



**THE FRAMEWORK FOR INTEGRATIVE SCIENCE, TECHNOLOGY,  
ENGINEERING & MATHEMATICS (STEM) EDUCATION  
ENDORSEMENT GUIDELINES  
September 2014**

# **Commonwealth of Pennsylvania**

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## TABLE OF CONTENTS

Definition of an Endorsement Certificate .....	1
Introduction to Integrative STEM Education Endorsement Guidelines .....	1
Overview of Integrative STEM Education Endorsement.....	2
Program Overview.....	2
Candidate Competencies .....	3
Content.....	4
Skills and Abilities.....	4
Instructional Practices .....	5
Assessment.....	5
Faculty.....	5
Related Information .....	6

## **DEFINITION OF AN ENDORSEMENT CERTIFICATE**

Following approval by the Department, baccalaureate or graduate degree granting institutions or intermediate units, alone or in cooperation with other institutions, community colleges or school entities, may offer short programs (12 credits maximum) that lead to the Program Endorsement. The Program Endorsement documents educator knowledge in new and emerging areas where formal certifications do not exist. The program endorsement is intended to improve a teacher's skills in dealing with complex classroom settings. These endorsements would be added to existing Level I or Level II Certificates but are not required to perform services in these areas.

## **INTRODUCTION TO INTEGRATIVE STEM EDUCATION ENDORSEMENT GUIDELINES**

This document describes the professional knowledge, skills, and competencies that candidates will acquire by completing a prescribed sequence of courses (including field experience). In addition to specific requirements and competencies, these guidelines discuss the Integrative Science, Technology, Engineering & Mathematics (STEM) Education Endorsement program design, candidate competencies, field experiences and any pre-requisite certificates needed by the candidate.

All endorsement programs must include some components of field experience. Field experiences are defined as a range of formal, required school and community activities participated in by candidates who are enrolled in educator preparation programs. These activities generally include supervision and mentorship by a teacher with expertise in the endorsement area. Effective field experiences provide candidates with increasing exposure to learning situations and school settings under the guidance of program faculty and trained mentors throughout the preparation program.

Institutions must demonstrate:

- How they implement field experiences.
- The duration of candidate field experiences.
- How these experiences are closely integrated with coursework, assessment practices and program goals.

### **Prerequisites for Integrative STEM Education Endorsement Program**

To be admitted into a STEM Endorsement Program, candidates must be enrolled in an approved Level I program or hold a Level I or II certificate.

## **OVERVIEW OF INTEGRATIVE STEM EDUCATION ENDORSEMENT**

It is clear that academic success depends on effectively preparing students for life in the 21st century. Therefore our educational system must be able to respond to this need by preparing students to thrive in an increasingly technological world and to solve the challenges of the Commonwealth's future in key areas such as energy, environmental conservation, and health care. Effective science, technology, engineering and mathematics (STEM) education is the key to meeting these needs. The stage is set for solid improvement to take place. Over the past decade, an interest in STEM education has resulted in the formation of multiple STEM programs. However, a number of important systemic elements have not yet been developed. It is time to more thoroughly coordinate efforts to prepare teachers to understand their impact on student preparation and achievement in STEM.

### **PROGRAM OVERVIEW**

The professional core courses, competencies and experiences for an Integrative STEM education endorsement program should be designed to address the specific set of issues, knowledge and competencies that are relevant to teaching and learning STEM. The program must prepare teachers who will be able to help students master academic standards and STEM skills. The program needs to include required competencies and field experience/job-embedded activities appropriate to developmental level.

The program design must describe clearly how the relevant set of knowledge, skills, and competencies inform the program design. The application must also indicate how the institution will assess whether candidates have acquired the required knowledge, skills, and competencies. All professional education courses should be grounded in theories of cognitive, emotional and social development, research and best practices in STEM education, and should enable candidates to gain the knowledge and experience to work successfully with all students.

### **Core Content for Integrative STEM Education Endorsement**

The core content knowledge required of the endorsement program candidate includes the following:

- Knowledge of standards, design processes, and the important role of STEM in workforce preparation.
- Application of STEM skills and ability to demonstrate them.
- Implementation of best practices in Integrative STEM education.
- Assessment of Integrative STEM learning in the classroom.

The institution offering the endorsement program is expected to show evidence as to how their program:

- will ensure that the candidate possesses knowledge, skills, and understanding of concepts related to STEM as described in the standards;
- prepares candidates to plan, design, and incorporate strategies to encourage active learning, interaction, participation and collaboration; and
- requires demonstrated competence in creating and implementing assessments in inquiry-based learning environments in ways that assure validity and reliability of instruments and procedures.

### **Sources for Ensuring Content**

For those who serve as content teachers at any level, the standards of relevant professional organizations will provide information about the required competencies. It is expected that STEM teachers will have knowledge of the Science, Technology, Engineering and Mathematics academic disciplines. To provide the understanding necessary across the disciplines, sources such as the following provide specific competencies:

- Next Generation Science Standards;
- Pennsylvania Core State Standards for Mathematics (emphasis on Mathematical Practices);
- International Society of Technology Educators' National Educational Technology Standards; and
- International Technology & Engineering Educators Association's standards for Technological Literacy.

The professional core of courses, competencies and experiences for the integrative STEM preparation program must be designed to address the issues and knowledge that are relevant for teaching and learning. The philosophy of Pennsylvania's Standards Aligned System (SAS) must permeate the candidates' course experiences, as well as their field experiences.

### **CANDIDATE COMPETENCIES**

The Professional Core Courses, competencies and experiences for the Integrative STEM preparation program should be designed to address the broad set of issues, knowledge and competencies that are relevant to STEM teaching and learning. The program must prepare teachers who will be able to help all students master academic standards and STEM skills. The professional core components of the program design must be maintained regardless of the configuration or options that the training program selects, either from samples in this document or others it develops. The Professional Core consists of a minimum of 12 credits and includes field experience/job-embedded

activities. Effective educational services require professionals to acquire a wide range of instructional and clinical skills related to STEM teaching.

Aligned resources and tools to support the acquisition of these competencies can be found on the Standards Aligned System (SAS) portal at [www.pdesas.org](http://www.pdesas.org).

Similar to the requirements in Chapter 354 of Title 22 of the Pennsylvania School Code, this section outlines the competencies required for endorsements, which ensure that candidates complete a well-planned sequence of courses and field experiences to develop an understanding of the structure, skills, core concepts, facts, methods of inquiry and application of technology related to the endorsement area. See 22 Pa. Code § 354.25(a)(3).

## **STEM Competencies**

### **I. Content**

- A. Demonstrate knowledge of the following standards: Next Generation Science Standards, PA Mathematics Standards, PA Science and Technology Standards.
- B. Understand STEM Education as an integrated approach across disciplines, connected to other disciplines beyond science, technology, engineering and mathematics.
- C. Recognize that STEM Education is general education with the intent to prepare a citizenry who can function in a science and technology rich society.
- D. Utilize problem solving approaches and the design process to answer complex questions, engage in critical thinking, investigate societal issues, and develop solutions for challenges and real word problems.
- E. Demonstrate knowledge of inquiry-based teaching and learning methodologies as applied to STEM education.

### **II. Skills and Abilities**

- A. Apply practices that integrate STEM disciplines through the design and implementation of multiple, integrated, developmentally appropriate learning experiences for all students.
- B. Represent real world phenomena through a variety of scientific, mathematical, technological, or engineering models.
- C. Explore basic fundamental concepts and major principles of science, technology, engineering and math through connections with other areas, especially history, language, arts, and culture, etc.
- D. Utilize the design process and a variety of resources (educational technology, information, materials, tools, machines) to safely and efficiently develop solutions to problems that require integration of concepts and skills from multiple

disciplines, including science, technology, engineering, math, language arts, social studies, arts, and/or physical education.

- E. Use mathematical and scientific formulas, principles, reasoning, and precise language to predict outcomes and solve technological and engineering problems.

### **III. Instructional Practices**

- A. Design, implement, and reflect on lessons and units that incorporate an integrative STEM learning cycle approach and developmentally appropriate methodology.
- B. Select, modify, and develop learning activities that support higher order thinking and creative problem solving which foster an understanding of the interconnectedness of Science, Technology, Engineering, and Mathematics.
- C. Establish and maintain a physically and emotionally safe learning environment that encourages and supports innovation, design thinking, and intellectual risk taking.
- D. Incorporate reading, writing, and questioning strategies through integrative and active strategies that supports the development of STEM literacy for all students.
- E. Engage students in the purposeful use of instructional technologies to increase access and extend their abilities to understand, transfer, and adapt STEM knowledge, skills, and dispositions.

### **IV. Assessment**

- A. Create differentiated learning experiences in integrative STEM education to meet the needs of all students.
- B. Elicit students' conceptions, reasoning and understanding through multiple forms of meaningful assessments including formative/summative and individual/group.
- C. Enable students to utilize strategies for self- assessment to build their capacity to monitor their own learning.
- D. Utilize diverse and authentic assessment strategies to monitor and adjust instruction across STEM disciplines and grade levels.

## **FACULTY**

Endorsement programs submitted for review to the Department of Education will include the qualifications of faculty assigned to teach each course within the program. Faculty who teach in the STEM Endorsement programs must have expertise in STEM, experience in K-12 instruction and advanced degrees in disciplines appropriate to STEM teaching.

Faculty teaching in the STEM Endorsement program should represent a strong combination of current practical and theoretical knowledge about schools, teachers,

adult learners and teaching. STEM Endorsement programs should consider the following elements when assigning faculty to teach the core courses:

- Faculty should have expertise in the areas of:
  - ✓ principles of integrative STEM education in grades K-12;
  - ✓ adult learning;
  - ✓ effective pedagogy;
  - ✓ emerging educational technologies;
  - ✓ educational degrees;
  - ✓ professional development;
  - ✓ experience in k-16 teaching/online; and
  - ✓ school leadership and scholarship.
  
- For faculty teaching courses, a doctoral degree is preferred. However, a master's degree may be sufficient if accompanied by other experiences that ensure the relevant expertise.
  
- Faculty should have experience in teaching in a STEM subject area. Additionally, faculty should have experience in professional development and school leadership. This may include, but is not limited to:
  - ✓ success in administrative positions;
  - ✓ leading professional development workshops;
  - ✓ attending professional conferences, and
  - ✓ leadership roles in professional organizations.
  
- Evidence of scholarship includes, but is not limited to:
  - ✓ publishing articles or books;
  - ✓ presenting at professional conferences, and
  - ✓ participating in curriculum development and program accreditation.

## **RELATED INFORMATION**

### **Application Process**

The institution's certification officer will recommend the candidates for the endorsement after successful completion of the STEM Endorsement Program. The candidate must complete the required PDE application for endorsement and pay the appropriate fee to add the endorsement to his/her certificate.