Computing Systems

Educator designs integrated learning experiences that develop criteria for defining computing systems and analyzing existing computing models.

Key Method

The educator uses the IPO model to design units and assessments to support determining students' understanding of essential vocabulary and key concepts in computing systems.

Method Components

What is Computer Science?

Computer science moves beyond using technology tools toward an understanding of how they work and ultimately designing new solutions to enduring human problems. Despite common misperceptions, computer science is not simply programming. Like any scientific discipline, computer science consists of a body of knowledge that informs how people understand and perceive the world around them, as well as practices for exploration, creation, and experimentation. Programming, defined as giving computers instructions to follow, is a practice used in computer science. The field itself is much broader, much as biology is not simply conducting lab experiments.

Why Should Students Learn Computer Science?

- Over 70% of jobs in STEM are actually computing jobs, and most of the others use computer science as a core part of the job.
- Many future jobs and opportunities will require knowledge and skills in the area of computer science. Therefore, students need multiple opportunities to use computer science to explore and understand the world.
- Even a student who does not end up programming in their job will still need to understand the central principles of how data, networking, the Internet, and cybersecurity impact the lives of people in their families and communities.
- Students need to know that when they use a free social media platform, their data can be shared with anyone.
- All of the strands of computer science have drastic impacts on how we live our lives.

Understanding the basic principles of computer science

influences how students will interact with the world around them.

Essential Vocabulary

K–2: Students should be introduced to these components: (see Resources for specific SOLs)

- Keyboard
- Mouse
- Trackpad
- Desktop computer
- Laptop computer
- Mobile device
- Tablet
- Printer
- Touchscreen
- Hardware
- Software
- Input
- Output

3–7: Students should apply these terms in context: (see Resources for specific SOLs)

- Computing system
- Input
- Output
- Processor
- Sensor
- Storage
- Sensors
- Internet

8: Students should apply these terms in context:

- Motherboard
- CPU
- GPU
- RAM
- NIC

IPO Computer System Model

The Input-Output (IPO) Model is a functional graph that identifies the inputs, outputs, and processing tasks required to transform inputs into outputs.

This is a widely used model for analyzing computing systems and designing computer software.

Supporting Research

Burgstahler, Sheryl. "Differentiating for Diversity: Using Universal Design for Learning in Elementary Computer Science Education." Universal Design: Implications for Computing Education, ACM Transactions on Computing Education, Oct. 2011, https://staff.washington.edu/sherylb/ud_computing.html

Honey, Margaret, et al. "STEM Integration in K–12 Education: Status, Prospects, and an Agenda for Research." The National Academies Press, National Academy Of Engineering And National Research Council Of The National Academies, 7 Feb. 2014, http://www.nap.edu/catalog/18612/stem-integration-in-k-12-education-status-prospects-and-an

Lewis, Colleen, and Niral Shah. "How Equity and Inequity Can Emerge in Pair Programming." Association for Computing Machinery, ICER '15 Proceedings of the Eleventh Annual International Conference on International Computing

Education Research, July 2015, http://blogs.hmc.edu/lewis/wp-content/uploads/sites/2/2013/07/LewisShah2015_EquitySpeed.pdf

Lewis, Colleen M. "Good (and Bad) Reasons to Teach All Students Computer Science." SpringerLink, Springer, Cham, 1 Jan. 2017, https://docs.google.com/document/d/1R57koI5El5B6jZQyZkmG4NY9MM4wwfJ13V13Yx4gWzw/edit#heading=h.gjdgxs

Resources

CodeVA - Computing Systems https://teacherslounge.codevirginia.org/portal/kb/articles/overview-computing-systems

STEM Integration in K–12 Education https://www.nap.edu/catalog/18612/stem-integration-in-k-12-education-status-prospects-and-an

Bridging the Encouragement Gap in Computing https://www.ncwit.org/resources/bridging-encouragement-gap-computing

Guide to Inclusive Computer Science Education: How Educators Can Encourage and Engage All Students in Computer Science https://www.ncwit.org/resources/guide-inclusive-computer-science-education-how-educators-can-encourage-and-engage-all

Computing at Schools (tenderfoot) QuickStart Subject Knowledge: Programming https://community.computingatschool.org.uk/files/8264/original.pdf

What is Big Data? https://curriculum.code.org/csp-18/unit4/1/

Code.org Lesson Envelope Variables https://curriculum.code.org/csf-19/coursef/6/

Simulating Experiments https://curriculum.code.org/csf-19/coursef/10/

Video: BIG DATA: A Revolution That Will Transform How We Live, Work, and Think https://www.youtube.com/watch?v=bYS_4CWu3y8

VA SOLs: Computer Science Standards of Learning for Virginia Public Schools http://www.doe.virginia.gov/testing/sol/standards_docs/computer-science/2017/stds-compsci-all.pdf

CSTA: Computer Science Teachers' Association - CS Standards http://www.doe.virginia.gov/testing/sol/standards_docs/computer-science/2017/stds-compsci-all.pdf

Aaronson, Leslie, and Jake Baskin. "Guide to Inclusive Computer Science Education: How Educators Can Encourage and Engage All Students in Computer Science." National Center for Women & Information Technology, 22 May 2019, http://www.ncwit.org/resources/guide-inclusive-computer-science-education-how-educators-can-encourage-and-engage-all.

Differentiating for Diversity: Using Universal Design for Learning in Elementary Computer Science Education

https://staff.washington.edu/sherylb/ud_computing.html

What are Computing Systems?

The Virginia Standards of Learning states:

"Computing Systems involves the interaction that people have with a wide variety of computing devices that collect, store, analyze, and act upon information in ways that can affect human capabilities both positively and negatively. The physical components (hardware) and instructions (software) that make up a computing system communicate and process information in digital form. An understanding of hardware and software is useful when troubleshooting a computing system that does not work as intended."

Submission Guidelines & Evaluation Criteria

To earn the micro-credential, you must receive a passing score in Parts 1 and 3 and receive a proficient for all components in Part 2.

Part 1. Overview Questions

250–500 words

1. Help us understand the context of computer science in your school and classroom. Is there a state or local mandate to include computer science instruction?

2. Why did you select to perform the Computing Systems micro-credential, and what is your current level of comfort with incorporating computer science content and instruction into your core curriculum?

3. Describe the student population you serve (such as demographics, grade level, location, etc.) and how these students will benefit from your professional development in the Computing Systems micro-credential.

4. In the field of computer science, women and minorities are underrepresented. How will you intentionally differentiate instruction to engage and inspire underrepresented groups through the design of your unit?

- **Passing:** Passing: Response provides accurate information that justifies the reason for choosing this micro-credential to address specific needs of both the teacher and the student. Educator includes a learning goal that describes what they hope to gain from earning this micro-credential. Specific details about how you will engage and inspire underrepresented minorities and girls are included.

Part 2. Work Examples / Artifacts

To earn this micro-credential, please submit the following two artifacts as evidence of your learning. Please do not include any information that will make you or your students identifiable to your reviewers.

Artifact 1: Computing Systems Unit

Create two or more computing systems lessons that include all of the following components:

- CSTA Standards and/or State CS Standards addressed
- Learning outcomes
- Description of the lesson
- Computing systems key vocabulary
- How Bloom's Higher-Order Thinking or Computational Thinking skills are included
- How will you intentionally engage and inspire underrepresented minorities and girls/women?
- Description of how CS topic (Computing Systems) will be integrated
- How the learning will be evaluated/assessed

Artifact 2: Culminating Student Activity

Create a culminating activity to determine students' understanding of new computing systems knowledge. Your activity needs to include:

- A student evaluation tool/rubric
- Computer science goals
- Content goals
- A description of the lesson (150–250 words)

Artifact 3: Student work samples

Upload two examples of student work from the activity above. You may choose from the following types of files to upload:

- Image
- Audio and/or video (30 sec–1 min clip)
- Document

null	Basic	Proficient	Developing

Artifact 1: Computing Systems Unit	Unit of two or more lessons that incorporate all of the following elements: CSTA Standards and/or State CS Standards addressed Learning outcomes Description of the lesson Computing systems key vocabulary How Bloom's Higher-Order Thinking or Computational Thinking skills are included Intentionally differentiated instruction to engage and inspire underrepresented minorities and females Description of how CS topic will be integrated How the learning will be evaluated/ assessed	Unit of two or more lessons that incorporate most of the following elements: CSTA Standards and/or State CS Standards addressed Learning outcomes Description of the lesson Computing systems key vocabulary How Bloom's Higher-Order Thinking or Computational Thinking skills are included Intentionally differentiated instruction to engage and inspire underrepresented minorities and females Description of how CS topic will be integrated How the learning will be evaluated/ assessed	Unit of two or more lessons that incorporate a few of the following elements: CSTA Standards and/or State CS Standards addressed Learning outcomes Description of the lesson Computing systems key vocabulary How Bloom's Higher-Order Thinking or Computational Thinking skills are included Intentionally differentiated instruction to engage and inspire underrepresented minorities and females Description of how CS topic will be integrated How the learning will be evaluated/ assessed
Artifact 2: Culminating Student Activity	Activity includes all of the following: -A student evaluation tool/rubric -Computer science goals -Content goals -A description of the lesson (150–250 words)	Activity includes some of the following: -A student evaluation tool/rubric -Computer science goals -Content goals -A description of the lesson (150–250 words)	Activity is missing most of the following: -A student evaluation tool/rubric -Computer science goals -Content goals -A description of the lesson (150–250 words)
Artifact 3: Student Work Samples	Two examples of student work are uploaded Student work is from the culminating activity The student work shows understanding and application of the learning goals	Two examples of student work are uploaded Student work is not from the culminating activity but may be from another computing systems lesson The student work shows	One example of student work is uploaded Student work is not from a lesson on computing systems The student work does not show understanding or application of the

		understanding and application of one of the learning goals	learning goals

Reflection

250-500

1. How did this micro-credential influence how you make connections to the real world through teaching computing systems? What did you find rewarding or enjoyable?
2. What other standards might you have integrated with computing systems across the curriculum, and how can you connect your instruction to career readiness moving forward?
3. How did you address the needs of girls and underrepresented groups in your classroom, and how did they respond to your choices in the lesson?
4. In what ways did students engage with collaboration, communication, critical thinking, creativity, and citizenship through computer science instruction?
5. What challenges, if any, did you encounter during this micro-credential process, and how did you overcome them?

- **Passing:** Passing: Reflection provides evidence that this activity has had a positive impact on both educator practice and student success. Specific examples are cited directly from personal or work-related experiences to support claims. Also included are specific actionable steps that demonstrate how new learning will be integrated into future practice.