NCW Computer Science Pathways

2019 Pathway Articulation Report
The first annual Central Washington Pathway Summit was hosted at Central Washington University, on March 11, 2019. This event was sponsored by Microsoft TechSpark and brought together more than 50 educators and partners from throughout North Central Washington to discuss pathways for rural students to have access to computer science education.

Together, partners from K-12 and higher education, business and industry, students, and state leaders are committed to ensuring that there is an equitable pathway for students in Central Washington to pursue computer science careers and this report outlines a shared set of recommendations to articulate a computer science credential pathway for students.

Our mission is to ensure that there is an equitable path in Central Washington for computer science education.

Why is it important?

Our vision is for all students to have access to computer science credentials and for students to know at the time they enroll in the high school course, when there is an opportunity to earn college credits, how to access the credits, and where those credits will be applied to a credential or degree. This will allow educators, students and families in North Central Washington to make informed decisions for the future.

Community colleges have a critical role as an intermediary educational institute in credential pathways like computer science, bridging K-12 and University systems. One quarter of all students graduating high school in North Central Washington begin higher education at one of two community and technical colleges (42% of all college-bound students). Enrolling in a local community college allows students a way to work towards a degree or credential from a familiar community, with some familial support, and work options nearby.

The State of Washington has invested in these paths with a system of dual enrollment options to help students get a 'jumpstart' towards post-secondary credentials. The educational data around students earning college credits while in high school is quite compelling. Students who earn at least 12 college credits while in high school are on average, more likely to earn their high school diploma, continue on to post-secondary education, and earn a post-secondary credential or degree.

At present, there are a handful of dual credit articulation agreements between select school districts and higher education partners for computer science courses. However, the agreements for articulation into these pathways are not equitably accessible for all youth in North Central Washington.

Students in North Central Washington are at a competitive disadvantage when compared to students in more urban districts in the state. Rural students have fewer opportunities to take courses like computer science in high school, there is a severely limited number of credentialed, rural computer science educators, and rural students have inequitable access to most dual credit opportunities in computer science.

In 2018, 16 schools in North Central Washington have forged strategic partnerships with generous philanthropic partners, like Microsoft and Code.org, who are providing curriculum and technical expertise for rural schools to implement industry relevant, introductory computer science courses for high school students.

This foundational computer science education is invaluable. Now, the regional postsecondary educators Big Bend Community College, Wenatchee Valley College, and Central Washington University, have come together to look for ways to improve opportunities for students in computer science and STEM through new degrees and pathways.

This collaborative effort will light the way for students to find a firm path towards a computer science degree or credential in North Central Washington that begins in rural high schools.
PART 1
Pathway Articulation

Challenges

The current pathway to computer science credentials has significant barriers and students are asked to repeat coursework as they transition from secondary to post-secondary institutions and between higher education institutions. The misalignment can have a detrimental effect on student persistence in the program, and credential attainment.

Students who transfer from a community and technical college to a university to pursue a degree in computer science have a significant challenge in attaining the necessary skills progression for computer science, as well as meet the general breadth requirements to earn an Associate of Arts and Sciences (AAS) Degree recognized under the current Direct Transfer Agreement (DTA). Frequently, students spend additional time and resources ensuring that they meet necessary curricular prerequisites for their program and meet the specific requirements of the AAS - DTA. These additional courses put strain on rural students in North Central Washington and can even compromise essential access to financial aid.

* Data is taken from 28 of North Central Washington's high schools ranging from 71 students to 2,300 students. Districts included: Brewster, Bridgeport, Cascade, Cashmere, Coulee Hartline, Eastmont, Entiat, Ephrata, Grand Coulee Dam, Lake Chelan, Mansfield, Manson, Methow, Moses Lake, Nespelem, Okanogan, Omak, Oroville, Pateros, Quincy, Soap Lake, Tonasket, Warden, Waterville, Wenatchee, and Wilson Creek.
**Recommendations**

It is essential to increase awareness about the foundational computer science skills that students develop at each stage and to improve alignment in articulations. The computer science field is continuously evolving and the steering team recommends a collaborative annual review of the skills mastered at each level.

The steering team has identified the following significant challenges that will require additional capacity, review and consideration for pathway alignment:

1. **New Articulations**
   
   Systematic annual review of high school computer science course offerings and regional articulation agreements, and specific outreach to expand access to dual credit opportunities. Such review and analysis this year produced several new articulations and expanded opportunities for students in several rural districts to earn up to 8 college credits for the year-long Introduction to Computer Science TEALS course.

2. **CS Language Fluency**
   
   Students typically begin computer science education in one computer language, building foundational skills and eventually mastering multiple languages to become proficient computer scientists. Unfortunately, the language students begin learning in, creates significant barriers for rural students as programs at higher education institutions demand proficiency with one language or another to advance. In rural schools, it is not feasible to offer foundational course sequences in multiple languages, but if students will need mastery in multiple computer science languages to be successful in the industry, then there needs to be intentional focus to help students transition to a new language at earlier stages. Big Bend Community College is exploring the development of a short bridge course that would support students with specific skills development to make knowledge transfers, build competency in a new language, and take advantage of their course offerings.

3. **Advanced Placement Equivalency Alignment**
   
   Several regional high schools offer students an opportunity to sit for the Computer Science Advanced Placement Exam (AP - CSA). The exam scores offer students an opportunity to earn college credits for computer science courses. Until recently, community and technical colleges awarded AP exam-takers only elective credits for strong performance on the exam. Conversely, the 4-year university awarded specific course credit for a required course for the same scores on the AP exam. This structural inequity is an area of significant concern as the great majority of college bound students in rural North Central Washington begin higher education at either Big Bend Community College or Wenatchee Valley College. Fortunately, a recent revision of the State Board Advanced Placement Equivalency Guide offers a significant improvement. Students who earn a 5 on the AP CSA exam, will now be awarded credit for their demonstrated mastery of foundational computer science skills. While this change is a significant improvement, there is still inequity in the regional pathway for development. Students who earn a 3, 4 or 5 on the AP-CSA exam earn computer science credits at University, while students must earn a score of 5 on the AP-CSA exam to earn computer science credits at the community college.
### Part 1: Pathway Articulation

#### Career and Technical Coursework Transfer

Sixteen regional high schools are utilizing career and technical education (CTE) to offer computer science courses for students. These courses can earn students dual credit at the community college if the course is articulated as a certificate or technical course; however, there is a barrier to articulating these courses to transfer college course numbers.

#### Computer Science Program Transfer Agreements

A bi-annual review process would bring additional clarity for students and families to know which associate degree offers the best alignment for students transferring into university programs. This will require greater alignment between computer science programs throughout Washington state. Currently, a Computer Science Education (WA-CSE) working group with representatives from across the state of Washington is working to revise the Associate of Science Transfer degree that offers students an alternative transfer degree pathway and will greatly improve transfer efficiency. Each of the higher education partners in North Central Washington is represented in this working group and collaboratively engaging to improve this critical component of the regional pathway.

### Current Programming Education Redundancy

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Articulation/Credit</th>
<th>Programming Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worst Case</td>
<td>No Articulation</td>
<td>Different</td>
</tr>
<tr>
<td>Better Case</td>
<td>Some Articulation</td>
<td>Different</td>
</tr>
<tr>
<td>Best Case</td>
<td>Good Articulation</td>
<td>Same</td>
</tr>
</tbody>
</table>

### Proposed Programming Pathway

**Ideal Case - Full Credit or Articulation - Language Neutral**

*May be integrated at either institution or low-credit options, common course*
Challenges

Rural schools are less likely than their suburban counterparts, to offer computer science courses (Google & Gallup, 2017). Many times, rural educators feel isolated from others in their field and this can be especially true of computer science educators. Very few school districts in Central Washington have more than one teacher who teaches computer science at the high school level, and some districts have none.

But this is changing rapidly in North Central Washington thanks to the Microsoft TEALS program. In the 2018-19 academic year, 16 school districts offered computer science courses for students in partnership with Microsoft TEALS.

The common course content and course delivery model has the added benefit of providing a foundation for the development of a professional learning community for computer science educators.

Recommendations

The 2019 Central Washington Pathway Summit provided an opportunity to gather educators from K-12 and Higher Education institutions to have a focused conversation about recent developments and practices in computer science education. This occasion also gave educators an opportunity to align the scope and sequence of the development of maintaining vertical team relationships. A desire for connection to other computer science educators emerged as a common theme at the Central Washington Pathway summit in 2019.

To expand and reinforce the computer science educator community in Central Washington, the steering team will advocate for the following components:

1 Establish A New CSTA Chapter

Presently there are two established chapters of the Computer Science Teachers Association (CSTA) chapters in Washington State: Puget Sound and Spokane. There are applications pending for the establishment of two additional chapters in central Washington: Yakima and Wenatchee. This distributed network of CSTA chapters will offer regular opportunities to plug in to a regional community of other computer science educators.
Part 2: Resources & Community Partnerships

2 Resource Repository

There is a need for a centrally organized information hub for materials regarding computer science education and resources. The desired platform could also provide a conduit of communication about local articulation pathways, professional development opportunities, and announcements. This recommendation has not yet been matched with a resource.

3 Annual Pathway Alignment Summit

The steering team recommends that there be an annual convening to serve as a platform for educators to continue this professional development and collaboration. This recommendation has not yet been matched with a resource.
Challenges

There is a shortage of skilled computer science professionals. This year in Washington there will be more than 9,000 new job openings, and there are only 3,000 Washington graduates prepared to fill them. Local industries like agriculture, energy production, manufacturing, health care and natural resource management all have growing need for technology and computer science skills. To create awareness in rural regions, students and their families need to hear about local opportunities in computer science.

Recommendations

To reach students in North Central Washington, there must be a collective commitment to increasing awareness about local opportunities in computer science:

1. Raise Up Community Voices
   Students and educators need to hear from businesses and community leaders that there is a local demand for computer science. Community partners like Big Bend Community College, Wenatchee Valley College, Wenatchee Valley Technical Skills Center, Columbia Basin Technical Skills Center, Skillsource, Microsoft, GWATA and the Apple STEM Network are working to expand the number of local internships in computer science and technology.

2. Increase Awareness About Local Demand
   Students and educators should learn about the usefulness of and demand for computer science skills. It is critical for them to hear about computer science skills needed in regional industries like agriculture, and computer science skills being used in the fields (i.e. GIS workers in the fields, automation and unmanned technology specialists, etc.) as well as the traditional programming settings.
Part 3: Building Awareness & Outreach

3 Increase Awareness About Available Training And Educational Pathways
Students and educators need resources to find available computer science and technology-related programs and advising.

4 Increase Awareness About Financial Support For Post-Secondary Education
Students and educators should become aware of the multiple sources of financial support through grants, scholarships (i.e. WSOS), and other resources beyond the standard Federal and state options available through FAFSA and WASFA, as well as student support service programs that support computer science students (i.e. MESA). Currently WSOS offers a Career and Technical College scholarship for Computer Science pathways in North Central Washington each year.

5 Start Early
Students need exposure to careers in computer science as early as possible. There are now many schools in North Central Washington introducing computer science in elementary and middle schools. To leverage these early learning opportunities to expand the career pathway, students and their families will need support to navigate the credential pathway opportunities, locally, and throughout the state. Corporate and educational partners should be tapped to support maker’s fairs, robotics events, and other fun hands-on computer-related activities for kids.

6 Celebrate Success
Every year, tech savvy students and educators in both K12 and higher education from throughout North Central Washington are recognized at the Innovator Awards Luncheon. Highlighting champions of computer science and technology brings awareness to the success stories happening locally, and inspires other educators, students, and businesses as they see the accomplishments of individuals with similar stories. The steering team is working together on a nomination outreach campaign to encourage more nominations for the Innovator Awards.

The Future Is Now: Computer Science Workforce
In the spring of 2019, GWATA (North Central Washington's Technology Alliance) released a short film to highlight regional businesses looking for computer science skills in their workforce. Featured companies were eager to participate in the video and promote computer science careers at Stemilt, LocalTel Communications, iSpyFire, and PetHub -- all local technology companies!

Watch online at www.AppleSTEMNetwork.org or by scanning the code to the right with the camera on your phone!
Challenges

There are just over 3,000 youth preparing to exit the K-12 system this year in North Central Washington. Of these, 49% are female, 46% come from a home that is considered rural, 67% are low income, 52% are students of color.

There are nearly 300 students currently enrolled in introductory computer science courses at regional high schools in North Central Washington, and while there is not currently data reported about the demographic representation of students in these courses, it is widely understood that the students in computer science courses do not demographically reflect the region. Only 24% of the computer science bachelor’s degrees awarded in Central Washington in 2017 were awarded to students of color, and just over 10% of computer science bachelor’s degrees were awarded to women.

New partnerships and Microsoft philanthropy empowered 16 rural school districts in North Central Washington to offer computer science for the first time through the Microsoft TEALS program. This program has opened the door for significantly greater numbers of students to pursue computer science credentials. However, the computer science students this year do not reflect the regional demographics.

Collectively, we recognize the need to work together to create greater engagement for underrepresented populations including women, first-generation college-bound students and students of color. We will work alongside statewide partners like Washington STEM to prioritize equity and ensure all students have access to computer science credentials.
Recommendations

To increase equity in the computer science cohorts:

1. **Targeted Outreach And Recruitment**
   To reach more first-generation, rural students, female students, and students of color we must be intentional in designing a pathway that originates where the students are, in rural schools. We must continue to develop and renew articulations to increase efficiency and ensure a fluid transition for students as they begin post-secondary education. Recruitment to post-secondary programs should help students understand that the computer science skills they are mastering in their high school computer science courses are valued and that there are programs ready to build onto this foundation. Recruitment strategies should also include regional events and “meet-ups”, potentially including evening events to engage families.

2. **Differentiate The Pathway**
   To increase the number of computer science credentials in North Central Washington, there must also be a way for students to begin coursework in a post-secondary environment in addition to those starting in high schools. While introductory programming courses have been offered for some time at Big Bend Community College and Wenatchee Valley College, differentiating the starting course for students will likely impact the cohort size for introductory courses. When courses have low enrollment, they can be at risk of cancellation. If introductory courses are not offered, students who begin post-secondary education, without computer science skills, are disadvantaged. Therefore, it is imperative that there be a continued institutional commitment to offer introductory courses, or alternative options, for students choosing to begin the credential pathway at the community college.

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**NCW Student Demographics**

- 49% of students are female
- 52% of students are people of color
- 67% of students are from low income households.
## Equivalencies for High School Introductory Computer Science Courses

### Intro CS TEALS or CS Principles

<table>
<thead>
<tr>
<th>Institution</th>
<th>Equivalent Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WVC</strong></td>
<td>CSC 101</td>
<td>5 credits</td>
</tr>
<tr>
<td><strong>BBCC</strong></td>
<td>CS 101 (3 credits)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CS 111 (5 credits)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*QHS Model</td>
<td></td>
</tr>
<tr>
<td><strong>CWU</strong></td>
<td>CS105 (4 credits if from WVC; CS101/CS LD 8 credits if from BBCC)</td>
<td></td>
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## Equivalencies for High School AP Computer Science Courses

### AP TEALS (based on UW course CSE 142/143)

<table>
<thead>
<tr>
<th>Institution</th>
<th>Equivalent Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WVC</strong></td>
<td>CS&amp;141 (5 credits - if we could articulate via CTE dual credit)</td>
<td></td>
</tr>
<tr>
<td><strong>BBCC</strong></td>
<td>CS&amp;141 (5 credits - if we could articulate via CTE dual credit)</td>
<td></td>
</tr>
<tr>
<td><strong>CWU</strong></td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

### AP Computer Science A (with exam) for Credit

<table>
<thead>
<tr>
<th>Institution</th>
<th>Equivalent Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WVC</strong></td>
<td>CSC&amp;141</td>
<td>(5 credits - Must score 5)</td>
</tr>
<tr>
<td><strong>BBCC</strong></td>
<td>CS&amp;141 (5 credits)</td>
<td>Must score 5</td>
</tr>
<tr>
<td><strong>CWU</strong></td>
<td>CS110 ONLY</td>
<td>(4 credits with score of 3 or 4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CS110 &amp; 111</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8 credits with score of 5)</td>
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</table>
High School Computer Science Course Descriptions

Introduction to Computer Science | Introduction to Computer Science TEALS

A high school course that focuses on computer theory, computing problems and solutions, and the design of computer systems and user. This course introduces fundamental concepts using the visual programming language Snap and the industry-standard programming language Python.

AP Computer Science | AP CS TEALS

The AP CS A course prepares students to take the College Board AP computer science exam. This challenging class is for students who are interested in an in-depth course in computer science theory and practice. Students will learn to program in the Java language, with emphasis on problem solving, computer science theory, applications, algorithms, programming style, and programming design. Students devote at least four hours weekly in class and at least one hour per day outside of class to succeed in this course.

Post-Secondary Computer Science Course Descriptions

BBCC --- | WVC CSC101 | CWU CS105
Course equivalent to INTRO TO CS TEALS only at WVC

WVC CSC101 (Introduction to Programming) Introduction to computer programming. Intended for non-science majors. Explores the basics of computer programming using the BASIC language. Topics include console I/O, variables, expressions, decisions, arrays, repetition, console graphics, file I/O and functions.

CWU CS105 (Logical Basis of Computing) Students develop mathematical and quantitative reasoning skills by learning the fundamentals of computer programming. Students gain an understanding of possible connections between technology and artistic expression.

BBCC CS101 | WVC --- | CWU CS101
Course equivalent to first semester of INTRO TO CS TEALS at BBCC and CWU

BBCC CS101 (Introduction to Computer Science) An introduction to computer science concepts and the role of computers in society. Topics include the history of computing, computer hardware, operating systems, the Internet, database management, an overview of programming languages, careers in computer technology, and the ethics of computing. This course is designed for Computer Science majors, and will emphasize principles and underlying computer technology concepts. BBCC doesn't offer this course anymore, it is for recording purposes only

CWU CS101 (Computer Basics) Integrated, project-based course using student-produced working materials in the form of a mini thesis. Microsoft Office tools are learned in a web-based practical application environment.

BBCC CS111 | WVC --- | CWU CS LD (no equivalency)
Course equivalent to second semester of INTRO TO CS TEALS at BBCC and CWU

BBCC CS111 (Intro to Computer Programming) An introductory computer programming course. Students learn to write and debug simple text based programs while exploring the fundamental principles of programming. Topics for study include input / output, statements, expressions, operations, variables, data types, control structures, program modularization, basic data structures and file input and output.
BBCC CS&141 | WVC CSC&141 | CWU CS110
Courses equivalent to AP-CSA Exam (Score 5 at BBCC or WVC; Score 3 or higher at CWU)

**BBCC CS&141 (Computer Science I: Java)** This course introduces students to the fundamental concepts of object-oriented programming with the Java programming language. The course will focus on the strengths of Java to create classes, objects and methods, algorithm development, program solving techniques, basic control structures, primitive types, and arrays. Students will master the basics of Java, developing solid programming skills that enable crossover programming skills for other essential languages.

**WVC CSC&141 (Programming Fundamentals)** Introduces programming fundamentals using a procedural, object-oriented language. Topics include expressions, simple I/O, data storage, variable usage, decision and repetition control structures, functions and parameter passing, design principles, and problem solving strategies.

**CWU CS110 (Programming Fundamentals I)** This course introduces students to the fundamental concepts of object-oriented programming with the Java programming language. The course will focus on the strengths of Java to create classes, objects and methods, algorithm development, program solving techniques, basic control structures, primitive types, and arrays. Students will master the basics of Java, developing solid programming skills that enable crossover programming skills for other essential languages.

BBCC CS&142 | WVC CSC&142 | CWU CS111

**BBCC CS&142 (Advanced Programming with Java)** Advanced Java is a follow-up to the programming concepts introduced in the Java I course. This course explores Java’s Distributed Applications features and covers inheritance, exceptions, graphical user interfaces, recursion, and data structures.

**WVC CSC&142 (Intermediate Programming)** Introduces the concepts of object-oriented programming to students with a background in the procedural paradigm. Topics include project management, classes, APIs, instantiation of objects, references, lists, file I/O of records, inheritance, composition, polymorphism, interfaces, exception handling, computer graphics, and basic GUI programming. Intermediate JAVA.

**CWU CS111 (Programming Fundamentals II)** Continuation of object-oriented programming concepts introduced in CS 110. Inheritance, exceptions, graphical user interfaces, recursion, and data structures.
Sample Central Washington University Computer Science Pathway

While at community college and high school dual credits:

- **ENG101** - Composition I: Critical Reading and Responding  
  BBCC ENGL&101 | WVC ENGL&101
- **ENG102** - Reasoning and Research  
  BBCC ENGL&102 | WVC ENGL201
- **MATH153** - Precalculus Mathematics I  
  BBCC MATH&141 | WVC MATH&141
- **MATH154** - Precalculus Mathematics II  
  BBCC MATH&142 | WVC MATH&142
- **MATH172** - Calculus I  
  BBCC MATH&151 | WVC MATH&151
- **CS110** - Programming Fundamentals I  
  BBCC CS&141 | WVC CSC&141
- **CS111** - Programming Fundamentals II  
  BBCC CS142 | WVC CSC&142

After transferring to Central Washington University:
A student who completes an associate's degree, including the courses listed above, can complete CWU's BS requirements in a rigorous two years, as detailed below. Some students will elect to take a little longer.

### Year 1

**Fall Quarter - 15 credits**
- **CS301** - Data Structures
- **CS311** - Computer Architecture I
- **CS325** - Technical Writing in Computer Science
- **CS112** - Foundations of Computer Science

**Winter Quarter - 14 credits**
- **CS302** - Advanced Data Structures and File Processing
- **CS312** - Computer Architecture II
- **MATH260** - Sets and Logic
- **CS392** - Lab Experience in Teaching Computer Science

**Spring Quarter - 17 credits**
- **CS380** - Introduction to Software Engineering
- **CS420** - Database Management Systems
- **MATH330** - Discrete Mathematics
- **CS446** - User Interface Design and Development

### Year 2

**Fall Quarter - 18 credits**
- **CS361** - Principles of Language Design I
- **CS480** - Advanced Software Engineering
- **CS427** - Algorithm Analysis
- **CS Elective**

**Winter Quarter - 16 credits**
- **CS362** - Principles of Language Design II
- **CS481** - Software Engineering Project
- **CS Elective**
- **CS Elective**

**Spring Quarter - 15 credits**
- **CS470** - Operating Systems
- **CS489** - Senior Colloquium
- **CS492** - Laboratory Experience in Teaching CS
- **CS Elective**
- **CS Elective**
Pathway Articulation Steering Team
Computer Science Focus 2018-19

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