

Computer Science Education and Costs

REPORT TO THE JOINT EDUCATION INTERIM COMMITTEE



WYOMING
DEPARTMENT OF EDUCATION

October 31, 2018

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BACKGROUND

In 2017, the Wyoming Legislature passed **Senate Enrolled Act 48** (SEA48). This bill requires the Wyoming Department of Education (WDE) to “conduct a thorough analysis of all changes and costs necessary to implement [computer science] in every school district in the state. In conducting this analysis the department shall conduct site visits and shall consult with Wyoming school districts currently offering computer science programs and courses. The department shall report the results of the analysis to the joint education interim committee not later than October 31, 2018.”

To support school districts in successfully meeting the statutory requirements detailed in SEA48, the WDE created the Boot Up Wyoming 2022 initiative. The WDE Boot Up Wyoming team also includes membership from the Professional Teaching Standards Board (PTSB). This team has met quarterly since March 2018, and will continue to work together and collaborate as the needs of districts become clear. This report outlines the recent work of Boot Up Wyoming 2022 including:

- Statewide Survey & Site Visits
 - Computer Science Course Content
 - Infrastructure, Hardware, & Software
 - Teacher Certification & Training
- Cost Analysis
 - Methodology
 - Example
 - Cost Estimates
- Content & Performance Standards

STATEWIDE SURVEY & SITE VISITS

To understand the costs facing districts in implementing computer science, the WDE developed a statewide survey soliciting information around technical, staffing, and curricular needs. Of the 48 school districts in the state, 44 responded. The WDE then conducted site visits with all 48 districts to consult and gather additional information about current computer science offerings, specific needs and concerns around developing and expanding programs, and additional costs likely to be incurred. The statewide survey and site visit information can be summarized in three areas: computer science course content; infrastructure, hardware, and software; and teacher certification and training.

COMPUTER SCIENCE COURSE CONTENT

Of the 44 respondent districts, 52 percent reported offering some sort of computer science courses. However, there is significant variance in the definition of computer science among districts. While some districts may offer a computational thinking course, others might consider keyboarding to be computer science. It was expressed that the development of computer science content standards will bring great clarity into what constitutes a computer science course.

Figure 1 demonstrates the number of districts providing computer science at specific grade levels. While 22 districts provide courses in high school, 16 districts offer computer science at the middle school level, and 13 offer it in elementary school.

FIGURE 1

What grades are being taught by computer science? *24 responses*

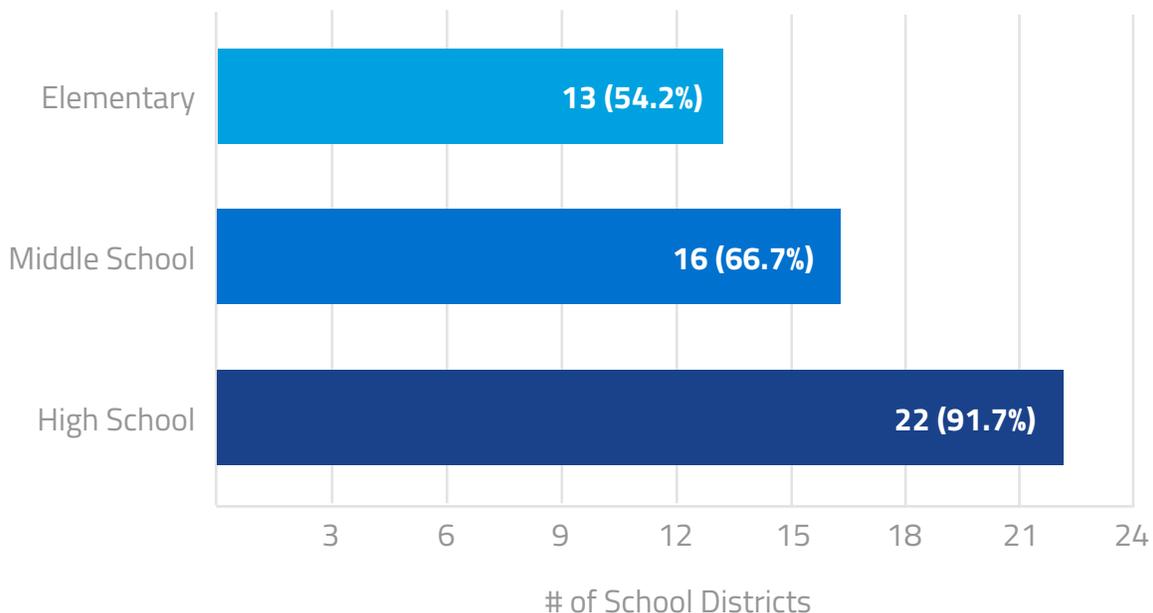
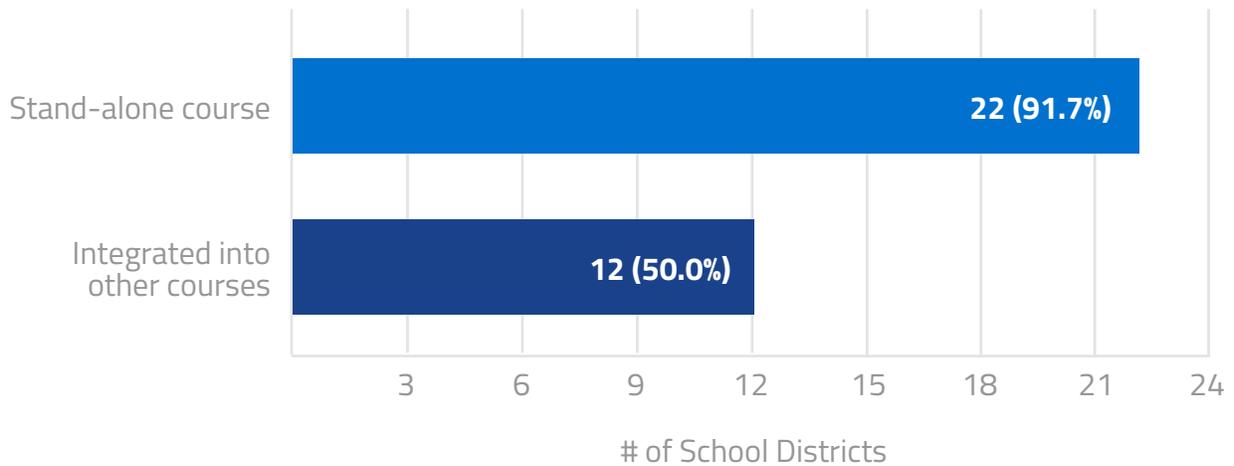


Figure 2 shows that while the majority of computer science courses are taught as stand-alone classes, others are integrating computer science into other courses, oftentimes as part of the Career Technical Education (CTE) classes offered by districts. It was also reported that roughly 8 percent of districts offer students the opportunity to take computer science courses online.

FIGURE 2

How are the computer science course(s) in your district offered?
24 responses



INFRASTRUCTURE, HARDWARE, & SOFTWARE

The WDE also solicited information from districts regarding needs for infrastructure, hardware, and software. With the deployment of the Wyoming Unified Network, schools have seen large increases in their broadband capacity. Since 2015, a coalition of the Governor’s Office, the WDE, the Department of Enterprise Technology Services, State Library, and EducationSuperHighway have been working with districts to improve internal networks and wireless capacity, along with utilizing the federal dollars available to be spent on wireless connectivity. Seventy-four percent of respondent districts believe they have sufficient infrastructure to support computer science education. However, 26 percent of districts believe they will need infrastructure upgrades, given that much of the curriculum and professional development available for computer science is online.

On the survey, 33 percent of respondent districts reported a need to purchase or upgrade their computer hardware. Districts described the use of makerspaces and robotics equipment that would engage students. There also was a stated need to upgrade computer labs or move to a 1:1 device/student ratio.

Nearly 58 percent of respondent districts do not believe there is adequate technology software in the district to teach computer science. However, when districts were asked to complete this survey, many did not have time to determine which programs they were going to be using with students; which created uncertainty around additional software or upgrading existing software. A few districts explained that with

the emphasis on computer science and the increase in student participation, they would need to purchase additional licenses for software already in use.

TEACHER CERTIFICATION & TRAINING

In the 2016-17 school year, only six school districts had certified staff to teach computer science. Results from the statewide survey report that eight school districts now have certified computer science teachers. This likely means that while some school districts will hire additional teachers to teach computer science, many will need to certify current staff to teach computer science. An elementary teacher can teach computer science in a self-contained classroom without additional endorsements. For an elementary teacher to teach computer science outside their self-contained classroom, they must be certified, similar to an Art or Physical Education teacher.

In order to meet this need, the PTSB developed the new **Exception Authorization in Computing Technology**. This allows currently hired and licensed teachers to teach computer science courses in a Wyoming school district through a district-approved professional development plan. These plans must also be approved by the PTSB Computing Technology Application Review Committee. Six educators have received the Exception Authorization since its inception in January 2018.

In addition to the Computing Technology Exception Authorization, the University of Wyoming, PTSB, and the WDE are working together to begin developing microcredentials in computer science. Microcredentials would allow educators to take a series of small courses and show they have developed skills needed to teach computer science. It would be possible for microcredentials to be used to acquire full computer science certification. This project is in its early stages of development.

Districts already implementing computer science typically provide professional development to staff through curriculum providers. For instance, districts have received training through Project Lead the Way, Creative Labs, Microsoft Imagine Academy, and BootUp PD. In the summer of 2018, over 500 educators participated in multiple professional development opportunities across Wyoming, most of which were provided at no cost. Key partners included Code.org, the University of Wyoming, and Microsoft. Additional online training is also available to educators through Apple Teacher.

However, districts expressed the need for even greater educator certification and training in both the survey and during site visits. 89 percent of respondent districts reported a need for “widespread training of teachers in computer science” throughout elementary, middle, and high schools.

District site visits also revealed how important it is for district and school leaders to understand what computer science is, and to bring forward the vision for its implementation. To provide support to district and school leaders, staff from both the University of Wyoming and the WDE will be trained in January by

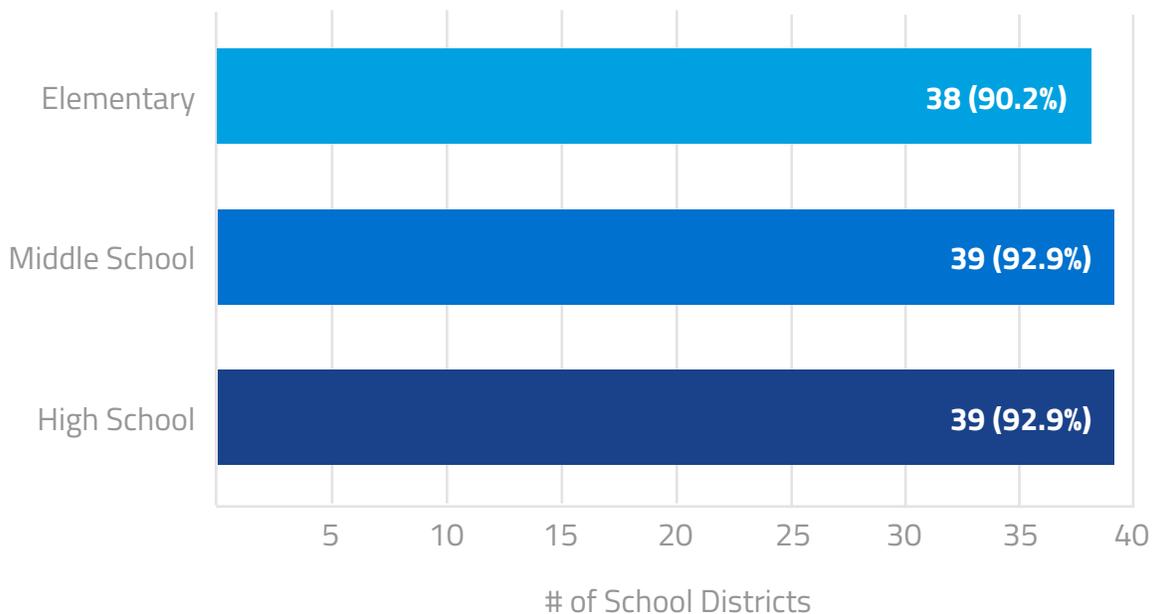
CS4ALL, which will assist districts in developing a computer science vision and implementation plan to ensure they are prepared to offer computer science courses that are aligned to standards by the 2022-23 school year.

Districts also described a possible need to add staff. While larger districts may be able to utilize a current staff member to teach computer science temporarily, districts that have started implementing computer science have found they need to scale rapidly to meet student interest and demand. Small districts have a different problem. Staff may be teaching their current classes, but they also have different tasks and responsibilities in the district. If they were to take on teaching computer science, they would likely have to abandon other courses or programs. However, virtual education courses may be a viable option to help these districts fulfill the requirement of offering computer science.

There was also concern about how to effectively offer computer science at the elementary level. While computer science may serve as an elective course at the secondary level, at the elementary level there are no elective courses. This may require districts teach computer science within current schedules with either classroom educators teaching computer science or through a technology integrator or media technology specialist teaching it as a pull-out class, similar to art or physical education.

FIGURE 3

If you need widespread training, what grade levels will need training?
42 responses



COST ANALYSIS

The Wyoming School Foundation Block Grant (Model) allocates school districts an amount equal to \$250 per model ADM for technology and equipment costs each year. These amounts may be used to purchase technology equipment and supplies and are in addition to the instructional material allocation of \$191.37 per model ADM. Additionally, at the high school level, districts with an approved CTE program are resourced \$9,428.77 per CTE teacher. These CTE programs may include technology related instruction for students. School Computer Technician (or Library Media Tech) positions are also resourced in the model at the school level. In the 2017-18 school year, the number of positions hired by districts exceeded the model provided positions by more than 200 percent.

METHODOLOGY

As required by SEA48, the WDE included questions of necessary costs for implementation in both the survey and at site visits. These estimated costs are approximations. While data was collected from every district, it became evident that most districts had not yet conducted cost estimates. Actual costs will vary based on the method and timeline each district chooses for implementation, along with other factors. Many districts reportedly will not know the extent of costs until content and performance standards and student demand develops. Detailed data collected from one large district was used to create reasonable assumptions. These assumptions were used in the creation of equations to predict costs for implementation. The assumptions are listed below, followed by the equation methodology and an example of the calculations.

Assumptions:

1. No new staff will be added at the elementary school levels.
2. The number of students per class is 24 for districts with enrollment greater than 243 and 7 for districts with enrollments equal to or less than 243.
3. Each secondary FTE can teach six classes each semester.
4. The average salary and benefits of an FTE is \$85,000.
5. A secondary class is only one semester long.
6. Assumes student demand for one class every 1.5 years (once every three semesters).
7. Assumes there will be need for additional equipment and licenses. This equipment is expected to cost \$48.87 per student annually, based on a three-year replacement schedule.

8. Costs for computer science certification for teachers are not included in an ongoing analysis; however, it costs \$11,340 per educator to complete the courses required by the University of Wyoming.
9. Costs associated with developing/aligning curriculum and revising district assessment systems to the new computer science standards are not included. A large district has estimated this cost at \$250,000.
10. Assumes all courses are offered in brick-and-mortar schools, and does not include option to offer students virtual courses.

The first calculation is determining the number of students taking computer science courses annually in the school district:

$$\begin{matrix} 1.5 & = & \textit{secondary enrollment} & / & x \\ \textit{(student demand cycle)} & & & & \textit{(students taking CS annually)} \end{matrix}$$

Once x is determined, or students taking CS annually is determined, the number of classes offered each semester is equated:

$$\begin{matrix} x & = & y \textit{ (class size) (2 semesters)} \\ \textit{(students taking CS annually)} & & \textit{(classes offered} \\ & & \textit{per semester)} \end{matrix}$$

Classes offered each semester is then used to solve for necessary FTE:

$$\begin{matrix} y & = & z \textit{ (6)} \\ \textit{(classes offered per semester)} & & \textit{(FTE) (# of classes taught by FTE)} \end{matrix}$$

Z, or necessary FTE, is then multiplied by the \$85,000 for cost. For total district cost, the equipment of \$48.87 is multiplied by total enrollment and added to FTE cost.

EXAMPLE

Data from Sheridan County School District #1 is used below as an example:

$$\begin{aligned}
 1.5 &= 476 / x \\
 x &= 317.33 \\
 317.33 &= y (24) (2) \\
 y &= 6.61 \\
 6.61 &= z (6) \\
 z &= 1.1 \text{ necessary FTE} \\
 1.1 (\$85,000) &= \$93,500 \text{ total estimated cost for necessary FTE in Sheridan 1} \\
 \$48.87 (476) &= \$23,262.12 \text{ total estimated cost for equipment in Sheridan 1}
 \end{aligned}$$

COST ESTIMATES

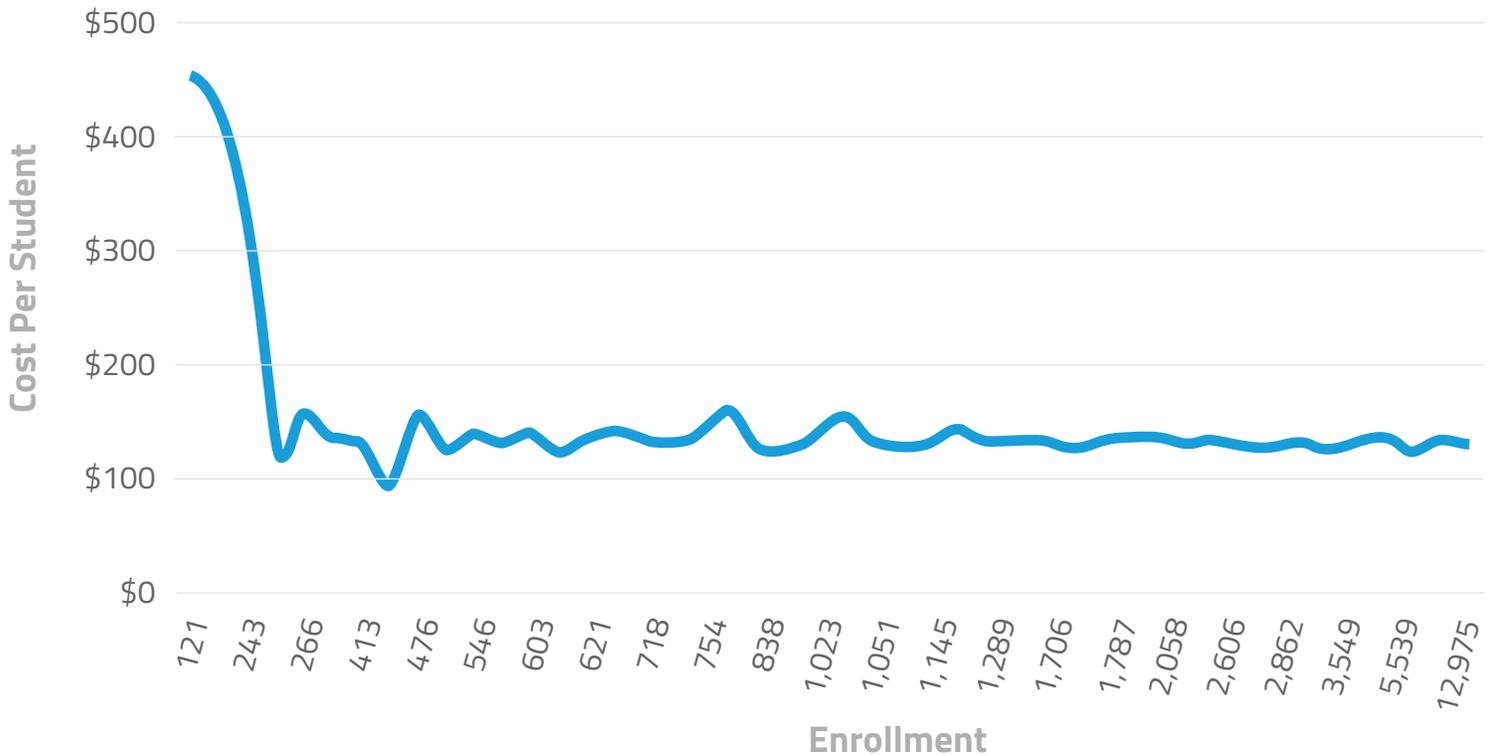
Based on this process, the total estimated annual statewide cost for computer science implementation is **\$12,269,574.08**.

This total estimated cost is broken down below, by individual totals for large, medium, and small districts in the areas of staff and equipment. School districts were categorized using their enrollment data. The highest third were considered large districts, the middle third were considered medium districts, and the lowest third were considered small districts. Estimated cost per student is calculated as well.

TABLE 1

District Size	Avg. Annual Staffing Costs Per District	Total Annual Staffing Costs	Avg. Annual Tech Costs Per District	Total Annual Tech Costs	Total Avg. Annual Costs Per District	Avg. Cost Per Student
Large	\$799,513	\$7,378,000	\$197,128.80	\$1,818,599.31	\$996,641.60	\$128.61
Medium	\$114,127	\$1,700,000	\$28,199.18	\$418,913.64	\$142,326.08	\$135.19
Small	\$52,628	\$807,500	\$11,356.88	\$146,561.13	\$63,985.01	\$164.64

Figure 4. Estimated Cost Per Student to Offer Computer Science Based on District Enrollment



The findings estimate the costs for districts to be as low as \$94.30 per student to about \$467.87 per student. As seen in Figure 4 above, increases in the costs per student rises exponentially the smaller the district. Additional data on the estimated cost for individual school districts is provided in Appendix A.

It should be noted that the Wyoming Education Trust Fund Grant is currently being prioritized for computer science implementation needs, at the request of both the Joint Education Interim Committee and the Select Committee for School Finance Recalibration. The WDE received 17 district proposals in 2018, amounting to \$738,022.94 requested. Of these proposals, 16 were focused on computer science with a total of seven awards amounting to \$295,728.00. Grants were funded in Fremont County School District #1, Fremont County School District #24, Lincoln County School District #1, Johnson County School District #1, Natrona County School District #1, Platte County School District #1, and Sublette County School District #1. Appendix B includes detail on each grant recipient.

COMPUTER SCIENCE CONTENT STANDARDS

According to SEA48, the State Board of Education (SBE) is required to promulgate computer science standards. In April 2018, 43 members, composed of educators, community members, parents, and business and industry partners, were selected from a pool of 103 applicants to serve on the Computer Science Standards Review Committee (CSSRC). The CSSRC reviewed two sets of national standards and six sets of state's standards (K-12) in order to lay the foundation for building the Wyoming Computer Science Standards.

Community input was collected through an online survey and six regional meetings. The purpose of the community input meetings was to gather input on the development of the standards for the CSSRC to consider.

The committee's standard development work started in June 2018, with a webinar to provide training to the committee members and to start the discussion as well as two in-person meetings. Committee members determined the grade-level standards and benchmarks, and then reviewed them in larger groups (elementary and secondary) to ensure alignment across the grades. The CSSRC will potentially have another meeting in spring 2019 to finalize the standards document for the SBE's review. Following the work of the committee, the next steps are to complete the rules promulgation process which includes gathering public comment and final approval by the SBE and the Governor.

In addition to the computer science content standards work, the WDE has also brought together a team comprised of district superintendents, curriculum directors, technology directors, technology facilitators, and teachers to define digital learning guidelines. Given the extensive online work many districts anticipate using for their curriculum, it is critical for students to understand how to effectively navigate the online resources. Both the computer science standards and digital learning guidelines committees are coordinating their work to ensure alignment between the digital learning guidelines and computer science content standards.

CONCLUSION

Districts are actively working to implement computer science at all grade levels. While some districts were already offering computer science courses, there will likely be a need to scale programs to meet growing demand. Even with the challenges facing districts, many are offering new computer science courses during the 2018-19 school year.

Information gathered from the survey and site visits indicate:

1. A clear vision of computer science education and expectations are needed. The computer science content standards are critical for defining computer science and the expectations of what districts need to teach. Districts will need additional support in unpacking the standards and benchmarks, better understanding of different curriculum available, and how to add computer science into their district assessment system.
2. Professional development is needed for teachers across the state. With limited funds, both the state and districts are looking to grant funds to help provide professional development to educators. Professional development includes teaching computer science as a stand-alone course or integrated into current curriculum.
3. Although six additional teachers have received certification allowing them to teach computer science in Wyoming, there are still very few computer science certified educators across the state. At the rate these educators are being added to the ranks, districts may still be struggling with having enough computer science teachers by 2022-23. Districts need additional information around the Computing Technology Exception Authorization. The use of microcredentials in the certification process may provide more opportunities for educators to receive certification.
4. Districts will likely incur costs that go beyond professional development for teachers. They will likely experience costs associated with curriculum materials, unpacking the standards, technology, and staffing.

APPENDIX A: COMPUTER SCIENCE COST ESTIMATION

District Name	Total Enrollment	Secondary Enrollment	Estimated FTE Needed	Estimated Cost Per Student	Total Estimated Cost Per District
Laramie #1	14,071	7,310	17.0	\$128.08	\$1,802,239.70
Natrona #1	12,975	6,821	16.0	\$130.51	\$1,693,342.27
Campbell #1	8,708	4,397	10.0	\$122.29	\$1,064,881.39
Sweetwater #1	5,539	2,880	7.0	\$132.83	\$735,745.60
Albany #1	4,026	2,079	5.0	\$130.80	\$526,600.73
Sheridan #2	3,549	1,831	4.2	\$125.80	\$446,480.97
Lincoln #2	2,883	1,502	3.5	\$128.65	\$370,902.74
Teton #1	2,862	1,421	3.4	\$125.24	\$358,444.27
Uinta #1	2,684	1,420	3.2	\$127.20	\$341,395.40
Sweetwater #2	2,606	1,396	3.2	\$130.55	\$340,222.52
Fremont #25	2,454	1,311	3.0	\$130.02	\$319,068.57
Park #6	2,058	1,089	2.6	\$133.25	\$274,219.43
Park #1	1,837	1000	2.3	\$133.03	\$244,370.00
Fremont #1	1,787	931	2.2	\$130.11	\$232,497.97
Carbon #1	1,762	901	2.1	\$126.30	\$222,531.87
Converse #1	1,706	924	2.1	\$131.10	\$223,655.88
Goshen #1	1,696	908	2.1	\$131.41	\$222,873.96
Johnson #1	1,289	682	1.6	\$131.36	\$169,329.34
Washakie #1	1,274	738	1.7	\$141.73	\$180,566.06
Crook #1	1,145	615	1.4	\$130.18	\$149,055.05
Sublette #1	1,064	551	1.3	\$129.16	\$137,427.37
Laramie #2	1,051	567	1.3	\$131.50	\$138,209.29
Big Horn #1	1,044	638	1.5	\$151.99	\$158,679.06

WYOMING

DEPARTMENT OF EDUCATION

District Name	Total Enrollment	Secondary Enrollment	Estimated FTE Needed	Estimated Cost Per Student	Total Estimated Cost Per District
Platte #1	1,023	559	1.3	\$134.72	\$137,818.33
Sheridan #1	930	476	1.1	\$125.55	\$116,762.12
Uinta #4	838	441	1.0	\$127.15	\$106,551.67
Niobrara #1	815	527	1.2	\$156.75	\$127,754.49
Weston #1	754	409	1.0	\$139.24	\$104,987.83
Uinta #6	739	401	0.9	\$130.04	\$96,096.87
Big Horn #2	718	381	0.9	\$132.48	\$95,119.47
Hot Springs #1	673	366	0.9	\$140.25	\$94,386.42
Fremont #14	621	313	0.8	\$134.13	\$83,296.31
Lincoln #1	613	311	0.7	\$121.86	\$74,698.57
Carbon #2	603	317	0.8	\$138.46	\$83,491.79
Converse #2	572	302	0.7	\$129.82	\$74,258.74
Sublette #9	546	303	0.7	\$136.09	\$74,307.61
Fremont #21	505	239	0.6	\$124.12	\$62,679.93
Big Horn #3	476	271	0.7	\$152.82	\$72,743.77
Fremont #38	444	161	0.4	\$94.30	\$41,868.07
Fremont #6	413	223	0.5	\$129.29	\$53,398.01
Fremont #24	389	202	0.5	\$134.63	\$52,371.74
Big Horn #4	266	153	0.4	\$155.93	\$41,477.11
Weston #7	254	130	0.3	\$125.41	\$31,853.10
Platte #2	243	117	0.9	\$338.34	\$82,217.79
Fremont #2	151	85	0.7	\$421.55	\$63,653.95
Park #16	121	69	0.6	\$449.36	\$54,372.03
Washakie #2	102	57	0.5	\$443.98	\$45,285.59
Sheridan #3	97	59	0.5	\$467.87	\$45,383.33
Statewide Total Estimated Cost:					\$12,269,574.08

APPENDIX B: 2018-19 WYOMING EDUCATION TRUST FUND GRANT

Total Funds Requested: \$738,022.94

Total Funds Awarded: \$295,728.00

FREMONT #1 \$49,940 "FREMONT1@CODER"

Fremont County School District #1 was awarded the Wyoming Education Trust Fund for Innovative Education in order to expand opportunities in computer science to preschool through eighth grade students in the district by creating a modern K-8 computer science and computational thinking curriculum to be implemented district-wide and developing resources kits for community preschools to teach introductory computer science and STEM skills. The target populations for this program are: after school program participants, tech club participants, and all K-8th grade students. The goal for this program is to reach at least 75 percent of Fremont #1 students in either computer science and coding or computational thinking during the 2018-19 school year.

FREMONT #24 \$35,350 "SHOSHONI CODE WRANGLERS"

Fremont County School District #24 was awarded the Trust Fund Grant to create and implement a Kindergarten through 6th grade computer science instructional program with a focus on professional development to be called "Shoshoni Code Wranglers." The goal is for the Shoshoni Code Wranglers to bring computer science content and performance standards to life through the utilization and learning of hydroponics, robotic gardening automation, coding and data collection and help teachers integrate cross-curricular content infused with computer science fundamentals. The overall district goal of this program is to promote meaningful instruction and targeted outcomes for both teachers and students.

JOHNSON #1 \$50,000 "THE MIDDLE SPACE PROJECT"

Johnson County School District #1 was awarded the Wyoming Education Trust Fund Grant to bring more computer science opportunities to students in grades 6-8 in Johnson County through the creation and use of a Makerspace. The target populations for this project are 6-8 grade students at Clear Creek Middle School in Buffalo and the students at the Kaycee School, with the target population potentially expanding to students and staff at additional schools in Johnson and Sheridan County. Through a partnership with Sheridan County School District #3, professional development offered through this program will be extended to neighboring staff to prepare them to also create a K-12 Makerspace and integrate computer science in the future.

LINCOLN #1 \$50,000 "FULL STEM AHEAD"

Lincoln County School District #1 received the Trust Fund Grant in order to establish a stationary STEM Lab classroom and an Analytical Science Lab as well as create two new courses to be offered in Fall 2018 for computer science and robotics. The target population for this program are students in grades 9-12 at

Kemmerer Junior Senior High School. The labs will be created to accommodate 28 students at a time and will also have "Adobe Creative Cloud for Teams" installed, which will support computer science integration with other areas and encourage collaboration and enhance student engagement.

NATRONA #1 \$50,000 "COMPUTER SCIENCE AT ROOSEVELT HIGH SCHOOL"

Natrona County School District #1 was chosen as a recipient of the Wyoming Education Trust Fund Grant to create computer science opportunities for students in the district. For this project, teachers at Midwest and Roosevelt High Schools, in collaboration with a consultant in computer science education, will develop and integrate computer science modules that directly connect to content area standards. The purpose of this project is to pilot a program that can indicate the effectiveness of utilizing classroom teachers of core content areas to introduce coding principles to higher risk and more diverse populations in small school environments, thus increasing the diversity of students exposed to introductory concepts by embedding those skills in content rich format in subject specific areas.

PLATTE #1 \$24,440 "CTACS-COMPUTATIONAL THINKING AND COMPUTER SCIENCE"

Platte County School District #1 was awarded the Wyoming Education Trust Fund Grant in 2018 to integrate Computational Thinking and Computer Science (CTaCS) into grades 3-8 beginning in the Fall of 2018. The district has chosen to follow the Code.org curriculum and make changes and adjustments as needed to fit the specific needs of their district. One teacher with extensive computer science experience will be teaching all classes in grades 3-8 and will develop a full curriculum over the next 2-3 years. Students in grades 3-5 will receive computer science as a specials class and students in 6-8 will be offered computer science as an elective course. With this program, each grade level will continue to scaffold the knowledge gained in prior years with an increased focus on the use of real-life programs and languages, application development, and potential computer science careers.

SUBLETTE #9 \$35,998 "SCSD #9 CYBER ACADEMY"

Sublette County School District #9 was chosen as a recipient of the Trust Fund Grant in 2018 to create a "Cyber Academy" in the district. The target population for the grant is for students in grades 5-8, with a focus on increasing availability to computer science opportunities to students of underrepresented groups including low socio-economic status and female students. The program aims to expose students to four integrated threads within the context of computer science to support and enrich their education through involvement in this after school program. The goal is to increase the likelihood that program participants will continue to take courses or elective in computer science throughout their education as a result of their participation in this program.