



**THE
CITADEL**
THE MILITARY COLLEGE OF SOUTH CAROLINA

Master's of Education Degree in Interdisciplinary STEM Education

DATE OF SUBMISSION: January 15, 2013



PRESIDENT, THE CITADEL

PROVOST, THE CITADEL

DEAN, THE CITADEL, SCHOOL OF EDUCATION

**171 MOULTRIE STREET
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Classification of Proposed New Program

| | |
|----------------------------------------------------------------------------------------------|---------------------------------------------------------|
| Program Title: | Master of Education in Interdisciplinary STEM Education |
| Academic Unit: | The Citadel, School of Education |
| Designation, type, and level of degree: | MEd |
| Credit Hours: | 34 |
| Proposed date of implementation: | January 2014 |
| CIP Code: | 131299 |
| Identification of Program as New or Modification: | New |
| Site: | The Citadel Main Campus and Online |
| Program qualifies for supplemental Palmetto Fellows Scholarship and LIFE Scholarship awards: | No |
| Delivery mode: | Online |

Institutional Commitment

The following groups have all approved the proposed degree in concept:

- The Citadel's School of Education Committee (March 8, 2012)
- The Citadel's Professional Education Board (March 8, 2012)
- The Citadel's Graduate Council (March 13, 2012)
- The Citadel's Academic Board (April 9, 2012)

Purpose and Objectives of the Program

Approval is requested for a new degree program— a Master's of Education degree in Interdisciplinary STEM Education at The Citadel. This program will provide an advanced degree related to the development and practice of modern pedagogy and progressive STEM content. Classes will be offered online through Blackboard.

This program is designed primarily for current middle and high school educators of the STEM disciplines seeking advancement of their skillset. However, it is anticipated that military personnel and educators of informal educational centers (such as aquariums, museums, and others) will also pursue this degree.

Ultimately, the curriculum aims to create 21st century STEM educators and leaders by facilitating a broader understanding of the interdisciplinary nature of STEM, a deeper knowledge of discipline-specific content, and new integrative approaches for the teaching and learning of STEM content. The coursework is intended to inspire in teachers a passion for STEM and an ability to effectively teach STEM content in an engaging way with career and industry applications.

Overview and Justification

The Schools of Engineering, Education, and Science and Mathematics, and the STEM Center of Excellence have in a collaborative endeavor developed an interdisciplinary master's degree in science, technology, engineering, and mathematics (STEM) education: the *Master of Education in Interdisciplinary STEM Education*. The overarching goal of this initiative is to improve middle and high school teacher effectiveness and significantly increase the number of high school graduates who are inspired to pursue and prepared to succeed in STEM degrees in college.

A STEM literate nation is critical to the United States' continued success in our global economy and the ability of American students to compete in the global workforce. Because of that, STEM education is at the forefront of our national and regional agendas. Both national and global development, defense, and sustainability are contingent upon fostering a passion for and innovations in the STEM disciplines.

In order to advance student learning in STEM, to inspire and prepare students to pursue careers in the STEM disciplines, and to enable our students to be successful in the global economy, highly qualified educators equipped with cutting edge STEM knowledge and 21st century skills are required. Educator preparation in current pedagogical practices and relevant and engaging STEM content is integral to student success and inspiration in the STEM disciplines. This program utilizes an interdisciplinary instructional approach with emphasis on modern pedagogy and progressive STEM content to ensure that educators completing this master's level program are prepared to teach in a 21st century world and can engage students with 21st century tools and curricula.

A graduate successfully completing this degree program will be adept at creating relevant projects for use in their classrooms and utilizing project-based instruction to more effectively engage their students in the STEM disciplines. This program will provide an advanced degree related to the development and practice of modern pedagogy and progressive STEM content. Classes will be offered online through Blackboard and available to a nationwide audience.

This program is designed primarily for current middle and high school educators of the STEM disciplines, military personnel, and educators of informal education centers (such as aquariums, museums, and others) seeking advancement of their skillset.

Ultimately, the curriculum aims to create 21st century STEM educators and leaders by facilitating a broader understanding of the interdisciplinary nature of STEM, a deeper knowledge of discipline-specific content, and new integrative approaches for the teaching and learning of STEM content. The coursework is intended to inspire in teachers a passion for STEM and an

ability to effectively teach STEM content in an engaging way with career and industry applications.

Need for the Program

It is projected that the state of South Carolina will see significant STEM industry growth and thus there will be an increased demand for trained employees. According to Career One Stop, the top growing industries in the state include: aerospace, biomedical science, information technology, and alternative energy; all of which require a background in STEM.

By 2018, South Carolina will need to fill 85,000 STEM-related jobs but unfortunately, our students may not be equipped with the skills to enter into, or be successful in, these high-demand, high-paying jobs. Nationally, South Carolina ranked 34 out of 52 in average NAEP Mathematics scores by all 8th grade public school students in test year 2009, and 40 out of 52 in average Science scores.

The key to improving student performance in STEM fields is to prepare highly effective STEM teachers. In its 2009 report: *STEM Education Recommendations for the President-Elect Obama Administration*, the National Science Board indicates “dedicated, high quality teachers are central to ensuring high quality STEM education for all students.”

Additionally, the National Science Board has ranked highly effective teachers as one of their top two priorities in ensuring quality STEM education. It is acknowledged that current mathematics and science teachers are not highly qualified and that there are shortages of qualified STEM teachers across the country. In order to improve student performance in STEM, to encourage student pursuit of STEM careers, and to support America’s prosperity, highly qualified STEM educators are required. The Business-Higher Education Forum’s publication: *An American Imperative: Transforming the Recruitment, Retention, and Renewal of Our Nation’s Mathematics and Science Teaching Workforce*, echoes this by stating that “Increasing the number of STEM-capable teachers is vital to increasing the number of students who choose and succeed in STEM majors.”

Increasing the number and effectiveness of highly qualified STEM educators is not only a great need in South Carolina; it is a nationwide issue. While some students are disinterested in STEM, the startling reality is that many of our students are simply ineligible for STEM careers. In the 2009 Programme for International Student Assessment (PISA) comparison, American students ranked 17th in science literacy among students from developed countries and 25th in mathematics literacy. “The hard truth,” U.S. Secretary of Education Duncan said, “is that other high-performing nations have passed us by during the last two decades...In a highly competitive knowledge economy, maintaining the educational status quo means America’s students are effectively losing ground.” The U.S. is not a top performer in any subject tested by PISA (reading, mathematics, and scientific literacy).

According to The Georgetown University Center on Education and the Workforce, in 2008, STEM occupations made up 7.3 million jobs in the United States. By 2018, it is projected that this will increase to 8.6 million jobs. By level of education, there will be job openings for:

9,000 high school dropouts
210,000 high school graduates
274,000 workers with some college but no degree
313,000 workers with associate's degrees
1.2 million workers with bachelor's degrees
779,000 workers with master's degrees or better

An additional 1.3 million jobs will be available in the STEM industries due to retirement and career changes. This makes an estimated total of 2.6 million job openings in STEM.

There is a critical need to build STEM literacy across our nation for the future benefit of our citizens. Sixteen of the 30 fastest growing jobs in our country require significant training in science and mathematics. According to the Occupational Outlook Handbook: Overview of the 2008-2018 Projections from the Bureau of Labor Statistics, nationally 62% of all jobs today require STEM skills and too many of our students fail to graduate with these skills.

STEM professionals are currently, and will remain, in demand. As indicated in the Bureau of Labor Statistics (2011) publication, *Occupational Outlook*, approximately one third of the nation's fastest growing jobs are in STEM-related fields. They also indicated that the number of college graduates earning STEM degrees would not be sufficient to meet the industry demand. Despite this job growth trend, a nationwide survey of high school students conducted in April 2011 by the University of Sciences in Philadelphia and Harris Interactive reveals that 49 percent of respondents are "definitely not" or "probably not" interested in pursuing a career in science or healthcare. Approximately half of the respondents indicated they "might" pursue a STEM-related career.

It is paramount that we foster in American students an interest in STEM. For America to remain competitive, we must nurture the next generation of innovators. We must work to increase student interest and proficiency in STEM subjects so that the youth of our nation pursue STEM degrees in order to meet the workforce and global economic needs. As stated by the Business-Higher Education Forum, "Both interest in a STEM career and proficiency in STEM subjects, especially mathematics, are necessary prerequisites for students to select and succeed in a STEM major." In order to excite students of all backgrounds about STEM, we need to prepare effective educators who can engage students in STEM. The degree program, as proposed, is designed to respond to the master-level education needs of STEM educators and prepares them to effectively engage their students in the STEM disciplines.

Centrality of the Program to the Mission of The Citadel

The Citadel Graduate College provides adults in the Lowcountry and the State of South Carolina opportunities for higher education by offering a broad range of educational programs of recognized excellence at both the graduate and undergraduate levels. These programs are designed to accommodate the needs of adult students seeking traditional and demanding academic challenges. By providing graduate research, scholarly contributions, affiliations with educational, business and science professional associations nation-wide and around the world, community outreach and development, and contribution of other resources, The Citadel Graduate

College supports and encourages stronger economic development in the region by identifying and creating new programs to benefit the community.

The proposed program will fall under the purview of The Citadel's STEM (Science, Technology, Engineering and Mathematics) Center of Excellence, which in 2010, was launched in a collaborative effort by The Citadel's Schools of Education, Engineering, and Science and Mathematics. The mission of the STEM Center is to advance STEM literacy in the Lowcountry of South Carolina and beyond through initiatives to increase P-20 student interest, participation and opportunities in the STEM disciplines, developing innovative teacher preparation and professional development activities, and supporting college-wide efforts to produce more graduates who are poised to become successful leaders in the STEM fields.. The Center has served as a catalyst for transformational educational models that put STEM skills at the center of education.

The STEM Center is part of a major strategic initiative, objective 2.2 (to create academic programs of distinction within each academic school) in LEAD 2018: The Strategic Plan for Leadership Excellence and Academic Distinction. In addition to the direct tie to objective 2.2, the STEM Center's proposed program also supports strategic objective 8.1, to enhance institutional outreach and economic development activities. In order for our region, our state, and our nation to be globally competitive in an innovation-driven economy, we must have a reliable STEM talent pipeline producing well-qualified STEM-competent employees. The proposed program will be a way to ensure educators have the tools and skills necessary to prepare students for a future STEM career.

Relationship of the Proposed Program to Other Related Programs within The Citadel

The master's degree in Interdisciplinary STEM Education complements current degree programs currently offered by The Citadel: As part of a larger effort to enhance mathematics and science literacy in the region, The Citadel has launched an accelerated Master of Art in Teaching (MAT) in Biology and in Mathematics to attract more mid-level science and mathematics professionals who are interested in becoming highly qualified high school teachers of biology and mathematics. By reducing the time needed to complete the MAT in either Biology or Mathematics to fifteen months, the program is more attractive to professionals interested in teaching as a second career, thereby increasing the number of qualified teachers in these critical need areas. The Master of Arts in Education in Mathematics is a degree program designed to enhance the mathematical knowledge and teaching techniques of middle and secondary mathematics educators. The Master of Education degree in Interdisciplinary STEM Education is another innovative initiative that works to improve the effectiveness of current educators and significantly increase the number of high school graduates who are prepared to succeed in STEM degrees in college. Several faculty from the School of Education and the School of Science and Mathematics who already teach courses for the MAT and/or the Master of Arts in Education in Mathematics plan to teach courses for the proposed program; therefore we are able to share faculty and course load requirements among all of these programs.

Similarities or Differences Between the Proposed Program and Those at Other Institutions

An investigation into similar programs at other institutions within and outside of South Carolina was conducted. Within South Carolina, no other master’s level degree programs in interdisciplinary STEM education could be found. Other higher educational institutions within South Carolina offer degree programs for science and mathematics educators but not a truly interdisciplinary STEM degree program. The MEd in Interdisciplinary STEM Education at The Citadel is unique to other similar programs in that it integrates the STEM disciplines in a holistic way in an online environment and progressively builds interdisciplinary teaching skills and content knowledge.

The following South Carolina institutions offer graduate academic programs with the same CIP code, 131299, as the proposed program. There is only one other public institution offering a program within the same CIP code, and none are at all similar to The Citadel’s proposed program.

| Institution | Degree & Program Name | Focus |
|------------------------------|------------------------------------|---------------------------------------------------------------------------------------------|
| Southern Wesleyan University | MEd, Classroom Leadership | General teacher education |
| Bob Jones University | MEd, Teaching and Learning | Increase effectiveness of elementary and secondary teachers in the Christian school setting |
| Lander University | MEd, Teaching and Learning | Specializations in Diverse Learners, Exercise & Sports Studies and Instructional Technology |
| College of Charleston | MEd, Teaching, Learning & Advocacy | Education of and factors influencing learning and engagement of diverse children |

Outside of South Carolina, there are approximately twelve similar programs mostly focusing on pedagogy and traditional science coursework. The table below summarizes programs that exist:

| University | Degree | Credit Hours | Length (months) | # Students Enrolled Annually | Delivery |
|---------------------------------------|----------------------------------------------------------------------------|---------------------|------------------------|-------------------------------------|-----------------|
| Berkeley University | Masters in Education in Math, Science and Technology | 20 plus thesis | 18 | 10 to 12 | On-site |
| Boise State University (ID) | Masters In STEM Education | 33 total | 24 | 10 to 20 | Limited online |
| Bradley University (IL) | Masters of the Arts in Elementary Math, Science and Technology Education | 33 | 33 | 25-30 | On-site |
| Brigham Young University (NV) | Masters in Teacher Education, Specialty in Integrative STEM Education | 42 | 24 + | 5 | On-site |
| California University of Pennsylvania | Master's of Education: Science, Technology, Engineering and Math Education | 30 | 30 | 35 | Online |

| | | | | | |
|-----------------------------|---------------------------------------------------------------------------------------------------------|-----|----|----------|----------------------|
| Cincinnati, University of | Masters of Education STEM | 45 | 24 | varies | Online |
| Framingham State University | Master of Education with a concentration in STEM for Teachers in Grades 1-6 | 30 | 18 | 10 | Limited online |
| Illinois State University | STEM Education and Leadership Master of Science in Technology | 30 | 24 | <15 | Online |
| Niagara University (NY) | Masters of Science in Education: Foundations of Teaching Math, Science and Technology | 37 | 18 | 10 to 20 | Limited online |
| Ohio State University | Masters of Education in Science, Technology, Engineering and Math Education | 41 | 24 | 30 to 45 | On-site |
| Oklahoma, University of | M.Ed. in Instructional Leadership and Academic Curriculum (ILAC) with a concentration in STEM Education | 41 | 24 | 20-24 | On-site |
| Virginia Tech | Master's of Arts in Integrative STEM Education or EDS in STEM Education | 30+ | 18 | 15-20 | Online (synchronous) |

Admission Criteria

Admission requirements for the MEd in Interdisciplinary STEM Education will be:

- A bachelor's degree from an accredited college or university (recognized by the Council for Higher Education Accreditation) demonstrating an appropriate preparation in STEM.
- GRE minimum score of 291
- Miller's Analogy Test minimum score of 396
- Undergraduate GPA of 2.5 or better
- Acceptance into The Citadel Graduate College

Demand for the Program

Locally, a survey was disseminated to K-12 educators of all disciplines. The survey assessed the interest of Lowcountry educators in a Master's in Interdisciplinary STEM Education and directed respondents to share preferences regarding on-site vs. online delivery of coursework and the need for financial assistance. One hundred fifty-six (156) teachers responded to the survey as of March 1, 2012.

Respondents included primary and secondary educators, with middle school educators being the slight majority (38%) followed by elementary school educators (35%) and then high school educators (27%). Seventy-two percent of the respondents currently teach science, technology or mathematics; the remainder teach non-STEM subjects.

When asked how important a master's in STEM Education degree would be to them, 54% of respondents indicated that it would be moderately, very or extremely important. An overwhelming majority of them, 85%, indicated that online coursework would be important to them when choosing a degree program; in fact, the survey results showed that respondents would be much more likely to enroll in an *online* Master's in STEM Education program at The Citadel than an *on-site* program.

Projected Total Student Enrollment

The Citadel expects to have an inaugural cohort of 15 students. The STEM Center and The Citadel's School of Education are fortunate enough to not only be the recipient of a South Carolina Commission on Higher Education Improving Teaching Quality (ITQ) grant, which has so far included three years of new cohorts), but also a new Center of Excellence grant, an innovative teacher professional development program that will establish STEM Ambassadors in high-needs districts.

Teachers who have gone and will go through these programs will be one of the initial target populations for the proposed program. Recruitment will also occur through the networks that the STEM Center has through the Lowcountry STEM Collaborative, which was borne from the STEM Center at The Citadel, and also through partnerships that the STEM Center has established with organizations such as STEM Centers SC and Next Steps in Science. The STEM Center is working with the above-mentioned organizations to co-host of a national conference occurring in autumn 2013 that will bring STEM educators from across the country together to learn, share and explore Next STEPS for STEM schools. The Citadel intends on marketing directly to the hundreds of educators who attend Next Steps institutes.

In addition to these strategies, The Citadel will market the program aggressively. The Citadel has doubled its marketing department this past year, and is already focusing on raising awareness of the institution's stellar graduate programs.

| Year | Fall | | Spring | | Summer | |
|-----------|-----------|--------------|-----------|--------------|-----------|--------------|
| | Headcount | Credit Hours | Headcount | Credit Hours | Headcount | Credit Hours |
| 2013-2014 | 15 | 90 | 15 | 90 | 15 | 45 |
| 2014-2015 | 30 | 180 | 30 | 180 | 30 | 90 |
| 2015-2016 | 30 | 180 | 30 | 180 | 30 | 90 |
| 2016-2017 | 30 | 180 | 30 | 180 | 30 | 90 |
| 2017-2018 | 30 | 180 | 30 | 180 | 30 | 90 |

Plan for Development

Over the past academic year, interested faculty from the Schools of Engineering, Education, and Science and Mathematics have met to discuss the vision, objectives, and strategy behind this degree program. A series of courses have been proposed and the core courses developed. Participating faculty have worked to align the proposed coursework to ensure a progressive attainment of skills by the students and plan capstone elements that will be included in each course. Following approval of this degree program by the Commission on Higher Education, faculty will work to develop the courses while working with The Citadel's online course instructional design team to bring the full vision of the courses into an online environment. Participating faculty will receive stipends from strategic initiative funds to support course development.

Curriculum

The 34-credit hour MEd in Interdisciplinary STEM Education is organized into two areas – core and electives. The coursework will consist of nineteen (19) hours of core coursework and fifteen (15) hours of electives. Transfer credit into the program will be accepted in accordance with The Citadel Graduate College policy on transferring graduate credit (page 14 of http://www.citadel.edu/root/images/CGC/2012-2013_CGC_Catalog.pdf).

Nearly all courses shown below are newly developed courses or existing courses that are being modified for the purposes of online delivery and integration into the STEM-centered curriculum. Several of the faculty who have modified existing courses have begun teaching blended versions in preparation of teaching their online course for the proposed program. Faculty have begun the required Online Faculty Academy and course design workshops to prepare for the proposed program's start date of January 2014.

| Core Coursework (19 Credit Hours Required) | Course Name | Credits |
|---------------------------------------------------|----------------------------------------------------------|----------------|
| | Teaching, Learning and Assessing with Technology | 3 |
| | Project Based Learning and Interdisciplinary Teaching | 3 |
| | Developing STEM Disciplinary Literacy Skills | 3 |
| | Leadership and Critical Issues in STEM Education | 3 |
| | Research and Statistics for STEM Applications | 3 |
| | Foundations in STEM I | 2 |
| | Foundations in STEM II | 2 |
| Choose five electives from the list below: | | |
| Electives (15 Credit Hours) | The Chemistry of Art | 3 |
| | Engineering Applications in STEM | 3 |
| | Forensic Science | 3 |
| | Introduction to Biotechnology | 3 |
| | Introduction to Nanotechnology | 3 |
| | Mathematical Technology Resources for STEM Education | 3 |
| | Multidisciplinary Experimental Design and Implementation | 3 |
| | Programming for STEM Educators | 3 |
| | STEM Education Through Robotics | 3 |
| | Total Credits | 34 |

Details of the core and specialty coursework are provided below.

Required Core Courses

Teaching, Learning and Assessing with Technology (3 hours)

This course explores the use of technology as a tool for: supporting teaching and learning; assessing students' outcomes; and helping educators accomplish their educational goals. Educator will explore theoretical foundations and educational principles required to create collaborative learning environments that are technology rich and pedagogical sound.

Project Based Learning and Interdisciplinary Teaching (3 hours)

This course will enable students to learn how to use a Standards-Focused Project Based Learning (PBL) Model to develop specialized instructional curriculum to be implemented and integrated

into an existing interdisciplinary educational system. Interactive and practical assignments are used to help teach the five major planning elements of PBL. Online discussions and interactive learning modules will be focused on the learning and application of PBL concepts. Furthermore, coursework is designed to help the student create a Project Based Learning curriculum for use in their teaching. For students enrolled in the STEM degree program, the curriculum developed in this class will be used as a component in their Capstone Project.

Developing STEM Disciplinary Literacy Skills (3 hours)

The purpose of this course is to enable those in the educational field to customize literacy practices to meet the unique demands of science, technology, engineering, and mathematics. Each content area demands specialized literacy skills. Therefore, in order to prepare students for literacy demands in careers and later in life, it is essential that literacy learning be embedded within the content knowledge. Educators will learn to assist K-12 students with the navigation of complex informational texts within STEM areas and be better prepared to help all students develop the necessary disciplinary literacy skills.

Leadership and Critical Issues in STEM Education (3 hours)

This course is designed to help candidates consider critical issues linked to successful leadership models in the integration of Science, Technology, Engineering and Mathematics (STEM) into educational endeavors. The on-line instructional approach for this course includes web-quest activities, asynchronous discussions, field experience interviews, and curriculum development activities as well as implementation reflective activities.

Research and Statistics for STEM Applications (3 hours)

This is a three (3) unit graduate course for teachers in STEM education with no previous background in statistics who will need statistics in their further studies and their work. The focus is on understanding the use of research and statistical methods in various areas of science and engineering. Topics to be covered include research methods, measures of central tendency, correlation, statistical inference, and basic design of experiments with examples and application in science and engineering. Teachers will become critical consumers of research products and learn the basic skills of planning, designing, executing and reporting research as well as evaluating and applying published research findings. Emphasis will concentrate on planning, developing, and producing a quality STEM research e-portfolio.

Foundations in STEM I and II (2 hours each)

The Foundations in STEM courses refresh student content knowledge in the STEM disciplines in order to prepare students for their chosen electives. These courses help eliminate minor content knowledge deficits of students while highlighting the interdisciplinary nature of the STEM disciplines.

Electives

Each student will be required to complete fifteen (15) credit hours of graduate instruction and will choose from the following elective courses. Each single course is designed to be appropriate for educators of most STEM disciplines highlighting the interdisciplinary nature of STEM. As other areas within the STEM fields develop appropriate courses may be proposed and implemented.

The Chemistry of Art (3 hours)

This course will address the chemistry involved in the preparation of artists' materials and artwork itself and the chemistry used in authenticating, restoring, and conserving art and artifacts.

Engineering Applications in STEM-Special Topics (3 hours)

The flight of heavier than air vehicles is a wonder and a marvelous application of the principles of physics. Turning these principles into technology which is safe and effective requires knowledge and understanding of these principles of physics which makes flight possible and a command of structured engineering design which makes useful applications possible. This course provides both an understanding of the physical principles of flight and an introduction to the engineering design process. Teachers involved in the STEM disciplines will find the design projects addressed in this course directly applicable as student design projects in their classes. Through these case studies your students can not only learn that the underlying physics is not that difficult but can also have fun implementing what they learn in the design projects.

Forensic Science (3 hours)

Forensic Science incorporates concepts of biology, chemistry and physics in learning about the science involved in crime investigations. Hands-on activities will be incorporated to illustrate the techniques. Topics to be covered include fingerprinting, blood typing, disputed documents, DNA analysis, drug and poison detection and identification, and fiber comparison. Actual cases will be studied.

Introduction to Nanotechnology (3 hours)

Nanotechnology is based on the science of designing materials from the atomic or molecular level. It has the potential to impact virtually every area of life, from medicine to ultrastrong materials to electronics to clothing. In this course students will learn about the foundational physics and chemistry behind nanoscience as well as nanotechnology applications.

Introduction to Biotechnology (3 hours)

This course covers current techniques in biotechnology research and applications and highlights the interdisciplinary nature of the topic. Discussions cover techniques used in genomics, and proteomics and the applications of these techniques. Current techniques are explained and ethical considerations are discussed. Emerging technologies in this field and their applications are introduced.

Mathematical Technology Resources for STEM Education (3 hours)

This course is applicable to multiple middle and high school academic disciplines: mathematics, science, technology, and middle/high school engineering such as Project Lead the Way. This course is 100% online in an asynchronous format; modules may be completed anytime within the week assigned. The course content will introduce students to open-source (free) mathematical software packages and tools. Middle and high school teachers will learn how to use these mathematical software packages and tools for mathematical modeling, classroom presentation and demonstration, illustration and exploration of mathematical concepts, and hands-on projects for teaching mathematics. The class will collaborate on a wiki. The prerequisite for this course will be successful completion of undergraduate class in College Algebra and Trigonometry.

Multidisciplinary Experimental Design and Implementation-Special Topics (3 hours)

In this course, students will learn methods of collaborative interdisciplinary experimental design in the STEM fields. The course is designed to provide students with the experience, tools, and methods needed to improve experimental design processes and strategies for implementation in their classrooms. This course, using relevant STEM content, provides case studies in multidisciplinary experiments emphasizing problem solving and experimental design.

Programming for STEM Educators (3 hours)

This course introduces programming and problem-solving using Visual Basic. Students will learn Visual Basic syntax, and basics of event-driven programming while working with variables, constants, data types, and expressions. Problem solving and decision-making are integrated as students also explore looping and multiple forms, using menus, common dialogs, procedures, functions and arrays, debugging, creating executable files, and distributing a Windows application. Concepts and methods of object-oriented programming and design, creating applications using a development cycle approach, and disciplined coding style are included. In addition, students will also learn about data organization and collection, file organization, sort and search techniques, database construction, and manipulating data created in Microsoft Access using Visual Basic.

STEM Education Through Robotics (3 hours)

Use the LEGO Mindstorms Robotics kit to build, test and program robots to accomplish various tasks. This exciting fusion of physics, mathematics, computer science and artistic expression can really draw students and teachers into active learning and experimentation. Hands-on experience will provide strategies and projects that teachers can use with middle and high school students; advanced options are available for those who want to go beyond the basics. Each assignment, project or test will have a due date that will be posted online. Access to a Mindstorms robotics kit with software is required for the course.

The Capstone: Embedded in the coursework is a capstone. Students will prepare an online portfolio that captures evidence of achievement. The Portfolio will consist of their developed project-based lessons, an analysis of lesson implementation, and statistical analysis of student impact. A panel of instructors will review student's work and evaluate their capstone project.

Typical Student Schedule

Since this curriculum is targeted solely for working professionals and the majority of the coursework is planned to be delivered online in asynchronous format, students will typically progress through the program at their own pace.

A student planning to complete their MEd in STEM Education in two years will require that they complete two courses per semester, along with two courses during each of two summer sessions.

Example Course Plan:

| Semester | Coursework | Category |
|---------------|--------------------------------------------------------------------------------------------------------|----------------------|
| Year 1 | | |
| Fall | Project Based Learning and Interdisciplinary Teaching Foundations in STEM I | Core Core |
| Spring | Teaching, Learning and Assessing with Technology Foundations in STEM II | Core Core |
| Summer | Multidisciplinary Experimental Design and Implementation Research and Statistics for STEM Applications | Elective Core |
| Year 2 | | |
| Fall | Developing STEM Disciplinary Literacy Skills Engineering Applications in STEM | Core Elective |
| Spring | Leadership and Critical Issues in STEM Education Mathematical Technology Resources for STEM Education | Core Elective |
| Summer | Programming for STEM Educators Introduction to Nanotechnology | Elective Elective |

Assessment Plan

Student learning outcomes include the ability to design project-based instruction and learning activities in STEM fields; ability to develop engaging STEM-related educational activities and evaluations that use inquiry, discovery and hands-on learning, ability to employ innovative ideas of integration of the STEM disciplines to solve real-world problems; and the development of critical thinking skills to evaluate and apply educational research that informs teaching and learning in STEM disciplines.

Learning outcomes will be assessed through a variety of ways including discussion board contributions, completion of embedded assignments, student self-assessments, video presentations and student capstone projects. Students will prepare an e-portfolio that captures evidence of achievement. The portfolio will consist of their developed project-based lessons/curriculum, a plan for implementation within their workplace, evaluation strategies and instruments, an analysis of implementation, and statistical analysis of student/school impact. Students will present and defend their research and a panel of instructors (2-3 faculty) will review student’s work and evaluate each capstone project. Each semester, results will be compiled and at least annually, program faculty will implement continuous improvement based on student data.

Programmatic assessment will occur through post-surveys delivered to each student upon completion of the program to gauge student satisfaction and self-efficacy as a STEM educator and through evaluation of student capstone projects. Alumni will also be surveyed one to two years after completion of the program to gather information on how each student is utilizing the knowledge gained through the proposed program and if possible, student performance and persistence in STEM coursework.

Faculty will meet at least annually during spring and/or summer to review student learning outcomes and results of post-surveys. The STEM Center will lead a dialogue with faculty from

the STEM disciplines and the School of Education to perform continuous improvement on course and degree content and delivery.

Faculty

The table below outlines the faculty who are team-developing courses.

| Rank | Highest Degree Earned | Field of Study | Teaching in Field (Yes/No) |
|---------------------|-----------------------|------------------------------|----------------------------|
| Professor/Dept Head | Ph.D. | Physics | Yes |
| Professor/Dept Head | Ph.D. | Chemistry | Yes |
| Professor | Ph.D. | Education | Yes |
| Professor | Ph.D. | Mathematics/Computer Science | Yes |
| Professor | Ph.D. | Chemistry | Yes |
| Associate Professor | Ph.D. | Chemistry | Yes |
| Associate Professor | Ph.D. | Education | Yes |
| Associate Professor | Ed.D | Education | Yes |
| Associate Professor | Ph.D. | Electrical Engineering | Yes |
| Associate Professor | Ph.D. | Mathematics/Computer Science | Yes |
| Assistant Professor | Ph.D. | Mathematics/Computer Science | Yes |
| Instructor* | M.A.T. | Mathematics | Yes |
| Instructor* | M.A. | Educational Technology | Yes |
| Instructor* | M.A. | Educational Technology | Yes |

**These instructors will co-teach with tenured or tenure-track faculty*

Any new faculty to be brought into teach courses for the proposed program will have a terminal degree in their field of expertise or have extensive experience in the discipline.

Courses taught for the proposed program will be worked into the regular teaching loads of The Citadel faculty. If needed, adjustments will be made by bringing in adjuncts from other programs, subject matter experts in the field or new full-time faculty. The goal will be to keep the program at or above 75% full-time faculty and at or below 25% adjuncts.

As mentioned above, every faculty teaching a course for the proposed program will have completed The Citadel's Online Teaching Faculty Academy. Each faculty member also has the opportunity to work with an instructional designer to develop specific components of their online course and each is given a stipend for course development. To encourage faculty's continual development of their area of academic expertise, The Citadel has developed a robust faculty development program that is funded by The Citadel Foundation that guarantees research grants to every new faculty and offers competitive grants to faculty for research and conference presentations.

Unit Administration and Faculty Support

The institutional definition of the full time equivalents was used to complete the chart below. Nine contact hours each term or 18 for the academic year constitutes one FTE. Note that The Citadel offers its Online Teaching Faculty Academy each semester and in the summer. Faculty participation in this professional development opportunity is incentivized with stipends.

| UNIT ADMINISTRATION/FACULTY/STAFF SUPPORT | | | | | | |
|-------------------------------------------|-----------|-----|----------------------------|-------|-----------|-------|
| YEAR | NEW | | EXISTING | | TOTAL | |
| | Headcount | FTE | Headcount | FTE | Headcount | FTE |
| Administration | | | | | | |
| 2013 – 14 | 0 | 0 | 2 *Dean, Program Dir. | .25 | 2 | .25 |
| 2014 – 15 | 0 | 0 | 1*Program Director only | .2 | 1 | .2 |
| 2015 – 16 | 0 | 0 | 1 | .2 | 1 | .2 |
| 2016 – 17 | 0 | 0 | 1 | .125 | 1 | .125 |
| 2017 – 18 | 0 | 0 | 1 | .125 | 1 | .125 |
| Faculty | | | | | | |
| 2013 – 14 | 0 | 0 | 4 | 0.889 | 4 | 0.889 |
| 2014 – 15 | 0 | 0 | 8 | 2.667 | 8 | 2.667 |
| 2015 – 16 | 0 | 0 | 8 | 2.667 | 8 | 2.667 |
| 2016 – 17 | 0 | 0 | 8 | 2.667 | 8 | 2.667 |
| 2017 – 18 | 0 | 0 | 8 | 2.667 | 8 | 2.667 |
| Staff | | | | | | |
| 2013 – 14 | 0 | 0 | 1 | .125 | 1 | .125 |
| 2014 – 15 | 0 | 0 | 1 | .125 | 1 | .125 |
| 2015 – 16 | 0 | 0 | 1 | .1 | 1 | .1 |
| 2016 – 17 | 0 | 0 | 1 | .1 | 1 | .1 |
| 2017 – 18 | 0 | 0 | 1 | .1 | 1 | .1 |

Physical Plant

All space required for this program is currently in place and available on The Citadel campus.

Equipment

All equipment required for this program is currently in place and operational on The Citadel campus.

Library Resources

Although several schools and departments at The Citadel maintain small, specialized collections of discipline-specific resources, Daniel Library is primarily responsible for the college's learning/information resources. Daniel Library is the facility that houses 99% of the college's learning/information resources in physical formats (books, print periodicals, maps, microforms, DVDs, etc.); and it oversees access to all of the electronically-formatted learning/information resources that the college owns or to which it subscribes. Daniel Library is also responsible for providing the services that make these resources accessible to students, faculty, and staff.

The Citadel is proud of its librarians and library support staff, and it recognizes the superior job they do in providing library instruction and access (through interlibrary loan and electronic means) to virtually any resource that faculty and students require. Consecutive building renovation projects beginning in 2009 have improved the library facility by adding study spaces, computer workstations, space for special events, and staff workrooms; and by improving electric and data capacity. In addition, Daniel Library continues to expand available study space by replacing print runs of journals with online archives.

The library is open 83 hours per week over seven days and offers services via email, chat, and telephone. Most electronic resources, interlibrary loan and PASCAL (South Carolina Academic Library consortium) requests, and self-renewals are available 24/7 on and off-campus.

Learning/Information Resources

In FY2012, The Citadel spent \$592,915 on electronic and print monographs, electronic journal archives and article aggregators, and DVDs to support the college curriculum.

| | | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Hours of Operation</u> 83 | <u>Circulation</u> 32,802 annually | <u>Reference/Research Assistance</u> 537 monthly |
| <u>Interlibrary Loan</u> 5,284 annually | <u>Reserves</u> 4,546 loans of 2,101 items annually | <u>Electronic Databases including ebooks</u> 196,730 annually |
| <u>Community Outreach</u> Middle and high school tours and instruction; partnership with Krause Leadership community writing workshop; exam proctoring | <u>Archives and Museum</u> 6,000 visitors annually. The Archives and Museum falls administratively under the Director of Daniel Library | <u>Official Depository (Partial) for US Government Documents</u> 65,504 titles in print and microform; additional electronic documents also cataloged |

STEM Learning/Information Resources

Currently, students and faculty at The Citadel have speedy (3-5 days from request to delivery) access to over 900,000 print monographs held by the Partnership Among South Carolina Academic Libraries (PASCAL). Over 600 print monographs have the specific subject headings SCIENCE—STUDY AND TEACHING (HIGHER), TECHNOLOGY—STUDY AND TEACHING (HIGHER), ENGINEERING—STUDY AND TEACHING (HIGHER), or MATHEMATICS—STUDY AND TEACHING (HIGHER). In addition, PASCAL and the State Library have multiple database subscriptions that would support Masters-level research in Interdisciplinary STEM Education. Academic Search Complete and other EBSCO databases have full-text access to the articles in over 7,300 peer-reviewed journals, including over 50 whose article abstracts include STEM EDUCATION. Locally, The Citadel subscribes to the ProQuest suite of Education journals, 53 of which are full-text and peer-reviewed in the subject of STEM education. At least 50 full-text monographs with the STUDY AND TEACHING (HIGHER) subject headings listed above are available via The Citadel's Academic Complete subscription from ebrary/ProQuest. There are 130 print monographs at the Citadel's library that have these subject headings. The majority of these resources were published between 1997 to the present year.

Accreditation, Approval, Licensure, or Certification

The MEd is not subject to specialization or professional accreditation. Graduates of the program are not subject to licensure or certification by any public or private agency.

Through the blending of pedagogical practices and progressive content, the following core propositions of the National Board for Professional Teaching Standards are embedded into the courses that comprise this innovative program.

- Teachers are committed to students and their learning;
- Teachers know the subjects they teach and how to teach those subjects to students;
- Teachers are responsible for managing and monitoring student learning;
- Teachers think systematically about their practice and learn from experience; and
- Teachers are members of learning communities

Specifically, the program develops 21st century STEM educators by facilitating a broader understanding of the interdisciplinary nature of STEM, a deeper knowledge of discipline specific content, and new integrative approaches for the teaching and learning of STEM content.

Articulation

There are no articulation agreements associated with the proposed program; no other similar programs exist in the state of South Carolina.

Estimated Costs and Sources of Financing

| Year | 2013-2014 | 2014-2015 | 2015-2016 | 2016-2017 | 2017-2018 | Total |
|-----------------------------------------------------------------------------|------------------|------------------|------------------|------------------|------------------|--------------------|
| Program Administration | \$16,500 | \$10,000 | \$10,000 | \$5,000 | \$5,000 | \$46,500 |
| Faculty Salaries (if 8 courses/yr) | \$19,000 | \$38,000 | \$38,000 | \$38,000 | \$38,000 | \$171,000 |
| Graduate Assistants | 0 | 0 | 0 | 0 | 0 | 0 |
| Clerical/Support Personnel | \$2,500 | \$2,500 | \$1,250 | \$1,250 | \$1,250 | \$8,750 |
| Supplies and Materials | \$4,000 | \$4,000 | \$2,000 | \$2,000 | \$2,000 | \$14,000 |
| Library Resources | \$2,000 | \$2,000 | \$2,000 | \$2,000 | \$2,000 | \$10,000 |
| Equipment | 0 | 0 | 0 | 0 | 0 | 0 |
| Facilities | 0 | 0 | 0 | 0 | 0 | 0 |
| Other (ITS Course Developer) | \$50,000 | 0 | 0 | 0 | 0 | \$50,000 |
| Faculty Developers | \$70,000 | 0 | 0 | 0 | 0 | \$70,000 |
| TOTAL | \$164,000 | \$56,500 | \$53,250 | \$48,250 | \$48,250 | \$370,250 |
| SOURCES OF FINANCING BY YEAR | | | | | | |
| Tuition Funding (\$501/credit hour) | \$68,850 | \$229,500 | \$229,500 | \$229,500 | \$229,500 | \$986,850 |
| Program-Specific Fees | 0 | 0 | 0 | 0 | 0 | 0 |
| State Funding (Legislative Approp.) | 0 | 0 | 0 | 0 | 0 | 0 |
| Reallocation of Existing Funds (institutional strategic initiative funding) | \$70,000 | 0 | 0 | 0 | 0 | \$70,000 |
| Federal Funding | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Funding (Endowment, Auxiliary, etc.) | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | \$138,850 | \$229,500 | \$229,500 | \$229,500 | \$229,500 | \$1,056,850 |

It is assumed that initially the program will draw in only in-state students. No unique costs or other state appropriations is expected to impact the proposed program, which will be funded through tuition funding and reallocation of existing institutional strategic initiative funding.

South Carolina Department of Education Requirements & SPA or Other National Specialized and/or Professional Association Standards

The proposed program does not lead to certification nor does it require student teaching internships.

The proposed program will comply with the standards contained in the Southern Association of Colleges and Schools (SACS) *Principles of Accreditation: Foundations for Quality Enhancement* and with the policies and procedures of the Commission on Colleges. The proposed assessment plan to address SACS Comprehensive Standard 3.3.1.1 is reiterated below.

| MEd in Interdisciplinary STEM Education | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Assessment Plan | | |
| Student Learning Outcome | Assessment Technique | Timeline for Results and Continuous Improvement Efforts |
| <ul style="list-style-type: none"> Students will be able to design project-based instruction and learning activities in STEM fields. | Embedded assignments and collective e-portfolios throughout | Results will be compiled each semester and at least annually the program faculty will implement continuous improvement based off the data |
| <ul style="list-style-type: none"> Students will be able to develop engaging STEM related educational activities and evaluations that use inquiry, discovery and hands-on learning | Capstone project ,embedded assignments and student self-assessment throughout | Results will be compiled each semester and at least annually the program faculty will implement continuous improvement based off the data |
| <ul style="list-style-type: none"> Students will be able to employ innovative ideas of integrations of the STEM disciplines to solve real-world problems | Embedded assignments, observation of presentations and e-portfolios throughout | Results will be compiled each semester and at least annually the program faculty will implement continuous improvement based off the data |
| <ul style="list-style-type: none"> Students will develop critical thinking skills to evaluate and apply educational research that informs teaching and learning in STEM disciplines | Capstone project, embedded assignments, student self-assessment throughout | Results will be compiled each semester and at least annually the program faculty will implement continuous improvement based off the data |