PROJECT NARRATIVE

A.1 Competitive Preference Priority Statements

**Competitive Priority 6: Innovations that Support College Access and Success**

The proposed STEM21 Academy model (STEM21) provides a standards-based, next generation 9–12th grade course sequence in math, science, and technology delivered in an interactive “blended learning” environment, engaging students in a progression of online coursework guided by teachers in classrooms and infused with authentic learning experiences. STEM21 students are eligible to obtain up to 15 college credits that articulate into the CT state college and university system. The ability to earn college credit while in high school is a proven strategy in motivating students to pursue post-secondary education, and facilitates college access and reduces financial barriers by providing up to a full semester of college credit at no cost. STEM21 uses research-based strategies to accelerate learning and prepare under-represented students for college-level STEM coursework (see Project Narrative Section B). Since preparing students for success in post-secondary STEM education is a primary goal of STEM21, standardized college entrance exams are part of the assessment strategy. For students to retain the college credit earned in STEM21, they must pass the College Board Accuplacer exam, used by CT state colleges and universities to determine student readiness for credit-bearing coursework. STEM21 students who do not achieve a passing score on the Accuplacer will receive tutoring to support their passing the exam and obtaining college credit. The College and Work Readiness Assessment (CWRA) will also be used to assess college/career readiness. The CWRA is the high school version of the Collegiate Learning Assessment (CLA), and measures how students perform on constructed response tasks that require an integrated set of 21st century skills. A new content module, “College Ready 21”, focusing on the college selection and application process, will be developed in collaboration with high school and college partners and integrated into the STEM21
course sequence in 10th and 11th grade. STEM21’s experiential learning activities involve a statewide network of college faculty and STEM professionals in discussion forums and mentoring of students on college pathways, the application process, financial aid, and scholarships. Integrated company tours, job shadowing, and internships provide relevant experiences that increase the competitiveness of high-need students’ college applications.

**Competitive Priority 8: Innovations that Serve Schools in Rural LEAs**

The two eligible (SRSA or RLIS) rural high schools in our project area, Region 1 High School (SRSA) in Falls Village CT and Drury High School (RLIS) in North Adams MA, have both committed as STEM21 project implementation sites. (See Appendix D for Letters of Commitment) Region 1 High School services six rural municipalities in the remote northwestern corner of CT, and its four-year cumulative drop-out rate is nearly twice the state average. [2] Drury High School’s drop-out rate also exceeds the state average and 26% of students have family incomes below the federal poverty level. [3] Unique needs of students at both schools include extremely limited exposure to STEM as a career pathway, due to geographic isolation and the absence of local STEM-related industries. To stimulate interest in and prepare middle school students for STEM21 participation in high school, students in 7th and 8th grade attending the rural schools connected to these high schools will be engaged in after school and summer STEM21 Academy preparatory programs. These programs will be developed in partnership with the CT Pre-Engineering Program (C-PEP), a 501 (c) (3) non-profit organization. Project staff will work closely with principals and guidance counselors to identify high-need middle and high school students and assure that they and their parents/guardians receive language and literacy-appropriate program information and facilitated enrollment.

**A.2 Need for the Project and Quality of the Project Design**

Applicant: EDUCATION CONNECTION
The lead applicant in this *i3 Partnership* application is EDUCATION CONNECTION, a 501 (c) (3) non-profit agency and regional education service center (RESC) in western CT with significant experience and proven results in improving teaching practice and student achievement. EDUCATION CONNECTION’s Center for 21st Century Skills, in collaboration with official partners CT College of Technology (COT); Southern CT State University (SCSU); CT Pre-Engineering Program (C-PEP); CT Office for Workforce Competitiveness (OWC); research partner, Education Development Center (EDC); a regional consortium of high-need school districts and other partners including the CT State Department of Education (CSDE) and private industry proposes an *i3 Development Project: Science, Technology, Engineering and Math Education for the 21st Century (STEM21). This project is highly responsive to Absolute Priority 3: Innovations that Complement the Implementation of High Standards and High-Quality Assessments, specifically by full development, implementation, and study of a highly promising program model designed to (a) increase the success of under-represented students in rigorous STEM coursework, (b) further develop and implement assessments aligned with high student content and academic achievement standards, and (c) use assessment findings to inform and improve teaching practice. The proposed STEM21 Academy will consist of a rigorous, standards-based grade 9-12 sequence of science, mathematics, and technology courses which synergistically meld evidence-based Early College High School, Career Academy, and cyberlearning strategies. As students progress from 9th to 12th grade, they build a depth of science, mathematics, and technology content knowledge and an increasingly sophisticated set of 21st century skills. *The majority of the individual courses to be incorporated into the proposed 4-year college-credit bearing sequence has previously been field-tested in diverse high school settings, and shows strong potential to support under-represented students’ entry into STEM*
college coursework and careers. The curriculum is infused with performance-based assessments, and aligns with the 2008 CT State Board of Education’s Plan for Secondary School Reform; the 2009 CCSSO Common Core State Standards; and CSDE science, mathematics, and technology standards/frameworks. The model’s exceptional instructional approach has been adopted by CSDE’s high school redesign initiative. The proposed project also responds to Competitive Priority 6: Innovations that Support College Access and Success, and Competitive Priority 8: Innovations that Serve Schools in Rural LEAs (previously described in Section A.1).

The need for more formal and systematic implementation and study of this innovative model is compelling: based on national and state assessments, most CT high school graduates are unprepared for college and STEM careers. National and state American College Testing Program (ACT) exam composite scores for 2009 indicate that, respectively, only 23-37% of graduating seniors are adequately prepared to complete college-level coursework in core subject areas, including mathematics and science.\[4\] ACT research is clear: “The students most likely to major in science, technology, engineering, and math (STEM) fields in college and persist to earn their degrees are those who develop interests in STEM careers through early career planning and take challenging high school classes that prepare them for college-level science and math coursework.”\[5\] CT’s achievement gap in college and STEM career readiness is especially evident among poor African American/Black and Hispanic/Latino high school students who score lower than white non-poor students in all core subject areas.\[6\] These abhorrent gaps are further evidenced in the most recent “The Nation’s Report Card” data from the National Assessment of Educational Progress. CT has the highest achievement gap in the nation among poor and non-poor public school 8th grade students in mathematics, science, reading, and writing. Differences in average scale scores between minority and non-minority students rank
Applicant: EDUCATION CONNECTION
Recently released 4-year cumulative data for the 2009 cohort of CT high school students shows an overall decline in graduation rates and alarming disparities in these rates by sociodemographic group: Hispanic/Latino (58.1%), African American/Black (66.2%), low income (59.9%), limited English proficiency (53.4%), and special education students (53.4%) compared with (86.8%) for White students. The National Governor’s Association Innovation America report cites an emerging consensus that our country’s ability to compete in the global marketplace is directly linked to public schools’ ability to adequately educate all students in STEM. Traditional approaches to STEM education fall short in meeting 21st century workforce needs. According to The Opportunity Equation, a 2009 Carnegie Commission on Mathematics and Science Education report, “reform in mathematics and science education is possible only if we “do school differently” in ways that emphasize the centrality of math and science to educational improvement and innovation.”

This project seeks to close these achievement gaps by fully developing, implementing and studying the effectiveness of the STEM21 Academy model (STEM21) in 12 diverse high schools (7 urban, 2 rural, and 3 suburban). A key enhancement is preparatory programs for high-need 7th and 8th grade students in schools connected to STEM21 high schools, to stimulate interest in Academy participation (see Section A.1). The guiding hypothesis is: If students, with emphasis on high-need students, fully participate in the STEM21 Academy, then they will demonstrate improved academic achievement, interest in, and readiness for college-level STEM coursework.

**STEM 21 Model Description and Planned Enhancements Overview:** STEM21 builds on the validated success of the Connecticut Career Choices (CCC) program. In partnership with OWC, the Center for 21st Century Skills at EDUCATION CONNECTION has developed and managed the statewide CCC Program since it began in 2002.
To date, one or more CCC courses, including most of those listed in the proposed STEM21 course sequence in Table 1, have been piloted in over 40 high schools, involving 60 educators and 1,200 students (>40% minority). STEM21 coursework development has been funded by CSDE, OWC, the National Science Foundation (NSF) ATE Program, and received significant in-kind support from the official and industry partners in this application. Courses are developed collaboratively by teams of teachers, college faculty, and STEM industry leaders, integrate 21st century workforce standards, and are delivered in a “blended” learning environment, engaging students in a progression of interactive online coursework guided by teachers in classrooms and augmented by experiential learning. Intensive professional development (PD) is provided to advance teacher content knowledge and skills in technology-enhanced instruction. Students participate in authentic learning experiences to cultivate commitment to pursuing STEM-related college degrees and careers. Formative and summative assessments are fully integrated.

21st Century Content and Delivery: MOODLE (Modular Object-Oriented Dynamic Learning Environment) is an open source web-based course management system that has been successfully tested and selected as the platform for delivery of STEM21 courses. MOODLE enables teachers and students to extend their classroom learning into a broader online community in a secure, password-protected environment where they collaborate across district boundaries, and interact with college faculty and STEM professionals via instant messaging, blogs, e-mail, and discussion forums. The extensive use of the Internet, digital media, and technology effectively engages under-represented students in rigorous STEM learning that builds 21st century skills and supports student achievement in post-secondary study in STEM fields. In a recent report on cyberlearning, the NSF cites research showing that “incorporating information and communications technology into science and mathematics can restructure the necessary
expertise for reasoning and learning in these domains, in effect opening up greater access to complex subject matter.” The STEM21 course sequence includes both required and elective science, mathematics, and technology courses. As illustrated in Table 1, the science course sequence (*) re-frames traditional high school science in a 21st century context. Ninth grade earth climate science is taught in the context of sustainable energy (E3), biology in the context of biotechnology (Bio21), chemistry (Chem21) in the context of nanotechnology, and physics (Phy21) in the context of robotics, with all courses meeting existing state standards. The 12th grade Research Capstone course and “College Ready 21” module (described in Section A.1) will be developed with i3 funding; other listed courses have been developed and pilot tested. Project partners will actively pursue public and private funding to expand course electives.

<table>
<thead>
<tr>
<th>Project Objectives With Related Activities</th>
<th>Year 1 2 3 4 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Complete development of the STEM 21 course sequence that articulates in the CT College and University System.</td>
<td>Convene curriculum teams to develop/test/refine “College Ready 21” module and new Research Capstone Course curriculum and assessments.</td>
</tr>
</tbody>
</table>

TABLE 1: STEM21 ACADEMY SCOPE AND SEQUENCE

The process for developing new curriculum has been extensively field-tested and refined over the past 8 years. The Center’s technology and content area specialists work with college faculty and master teachers to develop the course syllabus, content units, and assessments meeting state and national standards. Next, an advisory group of college faculty and STEM professionals review and validate course materials. Materials are then adapted for the online environment and Center
specialists and teachers co-evaluate their pedagogical effectiveness. Assessments are

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carefully monitored and student work analyzed to gauge learning progress. After revision, the course is submitted to CSDE for review and to COT for articulation approval for college credit.

*This curriculum development and validation process is a proven methodology leading to high-quality curriculum endorsed by K-12, state education, college, and industry stakeholders.*\[16\]

**Experiential Challenge-Based Learning:** Universal integration of experiential learning in STEM21 will take students and teachers beyond the classroom into real world environments. Students and teachers will meet quarterly at college and industry sites and participate in course-related workshops and project-based activities with students from other districts, college faculty, and STEM professionals.\[17\] A culminating summative assessment for all STEM21 students will be the presentation of their “challenge” solution at the annual CT Student Innovation EXPO where students “Research, Develop, Design, and Present” unique solutions to authentic problems. The 2010 challenge focuses on sustainable energy, environmental responsibility, and the emerging “green” economy. Student-directed teams from across the state showcase their solutions at EXPO, a full-day event held at the CT Convention Center in Hartford, for evaluation by a panel of college faculty and STEM professionals in three venues: online <http://ctexpo.org>, in an exhibition, and as an oral presentation. *In 2009, over 1,800 students, teachers, college faculty, professionals and community members participated. A recent study of program alumni indicated that EXPO participation was a contributing factor in their decision to pursue a STEM career.*\[18\] Blended learning model and EXPO evaluation data support their value in providing what Harvard educator David Perkins calls a “threshold experience”-exposing students to new content and skills in a way that cements a life-long interest. Presently over 50 college faculty and 100 STEM professionals are involved in these CCC Program components.
Assessments: In addition to high quality assessments to measure students’ progress toward college and career readiness (described in Section A.1), STEM21 courses utilize a variety of standards-based formative, interim, and summative assessment strategies to measure student achievement aligned with content standards and ensure the development 21st century skills such as creativity, collaboration, and problem solving. Common formative assessments are integrated into MOODLE to enable students and teachers to monitor the effectiveness of instruction and skill development in real time, and adjust teaching practice accordingly. A unique advantage of the online environment is that it allows the learner to reflect, revisit, and self-monitor assignments as they are completed to insure mastery of course content. In addition, traditional summative assessments, such as labs and tests, are included to assess learning progress. An electronic portfolio (ePortfolio) is integrated in MOODLE; students and teachers actively collaborate on the submission of exemplary materials that reflect content and skill acquisition.

Professional Development (PD): Consistent with CCC Program standards, all STEM21 teachers will participate in a variety of evidence-based PD activities during the summer and school year. The project’s PD approach is to support teachers in effective use of the nine instructional strategies that affect student achievement as outlined by Marzano et al. Center specialists facilitate teachers’ mastery of blended learning instruction and assessment strategies via classroom visits to observe, model, and coach the delivery of course content. Instructional specialists will also organize face-to-face and online professional learning communities to address course content and pedagogy issues, and disseminate best practices. STEM21 teachers will attend a five-day Summer Institute taught by master teachers, college faculty, and STEM professionals that prepares them to implement the curriculum while updating their knowledge.
and skills. This interaction is a powerful aspect of the Institute, and consistently identified by participants as a unique program strength. Externships are an important PD component. **Summer and After School Enhancements:** A planned model enhancement is to develop and implement after school and summer programs for 7th and 8th grade students who attend the 16 urban and rural middle schools connected to high-need STEM21 high schools in partnership with C-PEP. C-PEP presently provides after school and summer programs for students at 9 of these schools. Center instructional specialists will collaborate with C-PEP educators to infuse existing programs with 21st century content and skills to stimulate interest in and readiness for STEM21 Academy coursework. As an official partner, C-PEP will deliver after school and summer programs for middle school students who attend the 7 additional schools (6 rural and 1 urban).

**Participating STEM21 Schools:** STEM21 provides ongoing opportunities for students and teachers to interact in meaningful ways, cultivating appreciation of diversity and cultural competence. A major focus of this project is to demonstrate the effectiveness of the STEM21 model across diverse student populations, advancing academic achievement and college readiness in high-need students in urban, suburban, and rural school settings. School selection criteria included: 1) prior success in piloting one or more courses in the proposed STEM21 sequence with fidelity, and 2) a minimum of 75% of schools are high-need (i.e., Title 1, Priority, High Minority [42-93%], RLIS/SRSA) and demonstrate improvement in one or more student achievement/growth indicators. (See Appendix H for School Listing and Letters of Commitment)

**Project Goals, Objectives, and Key Activities**

The STEM21 vision is to accelerate, redefine, and revitalize teaching and learning in secondary schools by fully implementing and evaluating a rigorous grade 9-12 Academy program with proven results in engaging under-represented students in diverse school settings. (See Section
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B). STEM21 project partners seek to collectively close the student achievement gaps that are painfully apparent in our state and advance every student’s capacity to innovate and succeed in high school, college, and the global workforce. STEM21’s goals and objectives are ambitious and achievable; the project’s partners possess the knowledge, skills, and experience necessary to achieve them. **Major goals include:** 1) Increase under-represented student interest in, readiness for, and entry into college-level STEM coursework; 2) Further develop and test standards-based assessments to measure student academic achievement and growth and use these assessments to inform and improve teaching practice; 3) Identify key elements for effective STEM21 Academy model implementation and scaling in diverse school settings; and 4) Study the impact of middle school programs on future STEM21 participation by high-need urban and rural students.

**TABLE 3: STEM21 OBJECTIVES, ACTIVITIES, AND TIMELINE**
<table>
<thead>
<tr>
<th>Subject/Grade</th>
<th>9th Grade</th>
<th>10th Grade</th>
<th>11th Grade</th>
<th>12th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM Course Sequence</td>
<td>* Earth &amp; Energy Essentials (E3)</td>
<td>* Bio 21</td>
<td>* Chem 21</td>
<td>* Physics 21</td>
</tr>
<tr>
<td></td>
<td>* Algebra 21</td>
<td>Geometry 21</td>
<td>Digital Media</td>
<td>Research</td>
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<td></td>
<td>* Digital Media Communications</td>
<td>Movie Making</td>
<td>Animation</td>
<td>Capstone</td>
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<td>CCC Electives</td>
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</table>

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<thead>
<tr>
<th>Project Objectives With Related Activities</th>
<th>Year 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Complete development of the STEM 21 course sequence that articulates in the CT College and University System.</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Convene curriculum teams to develop/test/refine “College Ready 21” module and new Research Capstone Course curriculum and assessments.</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Publish/disseminate 4-year articulated STEM21 course sequence in MOODLE.</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>2. With C-PEP, co-develop and implement summer/after school programs for middle school students to stimulate interest/participation in STEM21.</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Co-convene curriculum teams to develop curriculum and assessments.</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Pilot test/validate curriculum in 9 urban school sites (current C-PEP sites).</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Full implementation of middle school programs (9 urban and 7 rural schools).</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>3. Pilot test, refine, and implement STEM21 model in 12 diverse high schools.</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Year 2 (2011-2012): Test/refine model in 7 sites (5 urban, 1 rural, 1 suburban).</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Year 3 (2012-2013): Implement/refine model in 5 remaining sites.</td>
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<tr>
<td>Years 4/5 (2013-2015): High fidelity implementation of STEM21 in 12 sites.</td>
<td>x</td>
<td>x</td>
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<td>4. Provide intensive PD to advance teaching practice and model fidelity.</td>
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<td>Digital Media</td>
<td>Animation</td>
<td>IT R&amp;D</td>
<td>Capstone</td>
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<td>Communications</td>
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<td></td>
<td>CCC Electives</td>
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</table>

**Project Objectives With Related Activities**

1. **Complete development of the STEM 21 course sequence that articulates in the CT College and University System.**
   - Convene curriculum teams to develop/test/refine “College Ready 21” module and new Research Capstone Course curriculum and assessments.
   - Publish/disseminate 4-year articulated STEM21 course sequence in MOODLE.

2. **With C-PEP, co-develop and implement summer/after school programs for middle school students to stimulate interest/participation in STEM21.**
   - Co-convene curriculum teams to develop curriculum and assessments.
   - Pilot test/validate curriculum in 9 urban school sites (current C-PEP sites).
   - Full implementation of middle school programs (9 urban and 7 rural schools).

3. **Pilot test, refine, and implement STEM21 model in 12 diverse high schools.**
   - Year 2 (2011-2012): Test/refine model in 7 sites (5 urban, 1 rural, 1 suburban).
   - Year 3 (2012-2013): Implement/refine model in 5 remaining sites.

4. **Provide intensive PD to advance teaching practice and model fidelity.**
   - Develop/deliver 5-day Summer Institutes; provide online and onsite coaching.
   - Use student assessment findings to inform and improve teaching practice.

5. **Provide STEM 21 experiential learning at college and industry sites.**
   - Recruit college faculty and STEM industry partners.
   - Plan and facilitate quarterly workshops/meetings at host sites.
   - Facilitate student-directed project presentations at EXPO.

6. **Assess/research/evaluate student achievement and growth outcomes and identify key elements for model improvement, implementation, fidelity, and scaling in diverse school settings; broadly disseminate findings.**
   - Design/validate study and data collection instruments; embed data collection into program implementation and evaluation plan.
   - Conduct ongoing formative, interim, and summative assessments of student achievement and growth.
   - Conduct quasi-experimental longitudinal research study to identify the model’s impact on STEM career interest/choice and college readiness/entry.
   - Disseminate/publish findings/recommendations via Communities of Practice, ED Innovation portal, and national, regional, and state partner networks.
Expected project outcomes include the refinement, expansion, and high fidelity implementation of the STEM21 Academy in 12 high schools (7 urban, 2 rural, 3 suburban; 11 in CT, 1 in MA), directly impacting over 960 students (>50% under-represented) and 60-80 teachers, and engaging over 1,000 middle school students from 16 high-need schools in STEM preparatory programs. Ultimately, all high schools in the involved LEAs (67,538 enrollment) will benefit by developing the capacity of teachers to advance STEM teaching practice within their districts.

B. Strength of the Research, Significance of the Effect, and Magnitude of the Effect

Evidence of STEM21 Model Efficacy

The Center, through its leadership in the Connecticut Career Choices (CCC) program, has engaged hundreds of CT educators and over 3,000 urban, suburban, and rural students in a variety of formal and informal STEM learning activities. Over 1,200 students and 60 teachers from 40 high schools have participated in one or more STEM-related blended learning courses developed by the Center to date through NSF, OWC, and CSDE funding. Over 40% of these students are from racial/ethnic groups under-represented in STEM careers. Evaluation of courses and coordinated experiential learning activities has been consistently conducted since the CCC program’s inception in 2002, and the results used to inform program development and continuous quality improvement. The model’s positive impacts from evaluation activities to date include that participating students have increased their interest in STEM careers, STEM skills, and improved their understanding of the 21st century global economy. Results of administrator, teacher, and student focus groups conducted annually since 2007 consistently indicate a high level of satisfaction with the STEM curricula and a high degree of enthusiasm regarding the blended learning model’s ability to increase student interest in and readiness for STEM college-level coursework. Under-represented student’s pre-post surveys in 2008-2009 consistently show
Applicant: EDUCATION CONNECTION
growth in interest in STEM coursework and related careers. Courses were rated overall by teachers as “exceptional” in the ability to promote student outcomes related to higher order thinking, interpersonal, and creative thinking skills. Preliminary results from a 2009-2010 pilot quasi-experimental study support the efficacy of the Bio21 and E-Commerce blended learning courses in increasing student content knowledge and career interest at statistically significant levels compared with students enrolled in similar traditional coursework. (See Appendix H for Evaluation Executive Summaries) These promising results warrant more formal and systematic study of the hypothesis that If students, with emphasis on high-need students, fully participate in the STEM21 Academy, then they will demonstrate improved academic achievement, interest in, and readiness for college-level STEM coursework.

The STEM 21 Academy builds on the partners’ success in CCC model implementation over the past 8 years while embracing effective practices from the Early College and High School Career Academy movements. Research shows that both Early College and Career Academies are particularly effective with urban and under-represented student populations. Early College High Schools blend high school and college in a rigorous and supportive college preparatory program. Career Academies are small learning communities within high schools that combine academic and technical curricula around a career theme, and establish partnerships with employers to provide work-based learning opportunities. These initiatives demonstrate positive impacts on student performance, graduation rates, and labor market indicators while creating pathways to post-secondary education. Research on blended learning also supports the proposed STEM21 project strategy. A recent U.S. Department of Education study indicates that students in a blended learning environment performed better than students who learn the same material either exclusively online or in a traditional classroom setting alone. Likewise, IBM
Applicant: EDUCATION CONNECTION
found that learners using a blended approach achieved retention and performance superior to a traditional face-to-face or stand-alone online model.\textsuperscript{[28]} Furthermore, “The Opportunity Equation” report cites support for blended learning instructional strategies with the potential to accelerate learning, and make learning richer, more motivating, and more connected to the real world.\textsuperscript{[29]}

C. Experience of the Eligible Applicant

Applicant Effectiveness in Improving Student Achievement, Attainment, or Retention

The proposed project is comprised of official partners with significant and notable experience in their respective areas. EDUCATION CONNECTION, the lead applicant and fiduciary agent, was established as a RESC in western CT in 1972, under CT Statute 10-66, a-m. This 501(c) 3 organization currently manages $11 million in federal and state grant awards and contracts. EDUCATION CONNECTION has a successful 38-year history of collaborating with school districts to improve teaching practice and student performance, including leadership in current reform efforts targeted to the state’s highest risk schools - the Connecticut Accountability Learning Initiative (CALI). CALI is an evidence-based reform model adopted by CSDE to accelerate learning and close the achievement gap in CT’s lowest performing schools. CALI includes a clear focus on achievement; a standards-based curriculum centered on core subject areas; use of data to inform instructional and leadership decisions; frequent assessment of student progress (formative, interim, and summative); an emphasis on research-based effective teaching strategies; collaborative teams focused on student learning; and accountability by teachers, principals, and parents/guardians. Each CALI Partner District is required to have LEA, school, and classroom-level data teams and to participate in ongoing PD and onsite technical assistance. State standards and rubrics are used to assess effectiveness and provide ongoing feedback for improvement. CSDE selected EDUCATION CONNECTION as the primary state resource and
lead trainer in common formative assessments. Over the past two years, EDUCATION
CONNECTION’s CALI-certified educational specialists have provided intervention services to
administrators and teachers in 9 high minority, high poverty Title 1 schools with impressive results: 4
of the schools subsequently met AYP, 1 met Safe Harbor, and 2 additional schools demonstrated
gains in standardized state assessments in reading and mathematics.

EDUCATION CONNECTION’s Center for 21st Century Skills has been a visionary leader in the
region, pioneering the integration of technology in secondary education throughout the state to
advance teaching practice, student achievement, and college and career readiness through
development, testing, and implementation of rigorous, ‘next generation’ STEM coursework in with
highly promising results. Evidence of effectiveness includes CCC Program blended learning course
implementation and curriculum testing in diverse settings (40 schools, 1,200 students, >40%
minority); sustained collaboration among students, educators, and STEM professionals; statistically
significant increases in student self-reported STEM career interest; and CSDE endorsement as a
model for 21st century high school redesign. The proposed project is a natural progression with strong
potential for statewide, regional, and national replication.

All 12 participating high schools have piloted at least one of the courses to be included in the
STEM21 Academy model. Selected schools’ state of readiness to implement the model is further
evidenced by the fact that 11 of these schools (6 high minority [42-93%], high poverty urban; 2 rural
[1 SRSA and 1 RLIS]; and 3 suburban) demonstrate improvement in one or more indicators of
student achievement/growth over the past two years including: achieving AYP in at least one year,
reduction in the 4-year cumulative high school drop-out rate, increase in the percentage of students
pursing higher education, and/ or scoring above the state average or showing gains in standardized
tests (CAPT/MCAS) in mathematics or science. (See Appendix H for School Data)
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D. Quality of the Project Evaluation

To provide critical information about high quality implementation and outcomes of STEM21 in diverse high schools, comprehensive research and evaluation efforts will be conducted incorporating quasi-experimental research and formative, interim, and summative assessments.

Research Study: Based on our prior successful collaboration on complex NSF-funded projects, Dr. Youn Joo Oh, EDC Senior Research Associate, will direct the longitudinal research study. The quasi-experimental research design will focus on student outcomes related to the following Primary Research Questions (RQ): RQ1. Do high school students, with emphasis on underrepresented students, who participate in the STEM21 Academy demonstrate a greater interest in and college career readiness in STEM areas than comparable students who do not participate in the STEM21 Academy? RQ2. Do middle school students, with emphasis on under-represented students, who participate in one or more of the preparatory STEM21 summer and after school programs elect to participate in the STEM21 Academy in 9th grade at a significantly higher rate than a comparison group of non-participating middle school students? Sample: RQ1. Within each participating school, there will be one intervention and one comparison classroom of 9th grade students that will be tracked for the four years of high school. Based on an average class size of 20 students, an initial cohort of 140 intervention and 140 comparison students will be studied in Year 2 (7 sites) and a second cohort of 100 intervention and 100 comparison students will be studied in Year 3 (5 additional sites). The sample post-hoc Monte Carlo power analysis for Latent Growth Model indicates that this is more than adequate to detect power of .80. Evaluation of current blended learning programs indicates that the risk of interference effects between participants and comparison teachers and students is slight. Completion of the 4-year study for this second cohort will occur through a no-cost extension.

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Within the 9 urban and 7 rural participating middle schools, 300 intervention and 300 comparison students from the same schools will participate in the study. Students will be tracked from the fall of 7th grade/8th grade through the spring of 9th grade. Pearson Chi-square Tests for Two Proportions power analysis indicates that this is more than adequate to detect power of .80. **Data Analysis:**

**RQ1.** The Second-Order Latent Growth Curve (LGC) Model will be used to examine statistically significant differences between the intervention and comparison groups in (a) interest in and (b) college/career readiness in STEM areas. To explore the proposed project’s potential for statewide, regional, and national replication, the second-order LGC Model will investigate curvilinear change in interest in and college/career readiness in STEM areas during the four years of intervention. **RQ2.** Chi-square analysis will be conducted to examine whether there is a significant difference between the intervention and the comparison groups in participation rate in the STEM21 Academy in 9th grade.

**Instruments:**

**RQ1.** Instruments in STEM areas include (a) STEM Interest Survey, (b) Interest Survey in the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & Mckeachie, 1991), and (c) Adapted Interest Survey in The Learning Communities for Science, Technology, Engineering, and Mathematics Academic Achievement (LCSAA) Attitudes Survey (Freeman, Alston, & Winborne, 2008). College and career readiness in STEM areas will be measured with (a) College and Work Readiness Assessment (CWRA), (b) Accuplacer, and (c) Science raw score from CT Academic Performance Test (CAPT). **RQ2.** Middle school students in both intervention and control groups will be tracked for their enrollment in the STEM21 Academy in 9th grade. (See Appendix H for Detailed Research Methodology and Timeline.)

**Project Evaluation:** While the research will focus on two specific student outcomes, the formative and summative STEM21 evaluation activities will address all aspects of the

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intervention and assess the project’s progress and impact against its stated goals and objectives. Mhora Newsom-Stewart, Ph.D. will serve as the project’s internal evaluator. She has significant experience as an internal evaluator on state and national education projects. Sousan Arafeh, Ph.D., the project’s third-party external evaluator, has extensive expertise in national research and project evaluation including the Center’s NSF ATE grant. (See Section G and Appendix C for qualifications) Dr. Arafeh will work closely with Dr. Newsom-Stewart, EDC, and the Advisory Board to oversee evaluation activities, conduct the summative evaluation, and ensure that instruments and analysis techniques are well-implemented to properly measure outcomes.

Evaluation activities will be based on the project’s goals (see the preliminary STEM21 Evaluation Logic Model Summary in the Appendix H). The major questions guiding the evaluation plan are: 1) How does participation in the STEM21 Academy impact student academic achievement, interest in, readiness for, and enrollment in college-level STEM coursework? 2) How does the middle school program impact participation in STEM21 by high-need urban and rural students? 3) Do the research and evaluation activities effectively document student achievement and growth outcomes; identify key elements for model improvement, implementation, fidelity, and scaling in diverse school settings; and are the research and evaluation findings broadly disseminated?

In Year 1, Drs. Newsom-Stewart and Arafeh will refine the logic model and comprehensive evaluation plan in light of project goals and, with EDC coordination, will identify and develop appropriate data collection instruments and activities. Evaluation activities in Years 1-5 will employ quantitative and qualitative methods including, but not limited to: expert evaluation of curriculum course sequence modules; pre/post assessments of student knowledge and interest in STEM subject areas; surveys of student course and/or post-secondary career path choices; review
of student achievement data on course/standardized assessments; pre/post assessments of improvements to teacher content knowledge and pedagogical practice; student, teacher, college faculty and industry partner surveys of efficacy of experiential learning activities; longitudinal research study findings; focus groups; structured interviews; and review of resources developed.

Ongoing formative evaluation activities will be conducted by Dr. Newsom-Stewart. As the external evaluator, Dr. Arafeh will ensure the validity of all data collection and evaluation activities. Assessment reports will be disseminated to stakeholders annually. *STEM21 evaluators and staff will cooperate fully with i3 evaluators. Evaluation activities will be consistent with national standards including the What Works Clearinghouse Procedures and Standards Handbook and IES/NCEE Technical Methods papers.*

E. **Strategy and Capacity to Further Develop and Bring to Scale**

This i3 Development Project will initially engage over 960 students (> 50% under-represented) and 60-80 teachers in 12 high schools in a rigorous *STEM21* Academy. Over 1,000 students from 16 high-need middle schools will be involved in STEM preparatory programs. During the 5-year project period, all high schools in the involved districts (67,538 enrollment) will benefit by developing teacher capacity. The project’s lead applicant and *STEM21* model developer, EDUCATION CONNECTION and the strong i3 partnership have successfully collaborated to pilot the majority of the proposed coursework. EDUCATION CONNECTION is an active participant in the statewide RESC Alliance, which will support scaling of the model. (See Letter of Commitment in Appendix D) The RESC Alliance consists of leadership from each of the six RESCS in CT; Alliance members have a 20-year history of collaborative development and implementation of education and technology-related instructional and PD services to CT LEAs. The *STEM21* scale-up plan will involve each RESC in the systemic implementation of *STEM21*
in all 168 CT high schools, with an enrollment of 176,534 students. Extending the after school and summer school programs offers the potential to reach an additional 86,704 7th and 8th grade students (263,238 total). Using a train-the-trainer approach, a scale-up leadership team of STEM21 Project instructional specialists, master teachers, and college faculty will coach and mentor RESC instructional staff, through professional practice groups. Each RESC will assist in LEA recruitment in their service area for model replication. As the statewide CCC implementation manager and STEM21 model developer, EDUCATION CONNECTION’s Center for 21st Century Skills is uniquely positioned to manage the statewide scale-up plan. Center administrative and content and instructional specialists, in collaboration with our valued STEM21 partners, are highly qualified to provide administrative oversight, PD, and technical assistance using both in-person and online strategies during scaling. STEM21’s open source, web-based learning platform, MOODLE, facilitates rapid model dissemination as it is easily downloaded and installed free of charge. Importantly, CSDE has committed funding for ongoing hosting of MOODLE as the learning platform in all CT school districts. CSDE’s partnership and their promotion of the model through the New England Secondary School Consortium will support scale-up throughout the northeast, with the potential to reach at least 500,000 students. Center staff is presently collaborating with LEAs in Boston and western MA to disseminate the model. In addition to dissemination via i3 Communities of Practice and the ED Innovation portal, our project leadership will utilize well-developed professional networks at the state, regional, and national level (including NSF ATE and ITEST) to share best practices and research findings through reports, journal articles, newsletters, web-based publications and presentations.

Total costs for the project period (excluding research and evaluation, non-student travel, dissemination, and indirect costs) are $3,041,900. This equates to an average cost per student
(based on 1,960 middle and high school students) over the five-year project period of $1,552. Project cost effectiveness is supported by leveraging the significant tuition savings for obtaining 15 credits at a CT four-year state university, based on $340/credit hour, or $5,100 per student. Using Project Year 5 costs for essential STEM21 leadership team scale-up personnel ($105,000), supplies ($140,000), and professional development ($159,250) the estimated costs for scale-up are reduced to approximately $200 per student: 100,000 students -$20 million; 250,000 students -$50 million; and 500,000 students -$100 million. This represents a highly favorable per student return on investment of 25:1 when compared with projected college tuition savings.

F. Sustainability

STEM21 involves respected leaders in systemic state and federal STEM education. EDUCATION CONNECTION, OWC, and the COT are intrinsically sustainable as they were created under state statutes. Even in the current economic climate, CCC funding has continued as a line item in the state budget. STEM21 Project leaders have leveraged significant funding support from private sector partners, meeting the 20% matching requirement (see Budget). All project leaders have a proven record of securing private, state, and federal grant funding; these efforts will intensify during and after the project period to assure sustainability. Public sector support is exemplary; CSDE and OWC jointly funded STEM21’s science course sequence, and NSF has supported model development. Over the past 8 years, high schools, college faculty, and STEM industry partners have contributed substantial in-kind services to ensure effective implementation of courses and experiential learning activities, which will continue. Evidence of regional sustainability includes CSDE’s partnership and their promotion of the model via the New England Secondary School Consortium. The high potential for sustainability and future scaling of STEM21 is evidenced by impressive growth in CCC sites (from six in 2002 to forty in
2010); currently there is a waiting list of interested schools. Courses are “institutionalized” through adoption in each LEA’s program of studies. Continuation of course delivery via MOODLE is assured; CSDE has committed to fully fund hosting of MOODLE as the common online learning platform in all 169 CT LEAs. CSDE will support model dissemination through the CT High School Redesign initiative. EDUCATION CONNECTION is ready to assume a leadership role in i3 Communities of Practice; this supports sustainability through replication of best practices, and the incorporation of effective strategies validated by other i3 projects.

G. Quality of the Management Plan and Personnel

The i3 project management team includes the project director, principal investigators, and senior project staff, guided by the STEM21 Advisory Board. All project leads have a successful history of collaborating to develop CCC STEM coursework and independently and jointly managing complex multi-million dollar grant projects, including NSF-funded STEM grade 9-16 educational initiatives. The project leaders share a cohesive vision; each brings superior skills and solid working relationships with internal and external stakeholders. Key roles and responsibilities for project leaders and senior staff follow; résumés are included in Appendix C.

**Project Director/Principal Investigator: Michael Mino, Founder/Director of EDUCATION CONNECTION’s Center for 21\textsuperscript{st} Century Skills.** Mr. Mino will oversee all project components to ensure goals, objectives, and deliverables are met, serve as the lead project liaison, and provide administrative oversight to the senior management team. Mr. Mino, a masters-prepared, state-certified Technology Educator, is the NSF ATE Project PI and Director of the CCC initiative. He has been recognized by the Computerworld Honors Program, American Society of Mechanical Engineers, and the Congressional Black Caucus for his work with diverse high school students. He served on the NSF/NASA-funded Technology for All Americans high
school standards development team, has 10 years of high school teaching experience, is an Apple
Distinguished Educator, and a revered expert in grade 9-16 STEM integration in the Northeast.

**Co-Principal Investigator and Primary Research Scientist: Dr. Youn Joo Oh, Senior Research
Associate, School Leadership Project at EDC.** Dr. Oh held a post-doctoral fellowship and earned an
Ed.D. in Educational Psychology and Technology from University of Southern California. She holds
a CAGS in Curriculum and Teaching, a M.A. from Boston University, and
B.S. in Chemistry from Seoul Women’s University. She has extensive research and evaluation
experience and will coordinate the project’s research study described in Section D.

**Co-Principal Investigator and Advisory Board Chair: Dr. Christine C. Broadbridge, Education
Director, CRISP NSF MRSEC, Professor of Physics, SCSU.** Dr. Broadbridge received Ph.D. in
Engineering from Brown University where she conducted research in materials science,
semiconductor electronics and solid-state physics. She established SCSU’s CRISP
Nano-Characterization Facility that utilizes microscopy facilities at Brookhaven National Laboratory
and Yale University under a NSF Materials Research and Science Center grant.

**Co-Principal Investigator and Post-Secondary Education Liaison: Dr. Karen Wosczyna-Birch,**

*Director of the COT and the NSF ATE Regional Center for Next Generation Manufacturing.*
As the COT Director since 1995, Dr. Wosczyna-Birch has provided leadership for the growth of
COT to create a seamless grade 9-16 STEM pathway. She is a nationally recognized Professor of
Science and Technology, receiving the National Science Teachers Association’s Catalyst Award for
teaching excellence in 2002. As COT Site Coordinators’ Council Chair, she will facilitate the
recruiting of college faculty and the use of campus facilities for the duration of the *i3* project.

**Co-Principal Investigator and Urban LEA Liaison: Bruce Dixon, CEO of C-PEP.** *C-PEP is a
non-profit educational organization with a mission of empowering under-represented youth to
explore, prepare for, and reach their full potential in STEM.* Previously Director of Client
Relations at The Hartford Financial Services Group, Mr. Dixon holds a M.B.A. from UCONN,
and serves on CT Association of Nonprofits and CT Academy for Education Boards.

**Senior Project Staff:** Dan Cogan-Drew, Director of Programs, Center for 21st Century Skills,
will manage the implementation of the *STEM21* project and coordinate project activities in
accordance with the timeline and milestones outlined in Section A.2 Table 3. Center Education
and Technology Specialists will refine curriculum as part of teams with teachers, college faculty,
and STEM professionals, and provide PD and coaching to assure engaging, high fidelity course
delivery. Debra Hinck, OWC Program Manager, will coordinate *STEM21* experiential learning
activities. Mhora Newsom-Stewart, Ph.D., will coordinate the formative evaluation plan.

**Independent Evaluator:** Sousan Arafeh, Ph.D., President of Research Images LLC, is the project’s external evaluator. Dr. Arafeh holds a joint doctoral degree in Education Technology and Policy and Communications and Cultural Studies from the University of Wisconsin-Madison. An AAUW National Research Council advisory board member, and a Senior Associate Advisor to CT’s P-20 Council, she has conducted studies for ED, Pew Research, the Gates Foundation, the College Board, and NSF. She will work with Dr. Newsom-Stewart and EDC to assure fidelity of all evaluation activities and conduct the summative evaluation.

**Advisory Board:** STEM21 Advisory Board members identified in Appendix H include senior-level STEM experts from industry, college, K-12, government, and non-profit entities; all are external to the project. *Advisory Board will meet quarterly with PIs and key project staff to review evaluation and research findings and provide recommendations for project improvement.*

**Official Partners:** Major roles and responsibilities for EDC, SCSU Center for Excellence in Mathematics and Science, COT, OWC, and C-PEP are summarized in Appendix H.