January 14, 2022

Members of the General Assembly of Virginia
General Assembly Building
Richmond, Virginia 23219

**Dear Members of the 2022 General Assembly:**

I am pleased to submit the report on the *Review of Computer Science in the Commonwealth Report* pursuant to House Bill 1885 passed during the 2021 Special Session I of the Virginia General Assembly legislation, which required the Virginia Department of Education to conduct a review of the 2017 Computer Science Standards of Learning in the Commonwealth.

If you have questions or require additional information relative to this transmittal, please do not hesitate to contact Michael F. Bolling, Assistant Superintendent for Learning and Innovation, at Michael.Bolling@doe.virginia.gov or (804) 225-2034.

Sincerely,

Rosa S. Atkins, Ed.D.
Acting Superintendent of Public Instruction

RSA/MFB/oml

Enclosure

# A Review of Computer Science in the Commonwealth Report

PRESENTED TO

THE GENERAL ASSEMBLY

NOVEMBER 2021

VIRGINIA IS FOR LEARNERS

VIRGINIA DEPARTMENT OF EDUCATION

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# A Review of the 2017 Computer Science Standards of Learning Implementation in the Commonwealth

## Executive Summary

This report is submitted pursuant to House Bill 1885 passed during the 2021 Special Session I of the Virginia General Assembly legislation, which required the Virginia Department of Education (VDOE) to conduct a review of the 2017 *Computer Science Standards of Learning* in the Commonwealth.

> *Requires the Department of Education to perform a comprehensive review of the ongoing implementation of mandatory computer science standards in elementary schools and middle schools and the alignment of middle school and high school computer science courses and course pathways. The bill requires such review to include recommendations for implementation processes at the local level, profiles of implementation processes that have been successful for school divisions, a description of opportunities for enhanced collaboration with relevant computer science stakeholders to expand computer science education opportunities for all students in the Commonwealth and for relevant professional development for teachers, and examining methods of data collection annually from local school divisions pertaining to computer science implementation. The bill requires the Department of Education to prepare a report on its comprehensive review and provide such a report to the Chairmen of the House Committee on Education and the Senate Committee on Education and Health, the Secretary of Education, and the Superintendent of Public Instruction no later than November 1, 2021.*

A Superintendent's Email, distributed on August 23, 2021, provided information for a 23-question survey to be completed by all school divisions and access to an online survey application. Survey questions were designed to elicit responses addressing the legislative requirement and are provided in Appendix A.

Of the 132 school divisions in the Commonwealth, 127 or 96 percent of school divisions participated in the survey. This report provides a summary of the findings within the schoolwide computer science implementation survey and student enrollment data of computer science courses within the Commonwealth of Virginia to provide a comprehensive review.

# Survey Results and Key Findings

The goal of this report is to review and assess the impact and implementation status of the 2017 *Computer Science Standards of Learning*. In 2016, the Virginia General Assembly approved legislation requiring that the Standard of Learning include computer science. The following year, the 2017 *Computer Science Standards of Learning* were developed with input from a myriad of stakeholders. The 2017 *Computer Science Standards of Learning* were written to provide all students equitable access to computer science education. Subsequently, this included the development of K-8 standards, designed for integration in multiple subject areas. At the secondary level, optional selection of elective modules at the middle school level, and a sequence of high school courses were created to expand access to computer science education to students, beyond the current computer science related career and technical education courses.

School divisions were given until fall 2019 to meet full implementation in the adoption of the computer science standards. This report outlines the progress of the ongoing implementation of the 2017 *Computer Science Standards of Learning.*

This report serves as a synopsis of the 127 (96%), survey responses of Virginia's school divisions and the School of the Deaf and Blind and analysis of the Virginia Department of Education's 2020-2021 computer science course enrollment data. A summary of the findings detailed in this report include:

- All responding divisions recognize the importance of 2017 *Computer Science Standards of Learning.*
- Computer science education is being addressed at multiple levels in many school divisions in Virginia through integration into core curriculum, standalone coursework, and through after school or enrichment programs.
- School divisions need support in the areas of personnel to teach and oversee computer science, professional development, and instructional resources to implement the 2017 *Computer Science Standards of Learning.*
- Lack of available time is cited as a barrier to meeting the mandate of full implementation.
- High school students are overwhelmingly enrolled in computer science foundational courses through the utilization of advanced placement courses and career and technical education foundational computer science courses.
- Middle school students are enrolled in at least one of the courses within the high school computer science course sequence at a higher rate than high school students.
- There is a need for professional development to be diversified in format and content to meet the learning needs of educators.

## Survey Administration

The survey consisted of a total of 23 questions within four sections: division level, elementary, middle and high school. Question format ranged from multiple choice, ranking, multiple selection, and open ended. It is important to note that despite the survey being administered at the start of an academic year and during a global pandemic, survey response was high.

Survey administration began with the understanding that this was the first time school divisions had to submit data related to the implementation of the 2017 *Computer Science Standards of Learning*. Determining appropriate division personnel to complete the survey was a challenge since many divisions do not have dedicated division personnel that oversee K-12 computer science instruction. In some cases, computer science instruction is led by Career and Technical division leaders, with their focus being on standalone high school coursework and supporting CTE course pathways.

### Survey Reflection

The 2021 Computer Science implementation survey was administered during the start of the academic year. Considering the division-level priorities at this time, it has been determined that the SY2022 survey will be administered at an earlier date. Likewise, modifications to question 20 and question 22 will be made to refine the data type and provide greater clarity for school division leaders. In addition to data refinement, additional questions will be added to the divisionwide survey. This will include questions related to standalone course offerings, enrollment data based on student unique identifiers, and the utilization of computer science course credit at the secondary level. Equally important, the 2022 report will consist of data related to teacher and regional stakeholders input. This will include results from a teacher survey and the potential of focus group interviews.

## Implementation of the 2017 *Computer Science Standards of Learning*

### School Division Implementation Status

School divisions were provided a two-year period to meet full implementation status. The survey gathered data on the progress local school divisions have made to meet this mandate. The results of the survey indicated that the majority of school divisions are in the planning stages of implementation and need significant support to adhere to this mandate. Whereas, a small percentage (38%) were in the implementation phases, whether just beginning or fully-implemented, of the 2017 *Computer Science Standards of Learning*.

*Table 1: School Division Implementation Status of the 2017 Computer Science Standards of Learning*

| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Beginning Planning: School division is beginning discussions on development of a plan to integrate the K-8 computer science standards. | 27.34% | 35 |
| Planning: School division development of a plan to integrate the K-8 computer science standards is in progress with interest-based integration occurring at the individual teacher level. | 35.16% | 45 |
| Beginning Implementation: School division's plan to integrate the K-8 computer science standards has been developed and implementation will begin in 2021-2022. | 29.69% | 38 |
| Fully Implemented: School division's plan to integrate the K-8 computer science standards has been fully implemented for students in grades K-8. | 7.81% | 10 |
| TOTAL | | 128 |

Sixty-two percent of school divisions are still in planning stages of implementation for the *2017 Computer Science Standards of Learning*. A majority of these school divisions indicated lack of instructional time, teacher awareness of the computer science standards, and curriculum development as priorities for meeting divisionwide implementation. The table below illustrates the six areas of needs that school divisions were asked to rank in order from highest area of need (1) to lowest area of need (6).

*Table 2: School Division Needs to Meet Implementation Status*

| | 1 | 2 | 3 | 4 | 5 | 6 | TOTAL |
|---|---|---|---|---|---|---|---|
| Curriculum and instructional resources for teachers | 20.31% 26 | 17.19% 22 | 24.22% 31 | 30.47% 39 | 6.25% 8 | 1.56% 2 | 128 |
| Division-wide internet access | 6.25% 8 | 3.13% 4 | 0.78% 1 | 3.91% 5 | 10.94% 14 | 75.00% 96 | 128 |
| Funding for hardware and software | 3.91% 5 | 6.25% 8 | 3.91% 5 | 6.25% 8 | 63.28% 81 | 16.41% 21 | 128 |
| Instructional time for implementation | 28.91% 37 | 23.44% 30 | 17.97% 23 | 19.53% 25 | 7.81% 10 | 2.34% 3 | 128 |
| Professional development for educators (teachers, administrators, and counselors) | 12.50% 16 | 28.91% 37 | 36.72% 47 | 16.41% 21 | 3.13% 4 | 2.34% 3 | 128 |
| Teacher awareness and understanding of the 2017 computer science standards | 28.13% 36 | 21.09% 27 | 16.41% 21 | 23.44% 30 | 8.59% 11 | 2.34% 3 | 128 |

In addition to the implementation barriers presented within the survey, school divisions were provided the option to share additional barriers. These comments could be organized into three categories:

- emphasis on the lack of instructional time;
- increased demands on educators who are overextended with core subject mandates and assessment; and/or
- unfunded mandate.

### *School Division Recommendations for Full Implementation*

The survey included a free response section to solicit the recommendations from school divisions on their needs to meet full implementation. Below is an indexed list of the recommendations shared from 48 percent of the survey responses to support local school divisions in meeting the 2017 *Computer Science Standards of Learning* mandate. These recommendations provide suggestions for legislative action, administrative and professional development, and VDOE resources.

Supports/resources needed for full implementation:

- Virginia Standards of Quality (SOQ) include computer science at the elementary and middle school levels. Survey response indicated the recommendation of one computer science teacher per 500 students
- Computer Science teachers at the elementary and middle school levels
- Funding for full-time personnel (computer science coaches/specialists)
- Middle school course alignment to develop course pathways
- Expand computer science extracurricular opportunities to build interest and community involvement
- Provide internet access for students who do not have internet access at home.
- Develop computer science resources for special education students

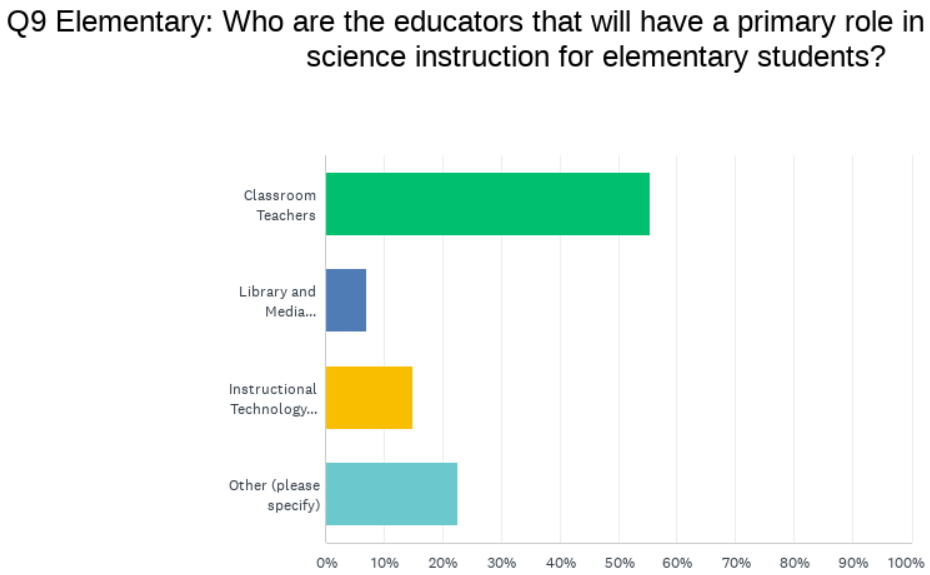
Develop well-defined curriculum alignment guides and resources to demonstrate “best-fits” within core subject areas:

- VDOE professional development (webinars, virtual, or in-person)
- Funding for professional development (resources, substitute teachers, etc.)
- Virginia standardized micro-credential program that could be recognized on teacher license
- Integrate the 2017 *Computer Science Standards of Learning* within the core curriculum frameworks that already exist
- Provide instructional resources, recommendations of curriculum options, exemplar anchor lessons, and guidance on the use of shared resources

## Implementation at the Elementary School Level

At the elementary level, 55 percent of school divisions reported classroom teachers hold the primary responsibility of providing computer science instruction. Computer special teachers, STEM coaches, Instructional Technology Resource (ITRT)/Technology Teachers, and Media Specialists were identified more often as personnel in the “other” category for the survey question.

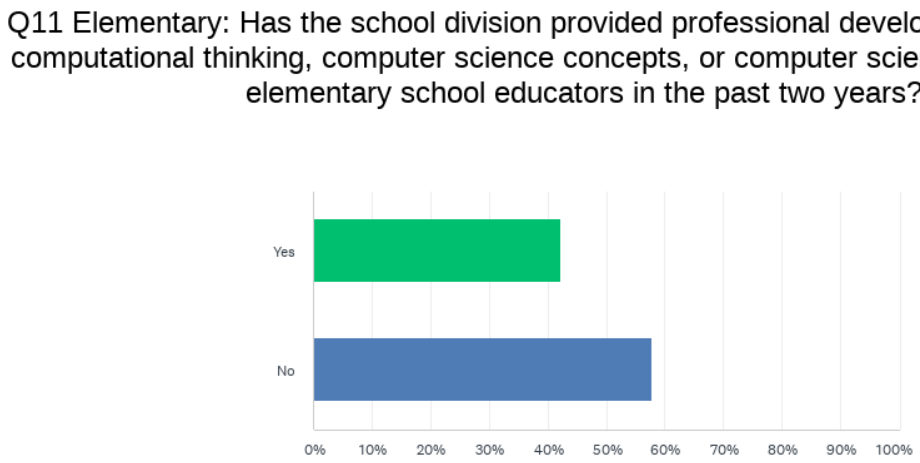
*Graph A: Elementary Educators*




Classroom teachers are required to teach four core subject areas. The computer science standards may be taught as content specific lessons or may be integrated into core discipline instruction. The survey results indicated the use of a collaborative approach to computer science instruction that included classroom teachers, instructional technology resource teachers, and library and media specialists. The collaboration of educators makes use of co-teaching methodology. Either approach requires educators to receive professional development that addresses content and pedagogy to prepare educators for instruction of the computer science standards. Subsequently, the survey solicited information on professional development provided by the school division.

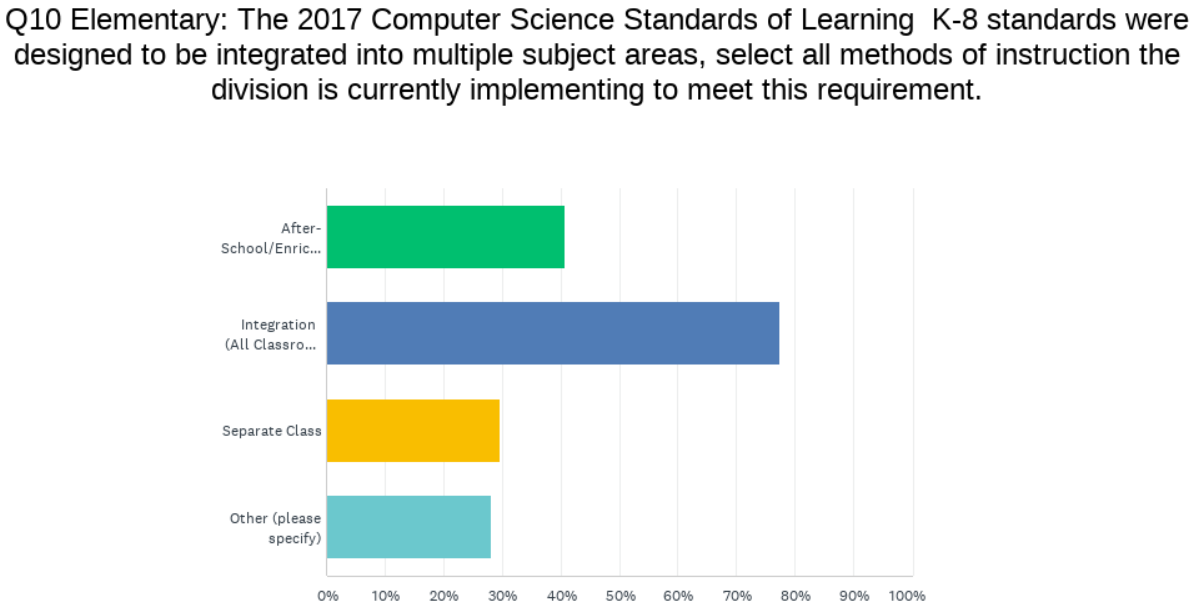
School divisions that provide professional development at the elementary level – 42%

*Graph B: Professional Development offered at the Elementary level*



This indicates a need for increased professional development opportunities at the school division level and a need to provide elementary teachers with prioritization on integrating the 2017 *Computer Science Standards of Learning* into core subject areas.

*Graph C: Elementary Instructional Approach*



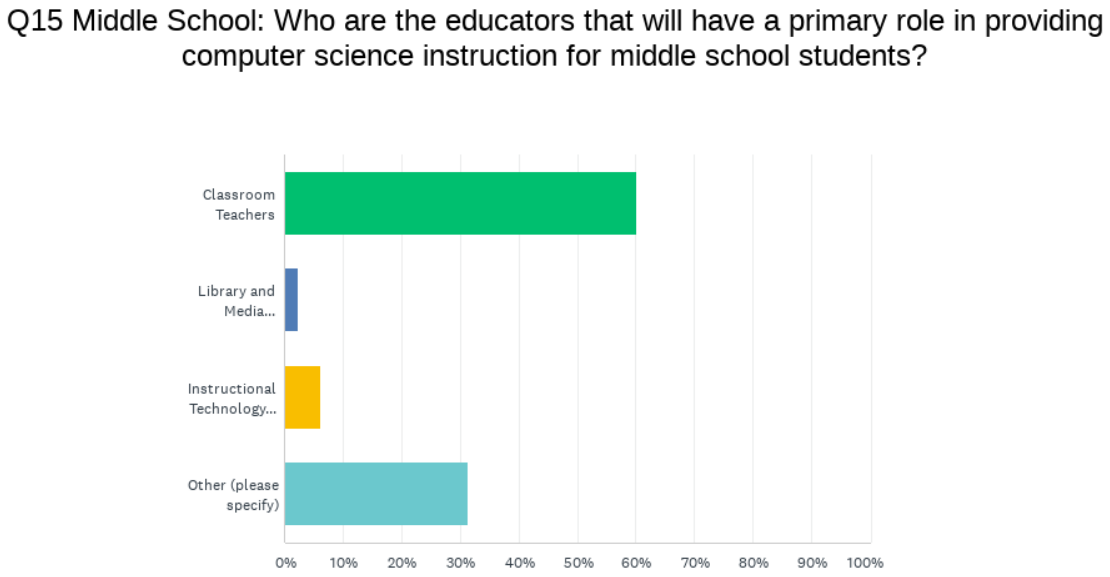

Seventy-seven percent of school divisions indicated integration as the primary method of instruction at the elementary level while 30 percent of school divisions indicated providing a standalone course at the elementary level.

According to the Virginia Department of Education's course enrollment data for 2020-2021, there were 5,670 students enrolled in Exploring Computer Science. This consisted of 11 elementary schools and 1 middle school.

## Implementation at the Middle School Level

Computer science at the middle school level consists of an integrated approach and the option for student enrollment in a number of standalone computer science courses. The middle school computer science elective course developed in 2018 provided school divisions with scheduling flexibility. These courses have various weekly duration with corresponding computer science standards based upon the duration of the course.

*Graph D: Middle School Educators*




Sixty percent of school divisions indicated computer science instruction is provided by classroom teachers. Thirty-one percent of school divisions indicated that computer science instruction is provided by Career and Technical Education teachers, STEM/Math lab instructors, and elective teachers.

The survey illustrated the multitude of instructional methods that are being utilized within a school division at the middle school level. The table below provides an overview of the survey responses.

*Table 3: Middle School Instructional Approach*

| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Integration 6-8 ( Classroom Teachers) | 55.47% | 71 |
| Middle School Elective Course 6 weeks | 6.25% | 8 |
| Middle School Elective Course 9 weeks | 41.41% | 53 |
| Middle School Elective Course 12 weeks | 3.13% | 4 |
| Middle School Elective Course 18 weeks | 45.31% | 58 |
| Computer Science Foundations | 16.41% | 21 |
| After-School/Enrichment Opportunities | 31.25% | 40 |
| Other (please specify) | 21.88% | 28 |
| Total Respondents: 128 | | |

According to the Virginia Department of Education's course enrollment data for 2020-2021, 2,282 middle school students were enrolled in the middle school computer science elective course.

In addition to the integration and middle school elective courses, school divisions have the option to provide high school level computer science courses at the middle school level. Middle school students were enrolled in at least one of the following high school courses:

- Programming – 701 students
- Game Design and Development – 51 students
- Computer Science Programming – 39 students
- Computer Science Principles – 948 students
- Computer Science Foundations – 1,369 students

## Implementation at the High School Level

At the high school level, computer science education is offered through student-selected courses. These courses consist of courses that are primarily categorized as computer science or career and technical education and provide either a computer science elective, career and technical education, science, or mathematics credit depending on the computer science course (Refer to *Table 9: Computer Science Course Credit Options for Mathematics, Science, and CTE credit for the approved list of courses*).

This report is solely reviewing the enrollment of courses that the VDOE has identified as a foundational computer science.

Foundational courses consist of computer science courses that have 20 hours of programming instruction. These courses include advanced placement courses, an international baccalaureate course, three new computer science courses and six career and technical education courses.

A number of computer science courses permit students to earn a mathematics, science, or career and technical education course credit instead of a computer science elective credit. The table below indicates courses that provide flexibility with course credit options.

*Table 4: Computer Science Course Credit Options for Mathematics, Science, and CTE credit*

| Current High School Computer Science Courses Eligible for Standard Units of Credit to Meet High School **Mathematics** Graduation Requirements | Current High School Computer Science Courses Eligible for Standard Units of Credit to Meet High School **Science** Graduation Requirements | Current High School Computer Science Courses Eligible for Standard Units of Credit to Meet High School **Career and Technical Education** Graduation Requirements |
|---|---|---|

| | | |
|---|---|---|
| Computer Mathematics<br><br>Advanced Placement Computer Science A<br><br>IB Computer Science | Advanced Placement Computer Science A<br><br>IB Computer Science | Programming 6640<br><br>Advanced Programming 6641<br><br>AP Computer Science Principles<br><br>AP Computer Science A |

These credit options for the computer science courses listed above posed some complexities when gathering division survey data on computer science course pathways. This was due to school divisions' current discretion to offer computer science courses within a sequence of mathematics courses without the need of a defined computer science pathway.

In addition to the various credit options illustrated in the chart above, computer science courses are primarily classified as either computer science (a component of STEM) or career and technical education. This distinction impacts the oversight of these courses and course pathways at both the Virginia Department of Education and at the local school division level. The survey results indicated divisions needed additional support to provide oversight for computer science that is non-career and technical education. This includes implementation and support of the computer science standards at the K-8 level.

The table below lists the computer science foundational courses and distinguishes between courses that are classified as either a computer science course or a career and technical education course that is computer science related. Courses classified as computer science-STEM are listed at the top of the table and the career and technical education computer science related courses are highlighted.

*Table 5: Computer Science Middle & High School Course Enrollment Data for 2020-2021*

| **Course Title** | **Total Student Enrollment (2020-2021)** |
|---|---|
| AP Computer Science A | 4,891 |
| AP Computer Science Principles | 2,882 |
| Computer Science Foundations | 1,721 |
| Computer Science Principles | 1,606 |
| Computer Science Programming | 499 |
| IB Computer Science (HL) | 165 |
| IB Computer Science (SL) | 144 |

| | |
|---|---|
| Programming | 5,626 |
| Advanced Programming | 1,337 |
| Game Design and Development | 918 |
| Game Design and Development, Advanced | 65 |
| Software Engineering Essentials-PLTW | 204 |
| Software Engineering-PLTW | 37 |

**Career and Technical Education courses are highlighted in the table above.*

The tables below provide the number of middle and high school students enrolled in Virginia public schools during the 2020-2021 academic year. This information and course enrollment data was used to review student participation in computer science foundational courses.

*Table 6: Middle School 2020-2021 Fall Membership*

| School Year | Grade 6 | Grade 7 | Grade 8 | Total Count |
|---|---|---|---|---|
| 2020-2021 | 95,586 | 98,957 | 99,499 | 294,042 |

*Table 7: High School 2020-2021 Fall Membership*

| School Year | Grade 9 | Grade 10 | Grade 11 | Grade 12 | Total Count |
|---|---|---|---|---|---|
| 2020-2021 | 102,932 | 101,512 | 95,394 | 94,398 | 394,236 |

Three percent (or 20,095) of Virginia middle and high school students were enrolled in a foundational computer science course in 2020-2021. Of those middle and high school students enrolled,

- 41% were in a CTE foundational computer science course
- 59% were in a non-CTE foundational computer science course
    - Students taking an advanced placement computer science course make up 65 percent of students enrolled in a Non-CTE foundational course.

Thirty-five percent of students enrolled in a non-CTE foundational course were enrolled in one of the computer science elective courses that are aligned to the 2017 *Computer Science Standards of Learning*.

These courses consist of Computer Science Foundations, Computer Science Principles, and Computer Science Programming.

*Table 8: Participation in 2018 Computer Science Courses by Grade Levels*

| | Computer Science Foundations | | Computer Science Principles | | Computer Science Programming-Non-CTE | | Total Student Enrollment by School Type |
|---|---|---|---|---|---|---|---|
| | Number of Schools | Total Student Enrollment | Number of Schools | Total Student Enrollment | Number of Schools | Total Student Enrollment | |
| Middle School | 13 | 1, 369 | 17 | 948 | 1 | 39 | 2,356 |
| High School | 8 | 327 | 19 | 625 | 14 | 451 | 1,385 |
| Technical Centers, Academies, Programs, and Governor's Schools | 1 | 21 | 1 | 32 | 1 | 8 | 61 |
| Virtual Virginia | N/A | 5 | N/A | 6 | N/A | 1 | 12 |
| Total Student Enrollment by Course | | 1,722 | | 1,611 | | 499 | |

***Data is based on school level data of course enrollment. Student enrollment is not identified by unique identifiers. This may result in a duplication of a student in the data due to a student transferring schools.*

According to the school-level course enrollment data, the non-CTE high school computer science courses: Computer Science Foundations, Computer Science Principles, and Computer Science Programming are used more often at the middle school level. Whereas, high school students overwhelmingly are participating in computer science through Advanced Placement or CTE courses. Once a student has taken a course, a student may pursue additional courses within that concentration. This creates a course pathway. A course pathway is two or more courses within a concentration.

- School divisions that provide high school computer science course pathways through the use of career technical education courses – 54%
- School divisions that provide high school computer science course pathways through the use of computer science courses – 44%

At the secondary level, computer science courses are taught by teachers who hold an approved subject-area endorsement. Many of the computer science courses are taught by teachers who are endorsed in a subject area other than computer science. This flexibility was given due to the limited number of computer science endorsed educators. Currently, there are 381 computer science-endorsed educators in the Commonwealth of Virginia. These educators often hold multiple endorsements. Out of the 381 computer science endorsed educators, 23 of these educators solely hold a computer science endorsement.

## Success Profile of Implementation

Irrespective of the school division's implementation status the survey results indicate that there is progress towards full implementation. Across the Commonwealth there are many indicators of success for the standard implementation and expansion of computer science. These successes should be considered when determining measures that can be taken to advance computer science education across the Commonwealth. The survey results indicated a number of indicators of success. The list below is a summary of the indicators of success indicated in the survey.

- Collaboration amongst educators and support staff, ITRTs, Computer Technology, STEM lab/coordinators, Media Specialists to integrate computer science in core subjects
- Separate computer science "connect" or "special" class in which students attend weekly at the elementary level
- Development of computer science related after school clubs
- STEM being a resource class at the elementary level
- Development of Makerspaces and Creation Station to promote student exploration and creativity
- Utilization of Code.Org and other resource materials
- Development of instructional resources: lesson plans, activities, and curriculum alignment to support computer science instructional needs.
- Integration of Computer Science Standards of Learning into pacing guides across curriculum areas
- Professional development with the intent to build capacity and teacher knowledge and understanding of computer science and computer science standards
- Schoolwide events such as Computer Science Rodeo, Code Day, and participation in Hour of Code
- Increase computer science course offerings and include electives focused on integration or have computer science units of study
- Utilization of state provided grants to provide professional development and develop curriculum resources
- Development of course pathways to ensure a complete pathway with courses at the middle and high school levels
- Participation in regional and national student computer science competitions
- Hiring dedicated personnel
- Increase course offerings to provide more flexibility in students' schedules

## Barriers to Implementation

The majority of school divisions cited lack of additional instructional time as the primary barrier to the implementation of the 2017 *Computer Science Standards of Learning.* Addressing the identified barriers at the local level is critical in developing a strategic approach to providing support and resources.

At the elementary level, the top three barriers for integration of the computer science standards consisted of the lack of instructional time, low teacher efficacy with computer science concepts, and lack of integrated curriculum resources.

*Table 9: Top 3 Barriers-Elementary*

| Priority | Barrier | Percent |
|---|---|---|
| 1 | Lack of Instructional Time | 80% |
| 2 | Educator Computer Science Knowledge | 77% |
| 3 | Curriculum Resources | 48% |

These barriers are reflective of the intended integrated instructional approach at the elementary level. Providing school divisions with curriculum resources and guidance on core subject alignment and cross curriculum connections will expand educator knowledge and reduce the impact on instructional time.

For details on additional barriers identified in the survey, please see the table below.

*Table 10: Barriers to Implementation-Elementary School*

| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Access to Ongoing Professional Development | 46.88% | 60 |
| Curriculum Resources | 49.22% | 63 |
| Educator Computer Science Knowledge | 76.56% | 98 |
| Hardware/Software resources | 13.28% | 17 |
| Instructional Time | 80.47% | 103 |
| Other (please specify) | 18.75% | 24 |
| Total Respondents: 128 | | |

At the middle school level, the top three barriers for either integration or offering computer science courses consisted of instructional time, educator knowledge, and teacher endorsement.

*Table 11: Top 3 Barriers-Middle School*

| Priority | Barrier | Percent |
|---|---|---|
| 1 | Lack of Instructional Time | 80% |
| 2 | Educator Computer Science Knowledge | 73% |
| 3 | Number of Endorsed Computer Science Teachers | 63% |

Middle school computer science education consists of both the need for integration and ability to offer a standalone course to a greater extent than seen at the elementary level. Yet, the lack of instructional time and educator computer science knowledge remain the top two barriers as seen at the elementary level. Due to the increase in student access to standalone courses at the middle school level, the shortage of computer science teachers is a barrier for local school divisions.

For details on additional barriers identified in the survey, please see the table below.

*Table 12: Barriers to Implementation-Middle School*

| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Access to Ongoing Professional Development | 50.78% | 65 |
| Curriculum Resources | 45.31% | 58 |
| Educator Computer Science Knowledge | 71.88% | 92 |
| Hardware/Software resources | 12.50% | 16 |
| Instructional Time | 78.91% | 101 |
| Lack of flexibility with course scheduling | 34.38% | 44 |
| Number of Endorsed Computer Science Teachers | 62.50% | 80 |
| Other (please specify) | 13.28% | 17 |
| Total Respondents: 128 | | |

At the high school level, the top three barriers for providing computer science course pathways consisted of: teacher endorsement, course offerings within master schedule, and professional development.

*Table 13: Top 3 Barriers-High School*

| Priority | Barrier | Percent |
|---|---|---|
| 1 | Number of Endorsed Computer Science Teachers | 89% |
| 2 | Master Schedule Planning (time to offer the course) | 54% |
| 3 | Professional Development for Instructors, Administrators, and Counselors | 48% |

High school computer science education is heavily dependent on personnel and master scheduling planning. At the secondary level, the level of expertise to teach computer science increases and the need to have specialized areas of focus, in particular to CTE computer science related courses is essential. The lack of computer science endorsed teachers is the overwhelming top concern at the high school level. Equally important is the ability to integrate computer science course options into a school's master schedule. The development of the master schedule includes informed administrators and counselors, personnel who are eligible to teach the course, and defined course pathways.

For details on additional barriers identified in the survey, please see the table below.

*Table 14: Barriers to Implementation-High School*

| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Access to adequate technology (ie Computers) | 6.25% | 8 |
| Access to curriculum | 21.88% | 28 |
| Adequate professional development for instructors/administrators/counselors | 48.44% | 62 |
| Broadband access | 7.81% | 10 |
| Educators endorsed to teach computer science | 89.84% | 115 |
| Implementation of course pathways within master schedule | 54.69% | 70 |
| Total Respondents: 128 | | |

In addition to the barriers identified by grade level, school divisions were provided the opportunity to identify additional barriers to implementation.

Respondents identified additional division level barriers including the following:

- Constant updates and changes to standards increase the workload on elementary teachers without increase in pay who also have less planning than secondary teachers
- Required implementation with an unfunded mandate
- State and federal accountability outcomes focused on improvement of core tested SOL content
- Limited funding for software and other instructional materials
- Interest/teacher shortage and lack of "extra teacher time" to devote
- Elementary teachers have so many PD focus areas and there is a limited time for additional PD to support computer science standards implementation
- Lack of an option or mandate to add a class or additional staff
- Alignment of an introductory sixth-grade course to create pathways to current CS/Tech elective course
- Funding for dedicated computer science staff both at the school building level and central office
- Multiple focus areas during the 2020 global pandemic
- Rigidity of the CTE courses which do not allow a focus on computer science in the tech Ed or business departments
- Not all schools offer business and computer science elective classes
- Ability to enforce integration and hold teachers accountable
- Professional development for new teachers and refreshers for veteran teachers

## Professional Development

A consistent theme throughout the survey results was the need for high quality professional development. The lack of appropriate PD was indicated as a barrier in the full implementation of the 2017 *Computer Science Standards of Learning.* Forty-two percent of school divisions provided computer science related professional development for elementary educators and 43 percent provided computer science related professional development for middle school educators.

The survey responses indicated a wide range of professional development needs. This consisted of a tiered approach to professional development based on the needs of the educators, funding to provide the professional development, and continuous support after an initial professional development.

*Table 15: School Division Professional Development Computer Science Integration Professional Development Needs*

| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Access to a variety of computer science professional development | 32.81% | 42 |
| Experts to lead the professional development | 32.81% | 42 |
| Follow-up and support after professional development | 46.09% | 59 |
| Funding for teacher participation in professional development | 29.69% | 38 |
| Increase number of virtual and face-to-face professional development opportunities | 13.28% | 17 |
| Options for personalized professional development for teachers | 32.03% | 41 |
| Professional development for administrators related to computer science standards and integration | 34.38% | 44 |
| Scaffolded professional development on the computer science standards to address different levels of teacher understanding/needs | 78.91% | 101 |
| Total Respondents: 128 | | |

This report does not make mention of the professional development that educators may seek on their own such as professional development provided through nonprofit organizations, higher education, and computer science education organizations.

## Efforts to Address Barriers and Enhance Collaboration

Through grants such as Advancing Computer Science Education (ACSE) and Advancing Rural Computer Science (ARCS) Education, the VDOE has been instrumental in providing awardees with initial funding to develop sustainable plans and making the necessary progress to address computer science within their school divisions. There are currently 11 award recipients for the ACSE grant and 11 partnering school divisions with ARCS. These grants were designed as collaborative partnerships amongst school divisions, business and industry, postsecondary institutions, and nonprofits. These collaborative grant opportunities provided funds to support:

- high-quality professional development aligned to the 2017 *Computer Science Standards of Learning* and integration of the curriculum connections;
- development of high-quality computer science curriculum and instructional resources made available to all teachers through #GoOpenVA; and
- summer and after school computer science related programming for students.

These efforts have made a significant impact in addressing professional development tailored to the needs of educators, curation of instructional resources for teachers by teachers, and have given educators a great

depth of understanding of the Computer Science Standards of Learning. It is through these funding opportunities that school divisions can begin to address some of the top barriers identified in the survey.

In 2019, the Virginia Department of Education (VDOE), in collaboration with CodeVA, hosted the first Computer Science (CS) Education Summit. In 2018, *Computer Science Framework* and cross-curricular alignment documents were developed to support instruction. The VDOE and CodeVA continue to collaborate on CS in Your Neighborhood student statewide competition and CS Teacher of the Year.

The VDOE has begun an instructional webinar series focused on understanding the computer science standards and the integration at the K-8 level. These efforts are ongoing.

## Conclusions and Recommendations for Implementation

There is immense opportunity for growth to support the mandate of statewide implementation of the 2017 *Computer Science Standards of Learning*. The insight from analysis of the survey responses and course enrollment data provides the VDOE with a more accurate depiction of where we are with the implementation of the 2017 *Computer Science Standards of Learning*. It is evident that there is a perceived need for professional development, instructional resources, and increased funding to support this mandate. Equally important was the analysis of the course enrollment data, which indicated the overall impact computer science education is having on Virginia students. While the K-8 standards are intended to be utilized with an integrated approach with the core subject areas, 11 elementary schools are providing standalone courses. At the middle school level, computer science is primarily leveraged through integration of standalone courses, notably the middle school elective courses and career technical education elective courses.

The overall total middle and high student participation in computer science in Virginia is three percent. Thirty-four percent of these students are enrolled in an Advanced Placement course. Forty-one percent of all students enrolled in a foundational computer science course do so through a career and technical education computer science related course. This indicates a need to provide a strategic approach to providing instructional support and increasing student awareness and knowledge at the elementary and middle school levels to encourage students to choose computer science electives.

The school division survey results provided significant data as to the progress Virginia has made with the adoption of the 2017 *Computer Science Standards of Learning*. The survey highlighted the prioritized needs at the local level for full implementation. The majority of school divisions indicated instructional time, educator knowledge, professional development, and instructional resources as areas of need.

Considering the feedback from school division leaders, the VDOE's course enrollment data, and the successes of the active grants (Advancing Computer Science Education and Advancing Rural Computer Science grants), the following recommendations are critical to the overall success of computer science education in the Commonwealth of Virginia:

- Increase collaboration with institutions of higher education (IHE) to develop high-quality, researched-based K-8 instructional resources that focus on integration, universal design, and accessibility of all core subject areas.

- Provide professional development and resources to encourage and support educators who pursue a computer science endorsement.
- Increase funding and grant opportunities to expand professional development and resources for educators to address core computer science concepts and integration of the 2017 *Computer Science Standards of Learning.*
- Seek funding to support programs to increase the number of educators with a computer science endorsement, including support for Praxis preparation and examination cost.
- Provide school division leaders, administrators, and school counselors with targeted professional development to assist in implementation of the standards and the development of computer science pathways at the middle and high school level.
- Partner with computer science stakeholders to design and develop asynchronous and hybrid learning opportunities to provide professional development that meet the varied needs of educators.
- Increase the number of computer science endorsed educators at the middle and high school and provide computer science training focused on the integration of computer science for elementary educators
- Expand professional development to include PD that focuses on understanding the standards, training on instructional resources and instructional practices.
- Partner with computer science industry professionals to provide professional development content specific professional development for educators and career exploration for students.
- Create cross curricular frameworks to support integration of computer science at K-8 and mitigate lack of instructional time

As we look to the development of the 2024 *Computer Science Standards of Learning*, information in the report can be used as a catalyst in determining next steps and strategic planning for computer science instruction. As computer science educators and leaders, we need to provide the skills and concepts students need to meet the societal needs of a technologically driven world that is rooted in computer science. As we consider this revision, we also need to be cognizant of the needs of educators in implementing the standards and consider ongoing support with concepts and pedagogy for a discipline that is changing and expanding daily.

In conclusion, this report will serve as the starting point for the development of a comprehensive Computer Science State Plan. This plan must be developed through the collaboration of various stakeholders. Input needs to be solicited from the public education sector, institutions of higher education (IHE), business and industry, and nonprofit organizations in order to inform the development of a statewide computer science plan to ensure full implementation of the standards and equitable access to computer science education for all students.

# References

Carol L Fletcher, J. R. W. (2021, February 1). *Cape: A Framework for assessing equity throughout the Computer Science Education Ecosystem*. ACM. Retrieved September 8, 2021, from https://cacm.acm.org/magazines/2021/2/250074-cape/fulltext.

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# APPENDICES

# Appendix A

## Virginia Computer Science Implementation Survey

### Division/School Information

****This survey should be completed by the person who is leading computer science instruction and/or general instruction for the school division.**

**This survey will provide the requested data as outlined in HB1885 which "requires the Department of Education to perform a comprehensive review of the ongoing implementation of mandatory computer science standards in elementary schools and middle schools and the alignment of middle school and high school computer science courses and course pathways."**

**Collected data will serve as valuable information to guide the development of a statewide strategic plan to support computer science instruction across the Commonwealth.**

### * 1. Please provide contact information for completing this survey:

**Full Name**

**Title**

**School Division/Regional Program**

**Email Address**

**Phone Number**

### *2. Superintendents' Region

### * 3. Which best describes the school divisions' implementation of the 2017 *Computer Science Standards of Learning* at the K-8 grade level?

- **Beginning Planning:** School division is beginning discussions on development of a plan to integrate the K-8 computer science standards.
- **Planning:** School division development of a plan to integrate the K-8 computer science standards is in progress with interest-based integration occurring at the individual teacher level.
- **Beginning Implementation:** School division's plan to integrate the K-8 computer science standards has been developed and implementation will begin in 2021-2022.

* 4. Has the school division's strategic plan been updated to include the integration of the K-8 Computer Science Standards of Learning?

- Yes
- No

5. If you answered yes to the question above, please upload a copy of either the division's strategic plan and/or implementation plan.

Permissible file uploads: pdf, doc, docx

Choose File | Choose File | No file chosen

* 6. Rank the school division's primary needs to meet the guidelines set forth in the 2017 *Computer Science Standards of Learning*.

- Curriculum and instructional resources for teachers
- Divisionwide internet access
- Funding for hardware and software
- Instructional time for implementation
- Professional development for educators (teachers, administrators, and counselors)

7. Please identify any additional needs the division may have that will support the implementation of the 2017 *Computer Science Standards of Learnings*.

* 8. Identify the school division's **top 3** professional development needs for computer science integration.

- [ ] Access to a variety of computer science professional development Experts to lead
- [ ] The professional development
- [ ] Follow-up and support after professional development
- [ ] Funding for teacher participation in professional development
- [ ] Increased number of virtual and face-to-face professional development opportunities Options for
- [ ] Personalized professional development for teachers
- [ ] Professional development for administrators related to computer science standards and integration
- [ ] Scaffolded professional development on the computer science standards to address different levels of teacher understanding/needs

Virginia Computer Science Implementation Survey

Elementary

**This portion of the survey is focused on computer science integration at the elementary level.**

## * 9. **Elementary:**

Who are the educators who will have a primary role in providing computer science instruction for elementary students?

- Classroom Teachers
- Library and Media Specialists
- Instructional Technology Resource Teachers (ITRT)
- Other (please specify)

## * 10. **Elementary:**

The 2017 *Computer Science Standards of Learning* K-8 standards were designed to be integrated into instruction multiple subject areas, select all methods of instruction the division is currently implementing to meet this requirement.

- After-School/Enrichment Opportunities Integration
- (All Classroom Teachers) Separate Class
- Other (please specify)

## * 11. **Elementary:**

Has the school division provided professional development focused on computational thinking, computer science concepts, or computer science integration for elementary school educators in the past two years?

- Yes
- No

## *12. **Elementary:**

Identify successes the school division has experienced implementing computer science standards at the elementary level.

## *13. **Elementary:**

Identify any potential barriers the school division experienced implementing computer science standards at the elementary level.

- [ ] Access to Ongoing Professional Development Curriculum
- [ ] Hardware/Software Resources Instructional
- [ ] Resources
- [ ] Time
- [ ] Educator Computer Science Knowledge
- [ ] Other (please specify)

Virginia Computer Science Implementation Survey

Middle School

**This portion of the survey is focused on both computer science integration at the middle school level, elective modules, or computer science courses.**

## * 14. **Middle School:**

The 2017 *Computer Science Standards of Learning* K-8 standards were designed to be integrated into instruction in multiple subject areas and standalone courses, select all methods of instruction the division is currently implementing to meet this requirement:

- [ ] Integration 6-8 (Classroom Teachers) Middle School
- [ ] Elective Course 6 weeks Middle School Elective Course
- [ ] 9 weeks Middle School Elective Course
- [ ] Other (please specify)
- [ ] 12 weeks Middle School Elective Course
- [ ] Computer Science Foundations
- [ ] After-School/Enrichment Opportunities

## * 15. **Middle School:**

Who are the educators that will have a primary role in providing computer science instruction for middle school students?

- ○ Classroom Teachers
- ○ Library and Media Specialists
- ○ Instructional Technology Resource Teachers (ITRT)
- ○ Other (please specify)

## * 16. **Middle School:**

Has your school division provided professional development focused on computational thinking, computer science concepts, or computer science integration for middle school educators in the past two years?

- Yes
- No

## *17. **Middle School:**

Identify successes the school division has experienced implementing computer science standards at the middle school level.

## *18. **Middle School:**

Identify any potential barriers the school division experienced implementing computer science standards at the elementary level.

- [ ] Access to Ongoing Professional Development Curriculum resources
- [ ] Educator Computer Science Knowledge Hardware/Software resources
- [ ] Other (please specify)
- [ ] Instructional Time
- [ ] Lack of flexibility with course scheduling
- [ ] Number of Endorsed Computer Science Teachers

Virginia Computer Science Implementation Survey

## High School

**This portion of the survey is focused on computer science course offerings and course pathways at the high school level.**

# *19. **High School:**

Does your division provide access to computer science pathways through the use of Career Technical Education (CTE) concentration/completer sequence courses (such as Programming 10152)?

- Yes
- No

# *20. **High School:**

Please provide the data on students who pursue a computer science course pathway that includes a CTE concentration/completer sequence.

| | |
|---|---|
| Number of students who entered in 2019: | |
| Number of students who completed in 2019: | |
| Number of students who entered in 2020: | |
| Number of students who completed in 2020: | |

# *21. **High School:**

Does your division provide students the option to choose a computer science course pathway that consists of two or more of the computer science elective courses (Computer Science Foundations, Computer Science Principles, Computer Science Programming-NCTE)?

- Yes
- No

## *22. **High School:**

Please provide the data on students who pursue a computer science course pathway that includes computer science elective courses.

Number of students who entered in 2019:

Number of students who completed in 2019:

Number of students who entered in 2020:

Number of students who completed in 2020:

## *23. **High School:**

Select the primary barrier(s) the division has encountered with offering computer science course pathways

- [ ] Access to adequate technology (i.e., Computers) Access to curriculum)
- [ ] Adequate professional development for instructors/administrators/counselors
- [ ] Broadband access
- [ ] Educators endorsed to teach computer science
- [ ] Implementation of course pathways within master schedule