# Using Micro-credentials to Improve Teacher Skills in Computer Science

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# Basics of Micro-credentials

There is a demand from industry for workers with skills in computer science and STEM. Students need access to high quality computer science (CS), computational thinking (CT), and STEM coursework. This puts pressure on K-12 educators to begin teaching computer science, computational thinking, and STEM. However, there is a shortage of educators equipped to integrate computer science and computational thinking into the K-12 curriculum (Shein 2019). Increasing the number of teachers who are proficient in CS and CT pedagogy and skills can improve access to CS and CT content for all students. Some ways to build teacher skills are through professional development, by encouraging teachers to take higher-education courses, or by developing or identifying targeted micro-credentials that teachers can earn.

The Department of Education's Education Innovation and Research (EIR) grant program has prioritized innovations in STEM and CS for several years. Many grantees focus on professional learning opportunities for educators. In 2019, there were four projects funded that involved development and or use of micro-credentials. Between now and 2024, those EIR grantees will implement projects using micro-credentials and assess their effectiveness on improving teacher knowledge and skills and student outcomes. Lessons learned from the four grantees will be highlighted below.

Micro-credentials are an emerging approach to professional learning where individuals earn a digital certification by demonstrating competency in one specific skill area at a time. They allow teachers to learn new skills and develop competencies. Teachers practice skills and are evaluated on discrete topics or practices. By demonstrating competence in a specific area, the teacher earns the micro-credential certification.

### How widespread are micro-credentials?

- Policies supporting micro-credentials are in place at a statewide level through legislation or the State's Department of Education in 11 states and the District of Columbia: AR, DE, DC, KY, MA, MO, ND, OK, RI, TN, UT, VA
- Micro-credentials have a presence in higher education as part of the curriculum or are available to educators in 35 states

Source: Digital Promise https://digitalpromise.org/initiative/educator-micro-credentials/micro-credential-policy-map/

Typically, micro-credentials involve teachers getting started by learning about the goals of the micro-credential and requirements for demonstrating proficiency. They then learn skills, engage in practicing skills, collaborate with others, and sometimes receive coaching. To demonstrate proficiency, teachers create artifacts that others can assess. A teacher submits a portfolio of artifacts. The portfolio is reviewed and the teacher receives feedback. If the skill or competency is demonstrated, the teacher earns the micro-credential.

There are several benefits to micro-credentials. First, teachers earn micro-credentials through demonstrating their skills in the classroom. Second, micro-credentials break complex skills into fundamental parts. This allows mastery of each component of a skill, leading to a more complex skill. Third, micro-credentials are often delivered online, which improves access, especially for teachers in

rural areas. Fourth, the online availability allows teachers to work on learning about skills at times that work for them before practicing in their own classrooms. Fifth, micro-credentials provide teachers with some level of autonomy over their professional learning. Teachers can choose which micro-credentials they think will most help their classroom practice. Lastly, states can align micro-credentials with their own standards and needs. (DeMonte, 2017)

In some settings, teachers can earn micro-credentials within a theme or area and stack them to create micro-endorsements. Micro-endorsements consist of multiple, individual micro-credentials representing a discrete set of competencies needed for certification in a given topic. Micro-endorsements can be combined into different programs such as Master's degrees, certification, or state recognized endorsements.

Because micro-credentials are typically offered online, there are numerous sources of providers. For example, DigitalPromise offers over 450 discrete micro-credentials; the NEA offers 175 (developed in collaboration with Digital Promise); and there are other providers such as BloomBoard, UTeach, and Discovery Education. In addition to these existing providers, states can develop micro-credentials in partnership with colleges or universities.

## Considerations for Establishing STEM/CS Micro-credentials

There are some considerations that states or districts need to weigh when deciding on professional learning options such as micro-credentials. First, a micro-credential framework must be rooted in specific state or district standards and policies. States and districts must consider skills that educators need, certification and recertification requirements, and professional development policies.

Second, a state or district must determine if there is a set of established micro-credentials that can be used. There are several existing micro-credential providers that offer micro-credentials focused on classroom management and organization strategies; teacher leadership; diversity, equity, and cultural competence; and working with students. There are also emerging micro-credentials on STEM, CT, and CS.

If designing new micro-credentials, states and districts need subject-matter experts not only in the content, but also in curriculum standards, instructional design, assessment development, and digital badging. Individuals with such subject matter expertise and skills may not exist within the state agency or district. Therefore, partnerships are important to supplement knowledge or skills gaps. Two of the grantees highlighted below involve partnerships between the state department of education, higher education, and others. These partnerships help ensure balance between the curriculum standards, content, and instructional design. If a state expects the curriculum standards to change in the near future, having an understanding of those expected changes may prevent the need for major revisions later. Voices of educators in the development of micro-credentials also help in setting appropriate learning goals.

Third, states and districts must articulate statewide goals and plans for educator professional learning. Each of the projects highlighted in this paper is implementing micro-credentials as part of a larger professional development plan. States, districts, and schools should figure out goals for educator professional development, and then set a framework. If micro-credentials are part of that framework, they should be integrated with other forms of professional learning.

# Reflections of Four Current EIR Grantees Using Micro-credentials

The Education Innovation and Research (EIR) Program provides funding to create, develop, implement, replicate, or take to scale entrepreneurial, evidence-based, field-initiated innovations to improve student achievement and attainment for high-need students; and to rigorously evaluate such innovations. In 2016, the Department of Education identified field-initiated innovations in Science, Technology, Engineering, or Math (STEM) as an absolute priority for EIR grants. The spotlight on STEM is inspired by the goal for the United States to be internationally competitive in the STEM field, creating long-term national economic growth and prosperity. The absolute priority aims to increase opportunities for STEM coursework in schools so that all students can "access and excel" in STEM, especially CS. The original focus was on rigorous and engaging instruction as well as authentic STEM experiences, such as laboratory, research-based, or experiential learning opportunities in a STEM subject in formal or informal settings. The goal was to engage students and increase participation in STEM. Over time, the priority has narrowed its focus to Pre-K-12 school programs with a specific focus on supporting STEM/CS achievement for underserved and underrepresented students in STEM.

The benefits of micro-credentials are especially relevant in STEM, CS, and CT. Micro-credentials in STEM and CS may prove to be as beneficial as or more beneficial than more traditional professional development models. In 2019, there were four projects funded that involved development and or use of micro-credentials. Grantees currently developing and implementing micro-credentials for CS and STEM face the challenge of determining how conditions in schools due to the COVID-19 pandemic affect both participation in micro-credentials and student learning. This summary highlights the work of four grantees as a resource for other states considering scaling micro-credentials.

## Louisiana Department of Education- Improving Pre-Engineering and Computer Science Education Through Micro-Credentialing

This project is a unique partnership among the Louisiana Department of Education, Louisiana State University, Bloomboard, Inc., and RAND Corporation to develop and study a set of STEM micro-credentials. The teacher micro-credentials are a set of scalable, competency-based certifications aimed at improving the rigor and quality of pre-engineering and computer science instruction in Louisiana's STEM Jump Start Pathways. The micro-credentials are aligned to the content of the courses taught in the pathways and help teachers apply their STEM training to the classes they teach. Teachers submit portfolio-based assessments for feedback to complete each micro-credential.

During the 2020-21 school year, the team developed, piloted, and revised seven micro-credentials:

- Developing Technical Reading and Writing Skills
- Facilitating Project-Based Learning
- Discovering Computational Thinking
- Including the Application of Legal and Industry Best Practices for Digital Design and Emergent Media
- Ensuring Ethics and Safety in Pre-Engineering Courses
- Exploring the Engineering Design Process
- Exploring the DDEM Design Process

They also developed and began piloting nine additional micro-credentials

- Teaching the Foundations of Digital Production & Practice
- Teaching the Foundational Concepts of Robotics
- Teaching the Foundations of 3D Modeling
- Teaching the Development of a Digital Media Portfolio
- Teaching Circuity Concepts through Mathematical Application
- Teaching Media Exhibition in the Digital Media Industry
- Teaching Engineering Project Management
- Teaching Programming for Digital Media
- Teaching Basic Programming Skills

To teach courses in Louisiana's STEM Jump Start Pathways, teachers are required to attend six intensive summer weeks of graduate-level training courses offered by Louisiana State University (LSU) related to the courses they intend to teach, and are encouraged to attend eight Saturday sessions. Teaching candidates must complete these courses and receive qualifying scores on the same end-of-course assessment their students will take in the course that they wish to teach. The micro-credentials developed through this project will serve as an alternative to the graduate level training courses.

For this project, teachers volunteered to be randomly assigned to complete the micro-credentials. A study will examine the impact of micro-credentialing on teacher practices and student outcomes, compared with business as usual. The project will produce information on changes in teacher instruction and instructional content. It will also produce information on whether having a teacher who receives one of the developed micro-credentials improves student engagement in STEM classes or student achievement.

## Green River Regional Educational Cooperative, Inc. (GRREC)– STEM$^{CS}$

The STEM-CS project is a partnership between the U.S. Satellite Laboratory collaborating with NASA through a Space Act Agreement, BloomBoard, Inc., Western Kentucky University, and participating GRREC school districts. The partnership supports high school and middle school STEM-CS teachers by enhancing their educational practice through various professional learning opportunities, including micro-credentials. Other teacher professional learning includes obtaining a Master's degree for dual-credit certification and National Board Certification. BloomBoard is offering the micro-credentials. BloomBoard's micro-credentials are created by educators, based on research, and designed to meaningfully improve teachers' instructional practices. They are earned through a "learn by doing" process, allowing teachers to submit evidence from their own classroom practice to demonstrate their skills. BloomBoard also offers micro-endorsements.

For this project, Kentucky public school educators designed and built the Computer Science for Educators (CSE) Bootcamp micro-credential. There are two micro-credentials, each based on completion of 10 short modules. The first focuses on programming and the second on Information Technology applications and standards. As teachers work through the modules, they apply what they are learning in their classrooms.

By investing in teachers through micro-credentials, dual credit credentials, and gaining credit toward a Master's degree, the STEM$^{CS}$ program plans to improve opportunities, access and outcomes for rural, high-need students. As teachers earn micro-credentials, they will be able to increase their teacher Rank (KY-EPSB classifies teacher education and experience in a Rank system). The project's evaluation will provide formative results on teacher outcomes of STEM knowledge, practices, and effectiveness. It will also use a comparative interrupted time series (CITS) design to assess the impact of STEM$^{CS}$ on student academic proficiency in science and mathematics.

## Winchester Public Schools– Metrics: Maximizing Engagement Through Regular Immersion in Computer Science

Metrics is a whole-school immersion approach to CS integrated across the curriculum into daily classroom and real-world experiences to boost traditionally underrepresented, high-need student aspirations, attainment, and achievement. The program is based on a theory of action that combining teacher development and support; rigorous CS curriculum units and assessments; student supports; and student real-world experiences through field trips and out-of-school activities will lead to greater student pass rates in 3rd and 4th grades. The micro-credentials are part of teacher development and are offered through UTeach and the National Education Association. For Metrics, teachers complete a CS certificate or STEM micro-credentials.

For Metrics, the criteria for these micro-credentials are that the teacher will research and complete the coursework for 15+ hours of work and produce an artifact of what they learned. Typically, the artifact included lesson plans and student work samples on the computer science concept they were learning. To date, 10 teachers have completed computer science micro-credentials. For teachers, their feedback for virtual and professional learning was that they valued choice and the availability to learn online when needed. By combining micro-credentials with coaching and feedback, teachers felt supported integrating new content as part of a team network. Building relationships among teachers across schools as they engaged in the professional learning of micro-credentials benefited the teachers as part of a community. Those teachers felt they could reach out to and ask for help from their peers. They were also exposed to how lessons might work in other buildings by interacting with teachers from other schools.

Over time, the impact of the Metrics program, including micro-credentials, will be assessed on the school average pass rates in math and reading among 3rd and 4th grade students. Schools implementing Metrics will be compared with schools doing business as usual and not implementing Metrics. The impacts of the intervention on student math and ELA achievement will be estimated using a Comparative Interrupted Time Series design with school level assignment. It will use five years of baseline data and four years of implementation data.

## Old Dominion University Research Foundation– Advancing Rural Computer Science

Advancing Rural Computer Science (ARCS) is a professional development program developed and implemented by Old Dominion University with partners at CODE VA and VDOE. The purpose of ARCS is to improve students' computer science exposure in elementary classrooms by increasing teacher computer science content and pedagogical knowledge and self-efficacy, and improving instructional skills to teach computer science through an interdisciplinary lens.

The goals of ARCS are to

- improve K-5 teachers' knowledge of computer science (CS) concepts,
- improve K-5 teachers' pedagogy for integrating CS into instruction,
- improve K-5 teachers' self-efficacy for teaching CS and,
- improve the frequency of K-5 teachers' CS-integrated lessons in the classroom, and
- improve K-5 students' content knowledge related to and interest in CS.

To achieve these goals, five micro-credentials were developed through collaboration among subject matter experts in the fields of CS, CS education, curriculum standards, instructional design, assessment development, and digital badging. Development involved four stages:

- Examination of the K-5 Virginia Computer Science Standards of Learning and Digital Learning Integration Standards of Learning
- Development of objective, multiple choice assessments for the content and pedagogical content knowledge portions of the courses.
- Creation of learning objects (static and dynamic multimedia presentations, videos, and information sheets that can be downloaded or viewed online by participants) for each competency.
- Creation of the digital certificates of completion and digital badges to be earned by participants.

Through this process, the team created and piloted five micro-credentials that are are now available to teachers and accessible to others through the NEA Micro-credential site:

1. Introduction to Computer Science, Digital Impact, and Digital Citizenship (DIDC)
2. Computing Systems, Networks and the Internet (SNIC)
3. Algorithms and Programming (ALPR)
4. Data and Analysis (DTAN)
5. Computer Science Lesson Integration (CLSI)

The ARCS program lasts two years. During the first year, teachers attend professional development during the school year and summer. In the second year, teachers work toward completing their micro-credentials. The micro-credentials can be used by teachers for licensure endorsement. As part of their work completing the micro-credentials, teachers develop integrated computer science lessons and resources for classroom use. Throughout both years, teachers are supported through a Networked Improvement Community (NIC) model. By completing micro-credentials and participating in a networked improvement community, teachers in the ARCS program are expected to improve their content knowledge, self-efficacy, and pedagogical knowledge and increase the frequency in which they teach CS-integrated lessons.

The evaluation of ARCS uses a randomized controlled trial design. Teachers volunteer to participate in ARCS and are randomly assigned to participate in the program immediately, or to delay participation for two years. The random assignment occurs at the school level so that all teachers in the same school are implementing at the same time. The evaluation will measure changes in teacher content knowledge, student attitudes toward CS, and student CS content knowledge.

## Looking Ahead

Each of the projects highlighted above includes the state's department of education as a partner or collaborator. This ensures the work will be aligned with the state standards and any regulations. The three projects that are developing new micro-credentials also each used content area experts and existing educators as part of the development team. Educators can contribute their classroom knowledge and perspectives to how the content is structured. This helps make the courses more approachable for teachers looking to improve their skills. Last, the projects highlighted above incorporate the micro-credentials into larger professional development efforts. For example, both projects in Virginia (Metrics and ARCS) use micro-credentials and a networked improvement community. The project in Kentucky (STEMCS) supports educators through pathways that include micro-credentials, leadership certifications, and higher- education tuition, while the project in Louisiana (Pre-Engineering and CS-STEM Micro-Credentials) provides stipends for teachers who participate in the micro-credentials.

These four highlighted projects cannot yet say if the micro-credentials they developed or offered changed teacher practice and student outcomes, or if micro-credentials are comparable to other forms of teacher professional learning. Each of the projects includes a research study. Some of the studies assess the impact of offering micro-credentials on teacher knowledge and skills and student achievement. The results of the impact studies will be made available at the completion of the projects, likely in 2024 or 2025. For now, the projects have found that teachers desire some autonomy and input in their professional learning. Many teachers are comfortable with technology and the flexibility it provides. But teachers also want hands-on learning experiences with feedback. Micro-credentials have the potential to meet the needs of teachers in professional learning.

## Citations and References


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