GREATNESS STEMS FROM IOWANS

GOVERNOR'S STEM ADVISORY COUNCIL

dedicated to building a strong STEM education foundation for all Iowans

Iowa STEM Council Computer Science Workgroup

Given:

- Computer Science: An academic discipline that encompasses the study of computers and algorithmic processes, including their principles, their hardware and software implementations, their programming, their applications, and their impact on society.
- Technology literacy and fluency: A spectrum of curricula ranging from literacy (understanding how to use technology) to fluency (the ability to express ideas creatively, reformulate knowledge, and synthesize new information and technology).

Iowa STEM Council Computer Science Workgroup - Subgroup 1

Computer Science Teaching Endorsement Recommendations

Endorsement Recommendations

- A computer science endorsement should be created in Iowa to align with teaching specific computer science courses.
- The endorsement will be ***required*** in order to teach the specific high school courses selected, ***strongly recommended*** for specific middle school courses, and ***recommended*** for elementary courses.
- This endorsement should be able to be obtained through a reasonable and attainable process.
- The requirements for the endorsement will be directly relevant to preparing teachers to teach the selected K-12 courses.

Endorsement Pathway Options

- It is recommended that the endorsement be available through ***semester hour credits***.
- It is recommended that the endorsement also be available through a ***competency-based system*** including but not limited to the following potential options:
    - Praxis II testing
    - Artifacts verifying knowledge, skills, and experience
    - University or college coursework or other advanced training aligned with approved coursework
    - Staff development
- Conditional licensure will be available to anyone who is required to obtain the endorsement. The conditional license will last for two years with the possibility of a third year extension.

Rationale: Currently, no specific endorsement is required to teach any technology course, but rather teachers simply need an endorsement in any subject area at the grade level taught. In order to effectively deliver instruction in the selected computer science courses, a content-specific endorsement should be required to ensure the proficiency of the instructor. Flexible options will be available to allow educators to demonstrate this proficiency.

<u>Background information on current teacher licensure pathways in Iowa:</u>

1. Traditional Teacher Preparation Programs
    - Candidates complete an approved program which includes both content and pedagogy coursework and also student teaching, after which they become fully-licensed teacher
2. Teacher Intern
    - Candidates hold a baccalaureate degree, ideally in the content area in which they plan to teach
    - Candidates also meet the subject matter course work requirements for one of the secondary teaching endorsements
    - Candidates successfully complete the introductory teacher intern program pedagogy coursework through an approved program.
    - Candidates apply for the teacher intern license and serve as the teacher of record in a high school during a one-year paid teaching internship.
    - Candidates finish internship year and remaining pedagogy courses and apply for the initial license
3. Career and Technical Authorization
    - Limited authorization option for those who have worked in the career and technical field (of computer science in this case) for at least 6000 hours (without a bachelor's degree), or 4000 (with a bachelor's degree).
    - HS students are only able to receive elective or CTE credit for courses taught by CTE teachers
4. Native Language Speaker Authorization
    - Limited authorization for those who have a bachelor's degree and speak a native language other than English. Applicants pass a Praxis II exam in their language. School districts may consider these applicants if no fully licensed teachers are available.

To satisfy a **graduation requirement** in Computer Science for all Iowa high school students, choices include the following courses:

- Computer Science Principles (AP Optional)
- Computer Science A (AP Optional)
- Exploring Computer Science

Goals: Educational stakeholders must prepare for a 21st century technological workforce by preparing students with the computer science knowledge base necessary for success in today's computing-intensive fields. Unless we act quickly and decisively to remedy the disconnect between our national technological goals and computer science education, Iowa will soon face an educational, competitive, and economic crisis. In light of today's economy, this lack of engagement with of our current status related to computer science education is short-sighted and potentially disastrous.

Iowa, a state proud of its leadership in education, is currently sitting on the sidelines while other states make improvements to ensure their high school graduates will be ready to meet the demands of today's high tech society. It is especially important for Iowa's girls, underrepresented groups, and rural students to have access to these 21st century skills.

To this end, it is imperative that Iowa's high school graduates have a consistent, rigorous, relevant computer science education, equipped with the computational thinking skills needed to be creators in the digital economy and to be active citizens in our technology-driven world.

Rationale: Iowa graduates need to be competitive in a global economy. Computing knowledge is imperative in almost all applications, including agriculture and food processing, health care, education, insurance, advanced manufacturing, renewable energy, financial services, transportation, the arts and nearly every other career choice. In fact, more than two-thirds of tech jobs are outside the tech sector.

It is the recommendation of this committee that these three courses be specified as graduation options because they provide the depth of knowledge and skillsets needed to prepare our students for Iowa careers. The individual courses have been designed and vetted by national experts in the educational, industrial and governmental fields. They are used widely throughout the United States as the standard curriculum framework for defining computer science coursework.

These three courses provide opportunities for all of Iowa's students to have an appropriate choice to fulfill their graduation requirement:

Computer Science Principles (AP Optional)
Introduces students to the foundations of computer science with the focus on how computing powers the world. Along with the fundamentals of computing, students learn to analyze data, create technology that has a practical impact and gain a broader understanding of how computer science impacts people and society.

Computer Science A (AP Optional)
This course is equivalent to a first-semester, college-level course in computer science. The course introduces students to computer science with fundamental topics that include problem solving, design strategies and methodologies, organization of data (data structures), approaches to processing data (algorithms), analysis of potential solutions, and the ethical and social implications of computing.

Exploring Computer Science
The course was developed around a framework of both computer science content and computational practice. Assignments and instruction are contextualized to be socially relevant and meaningful for diverse students. Units utilize a variety of tools/platforms, and culminate with final projects around Human Computer Interaction, Problem Solving, Web Design, Programming, Computing and Data Analysis, and Robotics.
Ethical and social issues in computing, and careers in computing, are woven throughout the six units.

Additional information about course recommendations:

Computer Science Principles (AP Optional)
Introduces students to the foundations of computer science with the focus on how computing powers the world. Along with the fundamentals of computing, students learn to analyze data, create technology that has a practical impact and gain a broader understanding of how computer science impacts people and society. Topics include:

Computational Thinking Practices
- Connecting computing
- Creating computational artifacts
- Abstracting
- Analyzing problems and artifacts
- Communicating
- Collaborating

Big Ideas
- Creativity
- Abstraction
- Data and Information
- Algorithms
- Programming
- The Internet
- Global Impact

Computer Science A (AP Optional)
This course is equivalent to a first-semester, college-level course in computer science. The course introduces students to computer science with fundamental topics that include problem solving, design strategies and methodologies, organization of data (data structures), approaches to processing data (algorithms), analysis of potential solutions, and the ethical and social implications of computing. The course emphasizes object-oriented and imperative problem solving and design using the Java language. These techniques represent proven approaches for developing solutions that can scale up from small, simple problems to large, complex problems. The AP Computer Science A course curriculum is compatible with many CS1 courses in colleges and universities. Topics include:

Object-Oriented Program Design
- Program and class design

Program Implementation
- Implementation techniques
- Programming constructs
- Java library classes and interfaces included in the AP Java Subset

Program Analysis
- Testing
- Debugging
- Runtime exceptions
- Program correctness
- Algorithm analysis
- Numerical representations of integers

Standard Data Structures
- Primitive data types (int, boolean, double)
- Strings

- Classes
- Lists
- Arrays (1-dimensional and 2-dimensional)

Standard Operations and Algorithms

- Operations on data structures
- Searching
- Sorting

Computing in Context

- System reliability
- Privacy
- Legal issues and intellectual property
- Social and ethical ramifications of computer use

Exploring Computer Science

The course was developed around a framework of both computer science content and computational practice. Assignments and instruction are contextualized to be socially relevant and meaningful for diverse students. Units utilize a variety of tools/platforms, and culminate with final projects around the following topics:

- Human Computer Interaction
- Problem Solving
- Web Design
- Programming
- Computing and Data Analysis
- Robotics

Ethical and social issues in computing, and careers in computing, are woven throughout the six units. Throughout the course, is placed on how computing enables innovation in a variety of fields and the impacts that those innovations have on society. Computing is situated within economic, social and cultural contexts and, therefore, influences and is influenced by each of these. The proliferation of computers and networks raises a number of ethical issues. Technology has had both positive and negative impacts on human culture. Students will be able to identify ethical behavior and articulate both sides of ethical topics. Students study the responsibilities of software users and software developers with respect to intellectual property rights, software failures, and the piracy of software and other digital media. They are introduced to the concept of open-source software development and explore its implications. Students identify and describe careers in computing and careers that employ computing.

NOTE: A wide variety of teacher training opportunities are already developed and provided by various colleges, universities and organizations. For example, a detailed curriculum and teacher professional development are available from Code.org, Project Lead The Way, Thriving in Our Digital World, Beauty and Joy of Computing, and Mobile CS Principles. Many of these professional development opportunities are free of charge and are offered in a timeframe convenient to high school teachers.

Recommendation: Require the successful completion of a high quality, one-year computer science course as a condition of high school graduation. School districts that offer a pathway of at least three high-quality computer science courses shall be designated as "Computer Science Ready."

Goals:

- To provide incentives for school districts to offer high quality computer science courses.
- To promote economic development.
- To expose students to computer science and to help prepare them to pursue computer science degrees and professions.

Rationale: In light of the critical importance of computer science skills to the state, the workgroup recommends the successful completion of high-quality computer science coursework as a requirement of high school graduation. The workgroup realizes that various details need to be discussed and decided prior to the implementation of this recommendation. The workgroup discussed the potential of computer science courses fulfilling mathematics, science, or foreign language requirements, but concluded that, within the context of long-term needs and goals, the "substitution" approach utilized by other states would not be a viable option to pursue in the long-term.

To assist offsetting expenses, funding could be offered to "computer science ready" school districts that offer the courses face-to-face.

The high quality computer science coursework shall supplement, but not take the place of, any other core requirements, including music, the arts, math, and science.

Alternative Delivery of Coursework: The high quality computer science coursework (as defined by Subgroup 2) should be as flexible as possible to achieve, and could, upon further analysis and provided that the coursework meets the content requirements recommended by Subgroup 2, include coursework offered in the classroom or through other channels, such as:

- Summer courses or "camps"
- Online courses through, for example, Code.org
- Career Academy courses
- Concurrent Enrollment courses
- Courses that integrate the content requirements recommended by Subgroup 2