Graduate Certificate in Interdisciplinary STEM (iSTEM) Education

I. Statement of Purpose:

The 12-hour graduate certificate in Interdisciplinary STEM Education (Science, Technology, Engineering, and Math) is designed for graduate students from all disciplines who wish to focus on issues related to Interdisciplinary STEM (iSTEM) Education. The goals of the Interdisciplinary STEM Education (ISE) certificate are to provide graduate students with a comprehensive educational foundation to understand local and global STEM issues, and support them to acquire the analytical skills needed to effectively implement appropriate instructional strategies for varying audiences. The Interdisciplinary STEM Education certificate program integrates STEM concepts, pedagogical approaches and best practices, and issues and actions in STEM Education.

The educational goals of the proposed iSTEM Education certificate program are:

- To prepare educators to both teach and integrate STEM Education into curricula and programs for diverse learner populations
- To increase STEM Education literacy for formal and informal educators

Conceptual Framework

Interdisciplinary STEM Education is an interdisciplinary and applied-approach curriculum based on the idea of educating students in four specific academic disciplines — science, technology, engineering and mathematics. The proposed certificate presents an approach to learning that removes the traditional barriers separating the four disciplines and integrates them into real-world, rigorous, and relevant learning experiences for students (Vasquez, Sneider, & Comer, 2013). To that end, the need to integrate all four elements of STEM takes on urgency with the advent of the Common Core State Standards and the Next Generation Science Standards (NGSS) (Hoachlander, 2014/2015), as well as the STEM Education Act of 2015 (U.S Congress, 2015). The Common Core Standards promote attention to technical reading and writing, and emphasize mathematical modeling while the science standards call for more focus on engineering and design, and integration of engineering with mathematics, science, and technology.

As part of the Innovation America Initiative, the National Governors Association (NGA) issued a policy guide for governors on K–12 STEM Education, Building a Science, Technology, Engineering, and Math Agenda, in February 2007. The guide recommended that governors lead efforts in their states to:

- Align state K–12 standards, assessments, and requirements with postsecondary and workforce expectations for what high school graduates know and can do;
- examine and increase the state's internal capacity to improve teaching and learning, including the continued development of data systems and new models to increase the quality of the K–12 STEM teaching force; and

- identify best practices in STEM Education and bring them to scale, including specialized schools, effective curricula, and standards for Career and Technical Education (CTE) that prepare students for STEM-related occupations.

These policy recommendations are proposed to support states in reaching the goal of graduating every student from high school with both essential STEM knowledge and competencies to succeed in postsecondary education and work. This requires schools to challenge every student with math and science courses that emphasize how math, science, and technology shape the world. This includes creating educational environments where both faculty and students work "outside the school walls" to investigate solutions to real world problems. Such schools prepare all students for success after high school, regardless of whether they specialize in STEM fields or not.

The Graduate Certificate in Interdisciplinary STEM (iSTEM) Education is designed for current educators who seek to advance their skillsets in the STEM disciplines. The overarching goal of the program is to create 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 proposed coursework is designed to equip STEM educators with the tools necessary to teach STEM content in engaging and interactive ways. The proposed Certificate in iSTEM Education also is designed to improve teacher effectiveness in Interdisciplinary STEM Education. Thus, a student successfully completing this certificate 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.

Link to Existing Programs: The certificate in Interdisciplinary STEM Education will be housed in the department of Interdisciplinary Learning and Teaching (ILT). The certificate will be closely linked to the Curriculum and Instruction (C&I), Instructional Technology (IST), and Early Childhood and Elementary Education (ECE) concentration programs. Graduate students in C&I, IST, and ECE will have the option to choose the certificate as their support courses for the Masters in Education (MAED), resulting in no additional course load requirements for these students. The certificate in iSTEM Education is also open to eligible students from other programs in the COEHD or other colleges, and for eligible Special graduate students.

II. Statement of Need:

In most K–12 systems, science and math are taught as discrete subjects unconnected to other coursework (Sanders, 2009). Under this model, students are not exposed to the connections between the work they are doing in math and science, and postsecondary fields of study and STEM occupations. In addition, these same students rely on technology every day through the use of smart phones, computers, and televisions without understanding the underlying connections to math and science. Moreover, the literature points to the fact that students typically form notions of their career paths in secondary school. To be sure, motivating interest in math and science requires improved pedagogical approaches in the classroom and opportunities outside the classroom to demonstrate linkages between math and science, real-world applications, and future careers.

The purpose of the proposed iSTEM Education certificate is to meet an identified need expressed by graduate students and educators interested in working professionally in the field of STEM Education. The proposed certificate program provides graduate students with an interdisciplinary perspective in understanding, interpreting, and dealing with issues and challenges in STEM Education. The proposed certificate program also addresses the national call to recruit more teachers into the teaching of STEM disciplines.

The proposed iSTEM Education certificate includes approaches that explore teaching and learning between/among any two or more of the STEM subject areas, and/or between a STEM subject and one or more other academic subjects. The graduate certificate also supplements and prepares formal K-12 STEM educators and administrators. In addition, the proposed certificate offers informal STEM educators (museums, governmental agencies, non-profits) opportunities to both explore and implement interdisciplinary alternatives to traditional STEM education. Moreover, the proposed iSTEM Education graduate certificate offers an integrated approach to a body of knowledge for current STEM educators, introducing them to the foundations, pedagogies, curriculum, research, and contemporary issues of each of the STEM education disciplines, as well as posing new integrative ideas, approaches, curriculum and other instructional materials.

III. Statement of Resources:

No additional resources are needed for this certificate. The Curriculum and Instruction, Instructional Technology, and the Early Childhood and Elementary Education graduate program areas housed in the Department of Interdisciplinary Learning & Teaching employ quality faculty to direct and teach courses within the proposed certificate program. Existing courses, classrooms, and technologies will support the program delivery. One new course is being created for this certificate.

IV. Description of Curriculum:

The iSTEM Education certificate will be awarded to graduate students at the Masters or Doctorate level, who have completed the 12 credit hours of approved courses. The iSTEM Education certificate requires 12 credit hours (four graduate courses). The 12 graduate credit hours for the iSTEM Education certificate can be applied towards the MAED degree or the PhD in Interdisciplinary Learning and Teaching with a concentration in C&I, IST, or ECE if the student chooses to become a degree-seeking graduate student. Students who opt to pursue the certificate but are not part of a graduate degree program will be admitted as Special Graduate students.

Requirements for the Interdisciplinary STEM Education certificate completion include:

- Completion of **12 graduate** hours of approved UTSA coursework with a GPA of 3.0 or above, and no courses in which grades of less than "C" (below 2.0 on a 4.0 scale) were earned may be applied towards the certificate.

A. Courses

Students will have the opportunity to register for the courses in the areas of Curriculum and Instruction, Instructional Technology, or Early Childhood and Elementary. The student's selection of designated area will depend on which MAED concentration is pursued. The proposed certificate courses are also available to other UTSA graduate students that desire to take one or more of the four courses in support of their individual degrees in other disciplines (i.e. students in engineering, mathematics, sciences, computer science) within our outside the COEHD.

C&I 6613 Nature and Meaning of Interdisciplinary STEM in Education (revised course title and description)
(3-0) 3 hours credit.
This course focuses on the nature and meaning of STEM with special emphasis on the role of STEM in educational environments. Participants will be asked to take a critical perspective on questions, such as: "What is Interdisciplinary STEM Education?" and "What about Interdisciplinary STEM Education is most important for a student to know?" The course will address the nature of STEM disciplines (the theories and problems which characterize them); the relationship between theory and empirical work; and the role of learning and teaching in pre-K–16 environments.

C&I 6623 Inquiry in Interdisciplinary STEM Education (revised course title and description)
(3-0) 3 hours credit.
This course will explore developing and designing learning environments for interdisciplinary STEM Education through inquiry, and provide a broad foundation for design and research into the teaching and learning of interdisciplinary STEM Education, in both formal and informal settings.

C&I 6633 Equity, Agency, and Participation in Interdisciplinary STEM Education (revised course title and description)
(3-0) 3 hours credit.
This course will focus on equity and agency issues in Interdisciplinary STEM Education as they relate to diverse demographics and communities. Agency is explored both as a process of becoming aware of and confident in one's ability to impact the community at large, as well as an expression and hallmark of democratic settings.

C&I 6963 Interdisciplinary STEM Education Trends and Issues (new course)
(3-0) 3 hours credit.
This course presents an introduction to historical and contemporary K-16 STEM Education developments, opportunities, and challenges from both discipline-based and integrative

approaches. Students will examine current Interdisciplinary STEM Education initiatives and considerations pertaining to policy, structure, process, and student learning.

B. Course Scheduling

Two courses (6 hours) will be offered during Fall and Spring semesters, respectively. Students will be able to complete the coursework required for the certificate in one or two academic years, depending on how many of the certificate courses they choose to take in a given semester. Anticipated start date for the certificate program implementation is Fall 2015

Fall 2015	Spring 2016	Summer 2016	Fall 2016	Spring 2017
C&I 6613 Nature and Meaning of Interdisciplinary STEM Education	**C&I 6633 Equity, Agency and Participation in Interdisciplinary STEM Education**		**C&I 6613 Nature and Meaning of Interdisciplinary STEM Education**	**C&I 6633 Equity, Agency and Participation in Interdisciplinary STEM Education**
C&I 6623 Inquiry in Interdisciplinary STEM Education	**C&I 6963 Interdisciplinary STEM Education Trends and Issues**		**C&I 6623 Inquiry in Interdisciplinary STEM Education**	**C&I 6963 Interdisciplinary STEM Education Trends and Issues**

Three iSTEM Education courses are drawn from merging currently existing courses in the ILT graduate catalog: C&I 6613: Nature and Meaning of Interdisciplinary STEM Education; C&I 6633: Equity, Agency, and Participation in Interdisciplinary STEM Education; and C&I 6623: Inquiry in Interdisciplinary STEM Education. C&I 6623 Interdisciplinary STEM Education Trends and Issues is a new course that will be proposed for the iSTEM Education certificate.

V. Faculty List:

Because this certificate draws from existing course offerings within the Department of Interdisciplinary Learning and Teaching, a fulltime, tenured or tenure-track faculty member from C&I, IST or ECE program areas will be appointed as proctor of the certificate program. The proctor, will also serve as Program Advisor, will be a qualified faculty member from ILT and will oversee admissions and advising activities for certificate applicants and students. Current C&I, IST, and ECE faculty will support the program as needed. These include:

- Dr. Maria Arreguín-Anderson, Associate Professor, ECE
- Dr. Emily Bonner, Associate Professor, C&I in Math Education
- Dr. Guadalupe Carmona, Associate Professor, C&I in Math Education
- Dr. Carmen Fies, Associate Professor, IST and Chemistry Education

- Dr. Brian Fortney, Associate Professor, C&I in Science Education
- Dr. Zaid Haddad, Assistant Professor, C&I, Social Sciences Education
- Dr. Crystal Kalinec-Craig, Assistant Professor, C&I in Math Education
- Dr. Christine Moseley, Professor, C&I in Science Education
- Dr. Elizabeth Pate, Professor, C&I in Middle School Education
- Dr. John Sutterby, Associate Professor, ECE
- Dr. Timothy Yuen, Associate Professor, IST

Faculty in the Department of Interdisciplinary Learning and Teaching have a history of academic collaborations in STEM Education with faculty from other departments, in the COEHD, College of Sciences, and College of Engineering, including:

- Dr. Stephen Ackley, Associate Professor, Geology
- Dr. David Akopian, Department of Electrical and Computer Engineering
- Dr. Mark Appleford, Department of Biomedical Engineering
- Dr. Pranav Bhounsule, Department of Mechanical Engineering
- Dr. Stuart Birnbaum, Associate Professor, Geological Sciences
- Dr. Aaron Cassill, Professor, Biology
- Dr. Óscar Chávez, Associate Professor, Mathematics
- Dr. Matthew Gibson, Assistant Professor, Department of Computer Science
- Dr. Yufang Jin, Associate Professo, Department of Electrical and Computer Engineering
- Dr. Drew Johnson, Professor, Civil and Environmental Engineering
- Dr. Sandy Norman, Professor and Chair, Mathematics
- Dr. Cody Patterson, Assistant Professor, Mathematics
- Dr. Xomalín Peralta, Assistant Professor, Physics and Astronomy
- Dr. Priya Prasad, Assistant Professor, Mathematics
- Dr. John Quarles, Assistant Professor, Computer Science
- Dr. Kay Robbins, Professor, Computer Science
- Dr. Can Saygin, Professor, Mechanical Engineering
- Dr. Hatim Sharif, Professor, Civil and Environmental Engineering
- Dr. Les Shephard, Professor, Civil and Environmental Engineering
- Dr. Heather Shipley, Associate Professor and Chair, Civil and Environmental Engineering
- Dr. Betty Travis, Professor, Mathematics
- Dr. Hung-da Wan, Associate Professor, Department of Mechanical Engineering
- Dr. Hongjie Xie, Professor, Geology
- Dr. Miguel José Yacamán, Professor and Chair, Physics and Astronomy

VI. Program Administration:

The Interdisciplinary STEM Education certificate is a joint effort of faculty in the Curriculum and Instruction (C&I), Instructional Technology (IST), and the Early Childhood and Elementary Education (ECE) graduate program areas, all within the Department of Interdisciplinary Learning and Teaching (ILT). The Interdisciplinary STEM Education certificate will be housed in the Department of Interdisciplinary Learning and Teaching, whose faculty and staff will support graduate students in the program. The program advisor will be a qualified faculty member from the ILT department. The Program Advisor oversees both admissions and advising activities for certificate applicants and students. The Program Advisor also will be responsible for overseeing the processes related to admissions' decisions, supervising students' progress, preparing certificate plans for students, and working with the Dean's Office in the College of Education and Human Development to certify students who have completed the requirements for the certificate. Students who declare the certificate, but are not part of a graduate degree program will be admitted as Special Graduate students in ILT. The Program Advisor will work with faculty members in the C&I, IST, and ECE graduate program areas within the department, and with interested students from other programs in the COEHD and other colleges, to make decisions about advising, recruitment, scheduling courses, and program policies. Certificates will be awarded upon completion of the 12 approved graduate courses with a GPA of 3.0 and no courses in which grades of less than "C" (below 2.0 on a 4.0 scale) are earned may be applied towards the certificate.

VII. Admissions Requirements:

As per the Graduate Catalog:

Students who apply for admission will be either students who are currently enrolled in a graduate degree program and who wish to earn a certificate in addition to their degree or students who are not currently enrolled in a graduate degree program. Students who are currently enrolled in a graduate degree program have already met university requirements for admission. In this case, no formal application process is necessary. The student should contact the Certificate Program Advisor and complete a form requesting permission to complete the certificate program, which would be signed by the Certificate Program Advisor and the Dean of the College or the Director of the Center in which the certificate program is housed. A copy of this form will be sent to the Graduate Advisor of Record for the student's degree program, the college in which the student's degree program is housed (or in the case of a program housed in a center that is not part of a college, the center will receive the form), and the Graduate School.

Students who are not currently enrolled in a graduate degree program will be required to apply for admission to UTSA as Special Graduate students, and to indicate their desire to pursue the requirements for a certificate. Applicants will be required to meet the university admissions requirements for Special Graduate students. Once admitted as a Special Graduate student, the student should contact the Certificate Program Advisor and complete a form requesting permission to complete the certificate program, which would be signed by the Certificate Program Advisor. A copy of this form will be sent to the Graduate School.

Admissions requirements will be the same for either graduate degree-seeking students or special graduate students. A maximum of 12 semester credit hours earned as a special graduate student may be applied toward a graduate degree, and then only when the student has been admitted as a graduate degree-seeking student and the credits earned for these courses have been evaluated and approved for this purpose by the appropriate Graduate Program Committee.

University-wide admission requirements that will also serve as admission requirements for this certificate include:

- the student must meet the grade point average requirement of 3.0 or higher (on a 4.0 scale) in all work counted as part of the degree program,
- no courses in which grades of less than "C" (below 2.0 on a 4.0 scale) were earned may be applied to a graduate degree, and
- to graduate, all graduate students must have a grade point average of at least a 3.0 (on a 4.0 scale) and be in good academic standing.

Departmental entrance requirements include a:

- bachelor's degree from an accredited university in an approved area of study, such as a major in one or more of the STEM (Science, Technology, Engineering, Mathematics), Education or related field as approved by the Certificate Program Advisor;
- minimum GPA of 3.0 for the last two years of work toward the bachelor's degree;
- a minimum GPA of 3.0 throughout tenure in the program; and
- no courses in which grades of less than "C" (below 2.0 on a 4.0 scale) were earned may be applied towards the certificate.

VIII. Projected Enrollments:

While the certificate is likely to draw new students to UTSA, it is also probable that current graduate students enrolled in the C&I, IST, and ECE program areas will pursue the certificate as part of their coursework towards the MAED or PhD degrees in ILT. This certificate will increase the student's marketability in the field for both internship and job placement upon completion of the degree. Many students in C&I, IST, and ECE are already asking about the certificate.

Projected Enrollments

Year	**One**	**Two**	**Three**	**Four**	**Five**
Enrollment	**10**	**15**	**15**	**15**	**15**

IX. Budget:

There are no additional funds requested in the management of this certificate beyond the Specific fees associated with the courses.

X. Endorsements:

The Interdisciplinary STEM Education Certificate is a collaboration between three graduate program areas housed within the same ILT Department. As per UTSA's *Policies and Procedures for Implementing and Administering Graduate Certificate Programs* endorsements requirement, Dr. Mari Cortez, Department Chair of ILT, has reviewed, accepted the proposal and provided a letter of support.

XI. Evaluations/Reviews:

Evaluation of the certificate program will be conducted annually. Student progress will be evaluated formatively based on success in Interdisciplinary STEM Education Certificate coursework. The summative evaluation will include student GPA of 3.0 or better in the certificate area coursework, and no courses in which grades of less than "C" (below 2.0 on a 4.0 scale) are earned may be applied towards the certificate.

It is the student's responsibility to apply for his or her certificate by submitting a completed Application for Graduate Certificate to the Enrollment Services Center no later than September 15 for the Fall Semester, February 15 for the Spring Semester, or June 15 for the Summer Semester. The application of any student applying for a certificate after the established deadlines will be processed the following semester. The application form is located at http://utsa.edu/registrar/forms.html

XII. References

Hoachlander, G. (2014/2015). Integrating STEM. *Educational Leadership,* December/January, 74-78.

National Governors' Association. (2007). Promoting STEM Education: A Communication Toolkit.

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U.S. Congress (September, 2015). STEM Education Act of 2015. *114th Congress (2015-16).* Washington, D.C.: U.S. House of Representatives.

Vasquez, J. A., Sneider, C., & Comer, M. (2013). *STEM lesson essentials, Grades 3–8: Integrating science technology, engineering, and mathematics*. New York: Heinemann.