Little Rock to develop and implement an inquiry-based curriculum in the undergraduate integrated science methods course for teacher candidates seeking a degree in early childhood education. Ms. Kidd is a Milken National Award educator and represented the City of Little Rock at the National Science Teachers Association as the 2014 recipient of the DuPont Office of Education National Science Teacher Education Scholarship. As the Technical Assistance Director for **STEM+C^2,** she will develop and direct the **Technical Assistance** component of the project with an emphasis on the **STEM+C^2** Toolkit. Ms. Kidd will serve as Technical Assistance Director @ 100% over 12 months annually.

Engineering Education Consultant (EEC). Dr. Christine Cunningham. In addition to Key Project Personnel, Dr. Cunningham, a leading expert on science and engineering education, is a critical member of the project team. She received her doctorate in Science Education from Cornell and is currently professor of education and engineering at The Pennsylvania State University. In 2017, she was awarded the prestigious Harold W. McGraw, Jr. Prize in Education which recognizes individuals who have made innovative and significant contributions to changes in P-12 Education. She will ensure that the engineering units implemented in **STEM+C^2** are informed by cutting edge research and emerging lessons from practice in integrating science, technology and computer science into engineering curricula. Dr. Cunningham will allocate 10 days annually to the project.

(C) 5 Year Management Plan

The management plan for **STEM+C^2** is presented in Table 3, Management Plan. The table delineates the project goals, with corresponding measureable objectives and activities/milestones listed under each goal. Each activity/milestone lists the personnel responsible for ensuring its successful completion and the timeline. The management plan will be implemented through extensive collaboration among the Principal Investigator (PI), Co-Principal Investigator (Co-PI), Curriculum Director (CD), Technical Assistance Director (TAD), Engineering Education Consultant (EEC), and the **STEM+C²** Advisory Panel.

Table 3: **STEM+C²** Management Plan

KEY: PI= Principal Investigator; Co-PI = Co-Principal Investigator ; CD=Curriculum Director; TAD= Technical Assistance Director; AP= Advisory Panel; ECC= Engineering Curriculum Consultant; X=Activity; T= Treatment; D= Delayed-Treatment

Goals, Objectives, and Activities/ Milestones	Staff Re-spon-si-bilities	YEAR 1			YEAR 2			YEAR 3			YEAR 4			YEAR 5		
		Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer
Goal 1: Develop, implement, and disseminate a replicable model linking universal screening, teacher talent-spotting, and innovative elementary gifted and talented services in STEM, including Computer Science.																
Objective 1.1: Develop and implement a statewide recruitment plan for 132 educators (60 teachers and 12 replacements), 30 gifted and talented teachers, and 30 principals.																
1.1.1 Disseminate **STEM+C²** recruitment information to district administrators, principals, and teachers through relevant center listservs, Arkansas Department of Education, Arkansas Association of Educational Administrators media and communications sources, and relevant Center listservs.	PI	X	X													
1.1.2 Develop the school team application packet.	PI Co-PI TAD AP	X														
1.1.3 Recruit and select school teams for participation.	PI Co-PI CD TAD	X	X					X	X							
1.1.4 Finalize participation agreements with teachers and their principals.	PI TAD		X						X							
1.1.5 Design and maintain a **STEM+C²** website.	CD TAD	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Objective 1.2: Develop and field test project deliverables on universal screening, talent-spotting, and STEM +C² curriculum resources in 90 classrooms.																
1.2.1 Develop *Blueprints for Biography: Computer Science Series* curricula; revise based on field test feedback.	PI CD AP	X	X			X	X		X	X		X	X		X	X
1.2.2 Develop the **STEM+C²** Toolkit and revise based on feedback from Advisory Panel.	PI Co-PI CD TAD AP	X	X		X	X		X	X		X	X		X	X	
1.2.3 Develop and implement a protocol for universal screening.	PI Co-PI TAD	X	X	X		X			X			X			X	
1.2.4 Develop Technical Assistance components; revise based on teacher and principal feedback.	TAD	X	X	X	X	X		X	X		X	X		X	X	
Objective 1.3: Implement STEM+C² in 45 Treatment and 45 Delayed-Treatment classrooms.																
1.3.1 Randomly assign school teams to Treatment and Delayed-Treatment cohorts.	Co-PI		X													
1.3.2 Notify teachers and principals of their cohort assignment and provide initial **STEM+C²** participation materials including the universal screening protocol.	TAD		X	X		X			X			X			X	

1.3.3 Schedule, implement, and formatively evaluate Summer Institutes.	**PI Co-PI CD TAD**		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		
1.3.4 Implement Technical Assistance components.	**TAD**			**X**	**X**	**X**		**X**	**X**		**X**	**X**		**X**	**X**	**X**
Objective 1.4 Disseminate the STEM+C² replicable model at 3 or more professional conferences and online.																
1.4.1 Submit proposals to relevant conferences.	**PI CD TAD**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
1.4.2 Disseminate **STEM+C²** model information at relevant conferences (AERA, ASEE, NAGC, NSTA).	**PI Co-PI CD TAD**				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
1.4.3 Submit articles and manuscripts to relevant publications.	**PI Co-PI CD TAD**	**X**			**X**			**X**			**X**			**X**		
1.4.4 Disseminate **STEM+C²** project information and updates through social media.	**TAD**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Goal 2: Increase the number of gifted and talented students from underrepresented groups screened, newly identified, and served through gifted and talented served in 30 elementary schools.																
Objective 2.1: Collect universal screening data from principals and gifted and talented teachers in 30 project schools.																
2.1.1 Collaborate with teachers and principals to collect math test data for universal screening.	**CD TAD**		**X**	**X**		**X**	**X**		**X**	**X**		**X**	**X**		**X**	**X**
2.1.2. Establish math accountability test benchmark.	**Co-PI**	**X**	**X**	**X**												
Objective 2.2: Increase teacher nominations of students from underrepresented groups for gifted and talented services by 50%.																
2.2.1 Plan, conduct, and formatively evaluate Summer Institute components focused on behaviors, needs, identification, and services for students from underrepresented groups for Treatment and Delayed-Treatment teachers.	**PI Co-PI CD TAD**	**T X**	**T X**	**T X**	**T X**	**T X**	**T X**	**D X**	**D X**	**D X**	**D X**	**D X**	**D X**			
2.2.2 Develop, conduct, and formatively evaluate Technical Assistance for Treatment schools.	**PI Co-PI TAD**	**T X**	**T X**	**T X**	**T X**	**T X**	**T X**	**D X**	**D X**	**D X**	**D X**	**D X**	**D X**			
Objective 2.3: Document, analyze, and increase the number of gifted and talented students newly identified and served in STEM+C².																
2.3.1 Collect baseline intervention teacher-nomination rosters.	**TAD**		**X**			**X**			**X**			**X**			**X**	
2.3.2 Collect and analyze artifacts from online modules such as Discussion Boards, Case Study Analysis, and lesson implementation.	**PI CD TAD**				**X**	**X**		**X**	**X**		**X**	**X**		**X**	**X**	
2.3.3 Collect and analyze post intervention teacher nomination rosters.	**Co-PI TAD**					**X**			**X**			**X**			**X**	
2.3.4 Collect and analyze rosters of newly-identified students for gifted and talented services from Grade 3 Treatment and Delayed-Treatment classrooms.	**Co-PI TAD**							**T X**						**D X**		
Goal 3: Increase student achievement in science and math through engagement with challenging integrated science, engineering, and computer science curricula.																
Objective 3.1: Increase students' scores on state science and math accountability tests.																
3.1.1 Align **STEM+C²** curricula with state math and science standards.	**CD TAD AP**	**X**	**X**													
3.1.2 Implement and revise **STEM+C²** curricula in Treatment and Delayed-Treatment schools.	**CD TAD**				**T X**	**T X**		**T X**	**T X**		**D X**	**D X**		**D X**	**D X**	
Objective 3.2: Increase students' STEM content knowledge on an above-level test at the p<.05 level.																

3.2.1 Implement engineering curricula in Grade 2 and Grade 3 Treatment and Delayed-Treatment classrooms; revise based on engineering consultant feedback.	**TAD ECC**				**T X**	**T X**		**T X**	**T X**		**D X**	**D X**		**D X**	**D X**	
3.2.2 Implement the **STEM+C^2** Toolkit in Grade 3 gifted and talented program services in Treatment and Delayed-Treatment classrooms and revise based on teacher and engineering consultant feedback.	**PI Co-PI CD TAD ECC**					**T X**		**T X**	**T X**					**D T X**	**D T X**	
Objective 3.3: Increase students' awareness of computer science and what computer scientists do through biographies and the corresponding *Blueprints*.																
3.3.1 Implement trade biography in *one* Grade 2 and Grade 3 in Treatment and Delayed-Treatment classrooms; revise *Blueprints* based on teacher feedback.	**CD TAD**				**T X**	**T X**		**T X**	**T X**		**D X**	**D X**		**D X**	**D X**	
3.3.2 Implement one *Blueprints for Biography: Computer Science Series* using two or more biographies in gifted and talented program services Grade 3 Treatment and Delayed-Treatment schools; revise based on teacher feedback.	**CD TAD**							**T X**	**T X**		**T X**	**T X**		**D T X**	**D T X**	
Goal 4: Increase educator knowledge and skills thus expanding access to effective teachers in high –poverty and/or isolated rural schools.																
Objective 4.1: Increase teachers' recognition of gifts and talents in students from underrepresented groups.																
4.1.1 Plan, conduct, and formatively evaluate a Summer Institute component on behavior, needs, identification, and services for students from underrepresented groups for teachers in Treatment and Delayed-Treatment classrooms.	**PI Co-PI CD TAD**	**T X**	**T X**	**T X**	**T X**	**T X**	**T X**	**D X**	**D X**	**D X**	**D X**	**D X**	**D X**			
4.1.2 Develop, conduct, and formatively evaluate a Technical Assistance component for Treatment classroom teachers.	**PI Co-PI CD TAD**				**T X**	**T X**		**T X**	**T X**		**D X**	**D X**		**D X**	**D X**	
Objective 4.2: Increase teachers' knowledge and skills for teaching STEM content, including computer science.																
4.2.1 Plan, conduct, and formatively evaluate a Summer Institute component focused on engineering and computer science content knowledge for teachers in Treatment and Delayed-Treatment classrooms.	**Co-PI CD TAD EEC**	**T X**	**T X**	**T X**	**T X**	**T X**	**T X**	**D X**	**D X**	**D X**	**D X**	**D X**	**D X**			
Objective 4.3: Increase teachers' knowledge and application of biography in engineering and computer science curricula.																
4.3.1 Align *Blueprints for Biography: Computer Science Series* curricula with the K-12 Computer Science Framework, Arkansas Computer Science Standards K-8, and the Common Core State Standards for non-fiction reading.	**CD TAD**	**X**	**X**													
4.3.2 Plan, conduct, and formatively evaluate a Summer Institute component on *Blueprints for Biography: Computer Science Series* curricula for teachers in Treatment and Delayed-Treatment classrooms.	**PI Co-PI CD TAD**	**T X**	**T X**	**T X**	**T X**	**T X**	**T X**	**D X**	**D X**	**D X**	**D X**	**D X**	**D X**			

4.3.3 Develop, conduct, and formatively evaluate a Technical Assistance component on *Blueprints for Biography: Computer Science Series* for teachers in Treatment and Delayed-Treatment classrooms.	**Co-PI TAD**				**T X**	**T X**		**T X**	**T X**		**D X**	**D X**		**D X**	**D X**	
Objective 4.4: 60% or more of teachers will initiate National Board for Professional Teaching Standards candidacy.																
4.4.1 Develop, conduct, and formatively evaluate a Technical Assistance component for Treatment and Delayed-Treatment teachers to submit one National Board certificate component.	**CD**												**X**	**X**	**X**	
Goal 5: Evaluate the effects of the STEM+C² model on 30 elementary schools.																
Objective 5.1: Implement formative feedback 3 times per year to ensure continuous improvement throughout the design and delivery of project services.																
5.1.1 Implement formative feedback through educator surveys to ensure continuous improvement throughout the design and delivery of project services.	**Co-PI**	**X**	**X**	**X**		**X**	**X**		**X**	**X**		**X**	**X**		**X**	**X**
5.1.2 Plan and conduct teacher focus groups and interviews to assess the fidelity of implementation and overall factors affecting **STEM+C²** project progress.	**PI Co-PI**					**X**			**X**			**X**			**X**	
Objective 5.2: Document and analyze student learning gains on STEM assessments at the p<.05 level.																
5.2.1 Collect Grade 3 student state accountability test data in science and math.	**Co-PI TAD**								**X**			**X**			**X**	
5.2.2 Develop, pilot, and revise above-level assessments to measure student learning gains in STEM and computer science.	**PI Co-PI TAD ECC**	**X**	**X**	**X**												
5.2.3 Collect and analyze pre-post above-level STEM and computer science assessment data.	**Co-PI TAD**				**X**	**X**		**X**	**X**		**X**	**X**		**X**	**X**	
5.2.4 Develop, pilot, and revise an assessment of identity in STEM and/or computer science.	**Co-PI TAD**	**X**	**X**	**X**	**X**											
Objective 5.3: Document and analyze teacher learning gains on STEM+C² assessments at the p<.05 level..																
5.3.1 Select or develop content assessments to measure teacher knowledge of best practices in universal screening, talent-spotting, identification, and delivery of services to students from underrepresented groups.	**PI Co-PI CD AP**	**X**	**X**													
5.3.2 Collect and analyze teacher learning gains from online modules such as Discussion Boards, Case Study Analysis, and lesson implementation.	**PI Co-PI**				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
5.3.3 Collect and analyze teacher learning gains of STEM on a project-developed measure.	**PI Co-PI TAD**				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
5.3.4 Collect and analyze teacher learning gains in understanding biography and its role in its development of STEM identities in young children.	**PI Co-PI CD**				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Objective 5.4: Disseminate STEM+C² research and evaluation results through conference presentations, publications, and online posting.																

5.4.1 Write annual program report for U.S. Dept. of Education	PI TAD				X			X			X			X		X
5.4.2 Disseminate **STEM+C^2** results and resources with national audiences (AERA; NAGC; ASEE).	PI Co-PI CD TAD				X	X	X	X	X	X	X	X	X	X	X	X
5.4.3 Submit articles and manuscripts to relevant publications.	PI Co-PI CD TAD	X			X			X			X			X		
5.4.4 Update **STEM+C^2** website sharing lessons learned, project outcomes, and research results.	**PI**			X	X	X	X	X	X	X	X	X	X	X	X	X
Objective 5.5: Establish Advisory Panel.																
5.5.1 Establish and annually convene Advisory Panel.	**PI**	X	X			X			X			X			X	

Project Services

Project services bring **STEM+C^2** to life. Collectively the strategies supporting students and their educators focus on: 1) providing sufficient intensity and quality to ensure access for students who have been traditionally underrepresented based on race, color, national origin, gender, or disability and 2) to maximize the impact of the services on them and their educators. (Figures 2 and 3 Continuum of Student Services and Continuum of Teacher Services), respectively display **STEM+C^2** services through graphics).

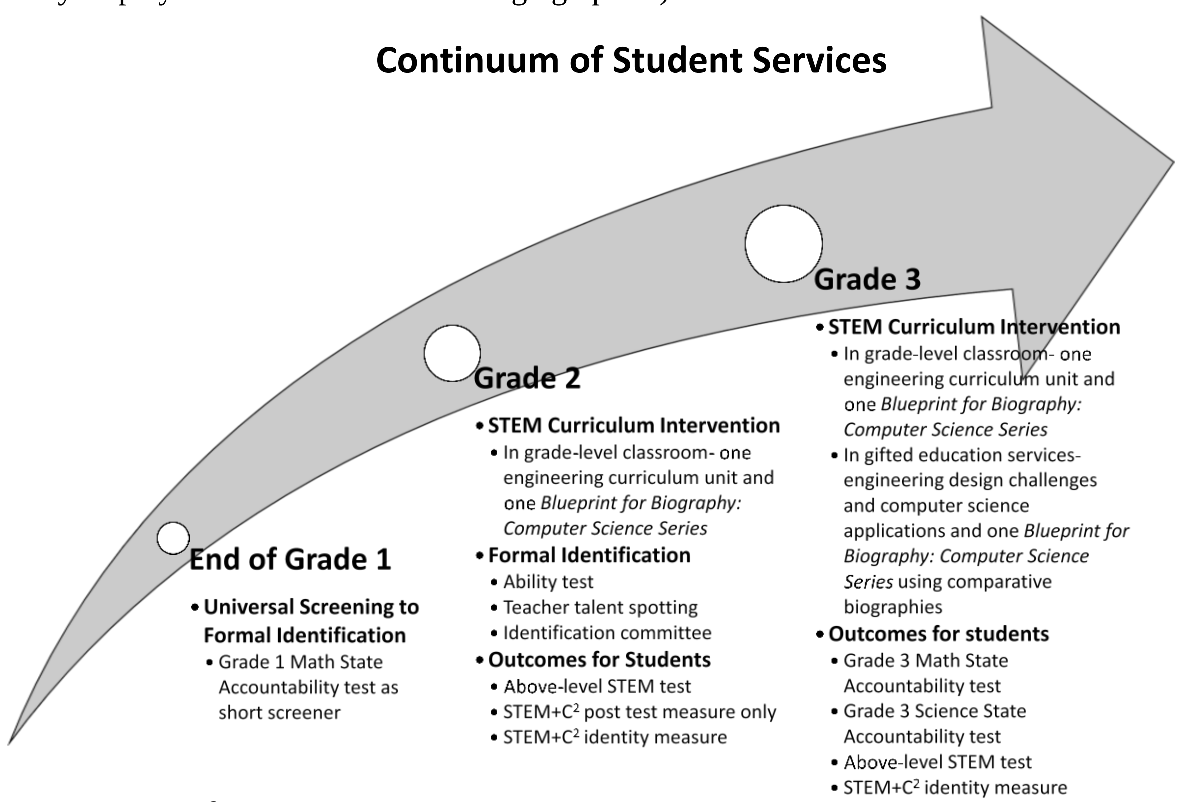
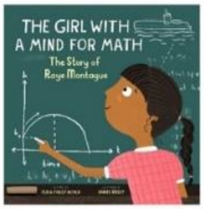
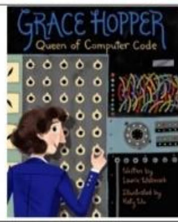


Figure 2: **STEM+C^2** Continuum of Student Services

Project Services Milestone 1: Recruitment and Rollout. During Year 1, the service activities focus primarily on developing and implementing a recruitment plan for Cohort 1 and Cohort 2 schools. The recruitment materials and school application packets will be developed. A distribution plan to reach eligible elementary schools statewide will be implemented with the support of the Arkansas Association for Educational Administrators (AAEA), the outreach of the Arkansas Department of Education and its Educational Service Cooperatives, through the state advocacy organization, Arkansans for Gifted and Talented Education (AGATE), and through the teacher email contacts maintained by the Jodie Mahony Center for Gifted Education. Criteria for the selection of schools will be established to ensure that the project service opportunities reach the eligible participants who are members of groups traditionally underrepresented based on race, color, national origin, gender, age, or disability. Following recruitment and selection, schools will be randomly assigned to Cohort 1 (Treatment) or Cohort 2 (Delayed Treatment) for rolling out services in staggered phases. This permits the project to serve more teachers and students and allows for inferences to be made about the effects of the project on students, teachers, and schools.

Project Milestone 2: Design and Develop Curriculum Resources. During Years 1 and 2 of the project curriculum resources will be designed, piloted and implemented, and revised based on teacher, Engineering Education Consultant, and Advisory Panel feedback. Three curricular activities are the foci of this milestone: 1) Selection of biographies and development of their corresponding *Blueprints*, 2) Selection and development of engineering design challenges linked to the units' science content and engineering practices, and 3) Development of computer science explorations linked to the innovations of computer scientists featured in the biographies and to the foundational practices of computational thinking, algorithmic tasks, and data representation.

Table 4: Alignment of Curriculum Biographies, Strands, and Core Ideas

GRADE	Trade Book Biography	Computer Science Strands	Engineering Core Ideas	Science Core Ideas
Grade 2		Computational Thinking and Problem Solving Data and Information Algorithms and Programs*	ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	PS1.A: Structure and Properties of Matter ESS2.C: The Roles of Water in Earth's Surface Processes
Grade 3		Computational Thinking and Problem Solving Data and Information Algorithms and Programs*	ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	PS2.A Forces and Motion PS2.B Types of Interactions
Grade 3 Gifted and Talented		Computational Thinking and Problem Solving Data and Information Algorithms and Programs*	ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	PS2.A Forces and Motion PS2.B Types of Interactions

* Algorithm within these standards implies a sequence of steps followed when completing a particular task.

This milestone also involves the development of the curricular resources which will be included in the **STEM+C²** Toolkit. These include the Grade 3 Engineering Design Challenges and the Computer Science explorations implemented by gifted educators in Grade 3 Gifted Education programs and services.

Milestone 3: Plan and Conduct Professional Development. During Year 1, the focus is on planning the content and format for regional **Summer Institutes**. Once the location of the Cohort 1 and Cohort 2 schools is established, the locations and dates for Cohort 1 will be set for Years 1, 2, and 3 and for Cohort 2 for Years 3 and 4. Technical Assistance occurs during the academic years in Years 2 and 3 for Cohort 1 and in Years 4 and 5 for Cohort 2. Evidence-based professional development models which have been used to increase teachers STEM content knowledge (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013) and understanding of the impact of culture and gender on student development of STEM identities (Capobianco et al, 2015; Center for Advancement of Informal Science Education, 2015) will be implemented during this milestone. In addition, teachers will observe modeling of pedagogical strategies and then "try them out" in a safe environment with the Curriculum Director and the Technical Assistance Director. In Years 2 and 3 for Cohort 1 teachers and Years 4 and 5 for Cohort 2 teachers, **Technical Assistance** is provided by the Technical Assistance Director (STEM content and strategies), the Curriculum Director (biography and *Blueprint* pedagogy; National Board candidacy), and the Principal Investigator (underserved groups, universal screening, and identification). As a culminating **Technical Assistance** activity, Cohort 1 and 2 teachers will be supported in initiating National Board for Teaching Standards candidacy to ensure access to effective teachers is available to students in high-poverty or rural schools.

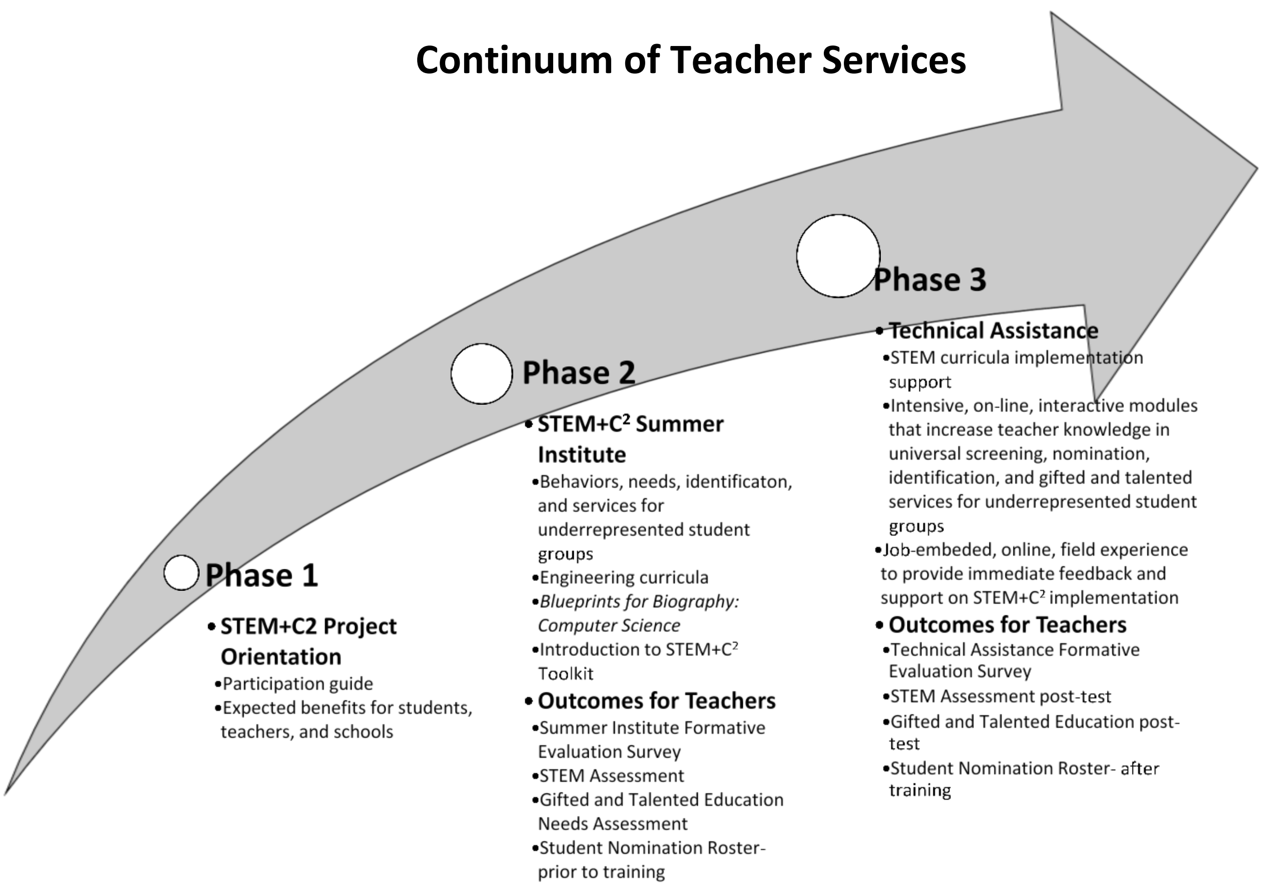


Figure 3: **STEM+C²** Continuum of Teacher Services

Project Services Milestone 4: Implement and Revise Universal Screening, Talent-Spotting, and Identification. Arkansas administers accountability tests in mathematics beginning in Grade 1 where universal screening will be introduced in the **STEM+C^2** project. While educators are familiar with the test, they will need assistance in systematically collecting and integrating the universal screening measure into the processes of talent spotting and identification. The **STEM+C^2** Toolkit will include crucial information on the rationale, the procedures, and the implications of integrating universal screening into the existing gifted education identification procedures required through Arkansas state rules and regulations. For example, districts often use non-verbal tests or multi-ability tests in identification. How the existing testing requirements can be innovatively adapted to increase the identification of underserved students will be included in the Toolkit. The differences between standard models of teacher nominations or referrals versus the use of talent-spotting, which is the use of rigorous curriculum in grade level classrooms to develop talents prior to initiating teacher referrals, will be explained and illustrated with example cases and scenarios in the **STEM+C^2** Toolkit.

Project Services Milestone 5: Implement the STEM+C^2 Model Services. Implementation of **STEM+C^2** services begins at the end of Year 1 and continues through Year 5. The complete suite of services are detailed above in Section D and summarized in Figures 2, 3, and 4. The fourth component of the **STEM+C^2** Model**, Evaluation,** is a continuous process across all years and is detailed below.

Evaluation of Project Services

To maximize the likely impact of project services, The Co-PI, in collaboration with the PI and the project staff, will conduct a **formative evaluation** to support program improvement and a **summative evaluation** to examine the effectiveness of the intervention. The proposed "responsive evaluation" perspective is framed by the belief that the fundamental role is to provide information to improve programs and services and to assess the impact on teaching and student learning (Stake, 2004). The configuration of project personnel and Advisory Panel members brings a significant history of program evaluation to the table. Collectively, they have experience with local, state, and privately- and publicly-funded evaluation projects.

First, the **formative evaluation** will focus on the fidelity of implementation of **STEM+C^2**. It will draw upon findings from teacher surveys and extant program data. The formative evaluation will address the following evaluation questions:

1. To what extent is **STEM+C^2** implemented with fidelity (focusing on the elements of adherence, exposure, quality of delivery, program specificity, and student responsiveness) (Mellard, 2010)?

   a. How well do participants adhere to the curriculum or the instruction in the intervention as intended (e.g., staying true to the intervention, avoiding drift and contamination)?
   b. To what degree is the intervention implemented with quality as it relates to the delivery of instruction?
   c. How often and for how many weeks do students receive the **STEM+C^2** curriculum intervention?
   d. To what extent are students engaged and responsive to the intervention?

2. To what extent did teachers report their professional development and technical assistance supported them in implementing the **STEM+C^2** model?

   a. To what extent did teachers report their professional development and technical assistance supported them in nominating and identifying gifted and talented students from underrepresented groups?

b. To what extent did teachers report their professional development and technical assistance was effective in supporting their implementation of the engineering units?

c. To what extent did teachers report their professional development and technical assistance was effective in supporting their implementation of the computer scientist biography and corresponding *Blueprint*?

3. What are the supports and barriers to teachers' and principals' participation in **STEM+C^2**?

4. To what extent do design, data collection protocols, and data analyses permit inferences about student outcomes?

5. To what extent do design, data collection protocols, and data analyses permit inferences about teacher outcomes?

Second, the **summative evaluation** will investigate the effects **STEM+C^2**. At multiple milestones, the Co-PI will evaluate the progress of and decisions made for the project to provide quality assurance that the implementation yields credible findings about the effectiveness of the program. For example, she will examine the study design with respect to threats to validity and power to detect an effect; will check for fidelity of implementation of the design (e.g., assignment to condition, number of sites, etc.); will verify that project personnel are tracking and reporting attrition and contamination and have provided evidence for the validity and reliability of data; and will provide guidance to the project team about each of these quality assurance milestones so that nothing comes as a surprise. **STEM+C^2** personnel will utilize a randomized design with 45 teachers (N=30 classroom; 15 gifted education) in experimental classrooms (Cohort 1 Treatment) and 45 teachers (N=30 classroom; N=15 gifted education) in comparison classrooms (Cohort 2 Delayed Treatment). The school teams will be randomly assigned to treatment or delayed-treatment conditions. The treatment group will receive the intervention services during the Years 1, 2 and 3 of the project; the comparison group will be provided with services in Years 3, 4 and 5. The delayed treatment design serves four purposes: (1) to increase educator buy-in and support of the intervention, (2) to provide services to more teachers and students, (3) to investigate replicability, and (4) to allow project personnel to examine the effects of a sustained, controlled intervention across two academic years. This evaluation design permits a replication study, allowing us to compare students in Treatment schools with those in Delayed Treatment schools during Years 1, 2, and 3 and also to compare students in the Delayed Treatment schools who receive services in Years 3, 4, and 5 with those who were in the same schools prior to Delayed Treatment (Years 1, 2, and 3).

Evaluation Milestone 1. Design and Develop Evaluation Tools

During Year 1, the evaluation activities will focus primarily on designing, developing, and refining evaluation instruments and processes to use for the balance of the project. These include instruments for teachers related to gifted education; surveys for teachers regarding (a) participation in **STEM+C^2**, (b) how **STEM+C^2** implementation is going (mid-year), and (c) how **STEM+C^2** went (end of year); assessment of teacher understanding of biography, biography pedagogy, and its importance in developing STEM interests and identity formation in young children; and student instruments on (a) STEM identity and (b) above-level STEM content. She also will develop a database to compile, manage, and track the data from the project.

Evaluation Milestone 2. Data Collection and Management

Data collection will begin in the spring of Year 1 and continue through Year 5. The project staff, along with data management support, will collect data from the following sources:

1. Teacher surveys administered after each **Summer Institute** and during the middle and end of the academic year when implementing **STEM+C^2** is supported with **Technical Assistance**.

2. Extant data of nomination and identification for gifted and talented services will be collected in all years and also from prior years to establish a baseline.

3. Student assessments from (a) Cohort 1 students prior to, during, and after Cohort 1 implementation, (b) Cohort 2 students prior to, during, and after the Cohort 1 implementation (to serve as a comparison), and (c) Cohort 2 students prior to, during, and after Cohort 2 implementation (to serve as a replication).

Evaluation Milestone 3. Analysis and Reporting

Interim formative reports submitted in Years 1 - 4 will summarize the survey data to provide formative feedback on professional development, curriculum, and instrumentation goals, objectives, and activities. These reports will evaluate the extent to which the Summer Institutes, Technical Assistance, and the curricula achieve the design goals and will make recommendations for improvement based on formative evaluation findings. The Co-PI will work closely with the PI and key project personnel throughout to provide recommendations that can be implemented in a timely fashion. In Year 5, a final summative report will describe the credibility of evidence for the impact of the program on teacher practice and student learning.

The following are the major approaches to **data analysis for the research design**:

1. Due to random assignment of school teams to Cohort 1 (Treatment) or Cohort 2 (Delayed Treatment) as well as the use of pre-treatment covariates including pretest scores and demographics, external threats to validity are minimized, and observed differences can be attributed to the intervention. Students are nested in the same class taught by the same teacher, thus, we will use multilevel modeling to appropriately adjust the standard errors and to allow us to examine cross-level interactions (McCoach & Adelson, 2010). We will analyze the effects of Cohort 1 implementation by comparing Cohort 1 data with that from Cohort 2 during the same

time period before Cohort 2 has received services. Cohort 2 will be evaluated by conducting a replication analyzing the effects by comparing data from Cohort 2 students receiving delayed treatment with that from Cohort 2 students prior to implementation.

2. Teacher nomination data and scores on teacher instruments will be analyzed using regression models that control for any pre-treatment differences.

Evaluation Milestone 4: Dissemination of Results. The major dissemination approaches for **STEM+C^2** are:

1. Presentations to scholarly and practitioner meetings and conferences such as the American Educational Research Association, the American Society for Engineering Education, the National Association for Gifted Children, the National Science Teachers Association,

2. Manuscripts submitted to journals such as *Gifted Child Quarterly, Journal of Advanced Academics, Journal for the Education of the Gifted, Journal for Equity and Excellence in Education, Journal of Teacher Education, Roeper Review, PRISM, Journal of Engineering Education, Computer Science Education.*

3. Practitioner-friendly materials and findings posted on the **STEM+C^2** website at the Jodie Mahony Center on Gifted Education.

Advisory Panel

An Advisory Panel, composed of individuals with specific areas of expertise, will complete an annual in-depth review of **STEM+C^2** activities, provide guidance on future directions for the project to the Principal Investigator, the Co-PI, the Curriculum Director, the Technical Assistance Director and the Engineering Education Consultant and develop a plan for **STEM+C^2** sustainability following the project period. Advisory Panel members will consist of stakeholders such as a teacher and a principal representative from participating schools; a central office administrator**;** a member of the computer science community; a member of Raye Montague's family who can provide unpublished documentary materials to be included in the *Blueprint* accompanying Ms. Montague's biography, the Arkansas State Director of Gifted and Advanced Placement Programs, a member of the Governor's Advisory Council on Gifted Education and the Commissioner from the Arkansas Department of Education (See Appendix C for letter of agreement). In the spirit of a technology-rich project for teachers and students, the **STEM+C^{2}** Advisory Panel will meet annually through virtual interface to review and provide guidance to the implementation and evaluation of the intervention in schools and the development of project deliverables.

Project Replication, Sustainability, and Impact

Project replication, a key aspect of **STEM+C^{2}**, occurs in three ways. First, the summative evaluation component of **STEM+C^{2}** will provide scientifically-based research on the project through experimental and quasi-experimental field studies. Second, **STEM+C^{2}** includes project deliverables, for example, field-tested *Blueprints for Biography*: *Computer Science Series*, universal screening implementation documents, an above-level STEM achievement measure, and a biography pedagogical knowledge assessment that can be used in other settings and with other STEM and Computer Science programs for young children. The **Summer Institute** and **Technical Assistance** materials and procedures will be fully documented, written up in replicable form in the **STEM+C^{2}** Toolkit, and disseminated to national and state audiences as well as posted on the Jodie Mahony Center for Gifted Education website. **STEM+C^{2}** is designed with replication and institutionalization in mind.