

# **An NCPR Working Paper**

## **Preparing Students for College Learning and Work**

### **Investigating the Capstone Course Component of Virginia's College and Career Readiness Initiative**

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## **Abstract**

The authors investigated the design and implementation of the capstone courses that are part of Virginia’s College and Career Readiness Initiative. Based on a set of performance expectations for college readiness, two capstone courses — one in English and one in mathematics — were developed to help support high school juniors and seniors who intend to enroll in college but are at risk of placing into developmental education. The courses were piloted in more than 20 high schools across Virginia during the 2011–12 academic year. To better understand the pilot year of the capstone courses in Virginia, NCPR partnered with the Virginia Department of Education to document the implementation of the courses. Researchers interviewed stakeholders at the state, school division, and school levels, as well as the creators of the curricula at four partnering institutions of higher education. They also visited several high schools and school divisions involved in implementing the capstone courses to understand how the curricula were being used and to learn more about course content and pedagogy. As a result, the authors identified issues that practitioners should consider as the capstone course initiative expands and implications for researchers investigating capstone courses.



# Contents

<b>Abstract</b>	iii
<b>1. Introduction</b>	1
Capstone Course Typology	2
Organization of This Paper	3
<b>2. Data and Methods</b>	5
Telephone Interviews	5
Site Visits	6
<b>3. The Development of the Capstone Courses</b>	9
History of the Virginia Capstone Course Initiative	9
Designing the Capstone Courses	13
Professional Development and Instructional Materials	16
<b>4. Implementation of the Capstone Courses</b>	19
Mathematics	19
English	29
<b>5. Discussion and Conclusion</b>	37
Considerations for Practitioners	37
Implications for Future Research on Capstone Courses	42
Concluding Thoughts	43
<b>Appendix A: English Performance Expectations</b>	45
<b>Appendix B: Mathematics Performance Expectations</b>	47
<b>References</b>	49



# 1. Introduction

Each year, inadequate academic preparation prevents millions of students nationwide from accessing, progressing in, or completing higher education. Colleges have implemented programs and policies to help students succeed, but there is little rigorous evidence about the effectiveness of such practices. For six years, the National Center for Postsecondary Research (NCPR) has worked to measure the effectiveness of programs designed to help students make the transition to college and master the basic skills needed to advance to a degree. In particular, NCPR has evaluated promising practices intended to reduce the need for developmental education and improve outcomes for those students who enroll in remedial coursework.<sup>1</sup> Many of the programs examined by NCPR have been administered exclusively by colleges and targeted at recent high school graduates or first-time college students, but researchers and policymakers are beginning to realize that the best time to help students avoid developmental education may be during high school.

The Commonwealth of Virginia created the College and Career Readiness Initiative (CCRI) to strengthen high school students' preparation for college and the workforce. To accomplish the goals of the initiative, the Virginia Department of Education (VDOE), in collaboration with the State Council of Higher Education for Virginia and the Virginia Community College System (VCCS), established performance expectations that defined the knowledge and skills required for students to be deemed college and career ready — that is, capable of succeeding in entry-level, credit-bearing college courses. Based on the performance expectations, two capstone courses — one in English and one in mathematics — were developed to help support high school seniors and juniors who intended to enroll in college but were at risk of placing into developmental education. The courses were the result of collaboration between the VDOE and the University of Virginia, Radford University, James Madison University, and the College of William & Mary. These four university partners received grants from the VDOE to develop, in cooperation with high school teachers, instructional materials for the capstone courses. The courses were piloted in more than 20 high schools across Virginia during the 2011–12 academic year.

To better understand the pilot year of the capstone courses in Virginia, NCPR partnered with the VDOE to document the implementation of the English and mathematics capstone courses. In this paper, we describe their implementation and discuss issues that may impact the growth of the initiative and the courses' effectiveness. We observed two distinct types of capstone courses in Virginia: (1) full implementation courses, in which high schools implemented a full capstone course in mathematics or English based on capstone course

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<sup>1</sup> The terms *developmental education* and *remedial education* are used interchangeably in this paper to refer to courses that students take in college to become college ready.

guidelines and materials produced by the university partners and teachers; and (2) embedded unit courses, in which units or portions of units of the capstone courses were integrated into existing courses. Overall, we found the capstone courses to be an innovative way to provide support for some students, but it was unclear whether their implementation was consistent with their aims.

## **Capstone Course Typology**

The capstone courses piloted by the VDOE exemplify the focus on college and career readiness that dominates national education policy. Historically, secondary education separated students into tracks based on whether they intended to attend postsecondary education or enter the labor force following compulsory education. In the modern education paradigm, however, all high school students need to acquire a core set of skills and competencies regardless of their plans for the future (Common Core State Standards Initiative, n.d.; Achieve, Inc., n.d.). This shift toward more uniform academic standards was largely a result of structural changes in the American economy. Increasingly, young people must attain higher levels of education and skill in order to find employment to sustain a middle-class lifestyle. To better prepare Virginia's high school graduates for college and careers, the VDOE used its newly created performance expectations in mathematics and English to develop capstone courses, which are designed to prepare students for college and the workforce.

In a review of the literature on capstone courses, Kannapel (2012) identified two main types of capstone courses: culminating experience capstone courses and transition capstone courses. Culminating experience capstone courses require high school seniors to gather the knowledge they have gained during high school and either apply it to a real-life problem or produce a culminating research project. Students in these courses may complete thesis-like projects on a topic of interest, produce portfolios of their best work, participate in community service projects, or perform service learning activities. These experiences are intended to give students an opportunity to practice the skills they will use in postsecondary education.

In contrast, transition capstone courses — the subject of the current study — focus on college preparation in a single content area, such as English or mathematics (Kannapel, 2012). According to the Southern Regional Education Board (SREB), the purpose of a transition capstone course is to prepare students to succeed in their first credit-bearing English or mathematics course in college (Barger, Murray, & Smith, 2011). Barger, Murray, and Smith (2011, p. 11) argued that “transitional courses differ from existing senior-year courses and closely reflect the reading, writing and mathematics skills that students need for introductory college courses.” According to the Charles A. Dana Center at the University of Texas at Austin, which worked with the American Diploma Project to develop criteria for high school mathematics capstone courses, transition capstone courses are targeted at “high school students



who may be more interested in a contextualized form of instruction in their senior year or are not yet ready for the demands of a traditional pre-calculus or calculus course” (Charles A. Dana Center, 2008, p. 1).

The need for transitional capstone courses implicitly suggests that the existing high school curriculum does not adequately prepare all students for the demands of postsecondary education and the workplace. The mathematics capstone courses, especially, are designed to entice those students who may not otherwise have taken a fourth year of mathematics to continue learning mathematics. Transition capstone courses are designed not to transfer the function of developmental education from colleges to high schools but to give students an experience that “maintains and extends prior mathematical knowledge, enhances the application of process skills, encourages the development of academic discipline and a positive attitude toward learning mathematics, and connects mathematics with varied student interests” (Charles A. Dana Center, 2008, p. 1). The courses assume that actively reengaging students with academic content will prepare them for college-level work.

## **Organization of This Paper**

The next section of this paper outlines the data and methods we used in our investigation of capstone courses in Virginia. The third section describes the history of the courses’ development and discusses the work of the university partners in creating curricular materials for the capstone courses. The fourth section highlights our main findings related to the implementation of the capstone courses throughout Virginia. The final section summarizes our findings and discusses their implications for schools looking to implement or improve transition capstone courses.



## 2. Data and Methods

With this study, we investigated the design and implementation of the capstone courses that are a part of the Virginia CCRI. NCPR documented the project during the 2011–12 academic year in order to better understand the use of capstone courses as an approach to increasing college readiness. Our research utilized a two-part strategy. First, we interviewed capstone course stakeholders at the state, school division,<sup>2</sup> and school levels, as well as the creators of the curricula at the four institutions of higher education. Second, we visited several high schools and school divisions involved in implementing the capstone courses to understand how the curricula were being used and to learn more about course content and pedagogy. During the site visits, we interviewed students and staff and observed capstone courses in English and mathematics.

### Telephone Interviews

At the beginning of the project, the VDOE provided NCPR with a list of 34 high schools that administrators believed were piloting some form of the senior capstone course in either English or mathematics in the spring of 2012. We attempted to contact all of the schools on this list. Twelve schools either declined to participate in the documentation study or did not respond. Five schools were not in fact piloting a capstone course during the 2011–12 academic year and were removed from our sample. The remaining 17 schools participated in the study, and we conducted 20 telephone interviews with capstone course instructors and other school-level respondents (e.g., math department chairs) and eight telephone interviews with school division–level administrators. These one-hour interviews focused on the high school context and culture, the school’s motivation for offering the capstone courses, the process of implementing the capstone courses, and the high school’s college readiness goals and initiatives.

We also conducted telephone interviews with four individuals employed by the university partners and three VDOE staff members. The purpose of the interviews with the university partner employees was to understand the development and design of the capstone courses, with emphases on the role the university instructors played in their development and on the professional development offered to teachers. The VDOE interviews focused on the design of the course from a policy perspective.

All interviews were guided by interview protocols and audio recorded. Clean interview notes were prepared following each telephone interview. These records were used to analyze the

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<sup>2</sup> School divisions in Virginia are similar to school districts in other locales. Unlike school districts, however, school divisions have no taxing authority and depend on local governments for funding.

major categories of interest related to the implementation of the capstone courses in piloting schools, including course design; student participation and recruitment; teacher selection; course content, pedagogy, and assessment; professional development for instructors; and factors facilitating or hindering the expansion of capstone courses.

## **Site Visits**

In addition to the telephone interviews, we contacted 11 high schools to schedule site visits in order to observe the capstone courses and conduct more in-depth interviews with school stakeholders. Schools were selected for in-person visits primarily based on their willingness to participate in the study and their geographic location. We visited three high schools offering the English capstone course in the spring of 2012 and eight high schools offering the mathematics capstone course.

A two-person research team visited each high school once between March and April 2012. During the site visits, we conducted semi-structured interviews with capstone course instructors, principals, and guidance counselors; focus groups with students who were then enrolled in a capstone course; and interviews with school division leaders involved in the capstone course implementation. Interviews were guided by a set of protocols. Students were recruited by their instructors and were provided lunch or snacks in exchange for their time. We interviewed 17 high school staff members, 84 students, and seven school division leaders in person. Most of our in-person interviews consisted of more in-depth conversations with respondents we had originally spoken with on the telephone.

Interviews with course administrators focused on course development and implementation, college and career readiness, and perceptions of course effectiveness. Interviews with capstone course instructors concentrated on course content, pedagogy, assessment, and student recruitment, as well as perceptions of the benefits of the course and how it could be improved. Student focus group interviews focused on experiences in the capstone course as well as students' perceptions of how prepared they were to enter college.

We observed 11 capstone courses (three in English and eight in mathematics) with various formats in seven school divisions. Observations were conducted using a standardized observation protocol. The protocol allowed us to capture information on course activities, student reactions, student-teacher interaction, and time spent on various topics and activities. Researchers also took a running record of the class session as field notes. Observation notes were recorded soon after the observation was conducted. At each school, we also collected capstone course-related documents, including texts, course syllabi, and assessments.

Researchers' site visit reports were analyzed with a set of codes developed by the research team. The team met weekly to discuss emerging findings and areas of the coding scheme in need of refinement. The set of codes used covered a range of topics, including course design; student participation and recruitment; teacher selection; course content, pedagogy, and assessment; professional development for instructors; course satisfaction; and factors facilitating or hindering scale up. Findings related to these topics are discussed in detail in Section 4.



### **3. The Development of the Capstone Courses**

#### **History of the Virginia Capstone Course Initiative**

Education reform in Virginia is marked by a strong reliance on local control of public schools. According to Kirst (1987, p. 4), “Despite legal primacy of the state government, important decision making power has traditionally been delegated by states to local school district officials.” Individual school districts are allowed to make their own choices regarding the majority of schooling matters, including curriculum, financing, and teacher salaries. Although the standards and accountability movement has created a more consolidated, state-controlled education system in many places (Kirst, 1987), Virginia still values local control, and state officials try to give school divisions considerable latitude in their curriculum choices (e.g., the VDOE does not give school divisions a prescribed reading list for high school English). Consequently, Virginia’s capstone courses developed within a long tradition of local control afforded to school divisions and high school reform dating back to the mid-1990s.

#### **Virginia’s Standards of Learning**

Since 1995, Virginia has used the Standards of Learning to set the expectations for student learning and achievement in grades K-12 in English, mathematics, science, history/social science, technology, the fine arts, foreign language, health and physical education, and driver education. These standards represent the “minimum expectations for what students should know and be able to do at the end of each grade or course” (Virginia Department of Education, “Testing,” n.d.). The standards have been revised twice, in 2001–03 and again in 2008–10, as required by legislation of the Virginia General Assembly.

Students’ mastery of these standards is assessed at the end of each academic year. Statewide end-of-course assessments, commonly referred to as “SOLs,” are administered in mathematics, English, science, and history/social science and used to determine school accountability ratings. The Virginia Board of Education has also prescribed the number of assessments in specific content areas that high school students must pass to earn Standard and Advanced Studies Diplomas.<sup>3</sup> Students’ end-of-course assessments are graded on a scale of 0–600 with 400 as the minimum level of acceptable proficiency and 500 indicating advanced

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<sup>3</sup> To graduate with an Advanced Studies Diploma, a student who entered ninth grade prior to 2011–12 must earn at least 24 standard units of credit (compared with 22 for a Standard Diploma) by passing required courses and electives and earn at least nine verified units of credits (compared with six for a Standard Diploma) by passing end-of-course SOL tests or other assessments approved by the Board of Education. To receive an Advanced Studies Diploma, students must also take four years of mathematics, compared with three years for a Standard Diploma.

proficiency. In high school, students must pass the English SOL assessment at the end of each year as well as SOL assessments for Algebra I, Geometry, and Algebra II.<sup>4</sup>

### **Virginia’s College and Career Readiness Initiative**

In 2004, Virginia Governor Mark Warner, then chair of the National Governors Association, began to call for increasing rigor in students’ senior year of high school. This paralleled the national conversation on high school reform, which expanded to include an emphasis on college readiness. Concurrently, improvements in state data systems and the use of individual student identifiers enabled the VDOE to identify a gap between the secondary high school completion benchmarks as delineated by the Standards of Learning and postsecondary education expectations. Students could graduate high school if they passed end-of-course assessments and yet be inadequately prepared for the rigor of college-level English and/or mathematics in college.

In 2007 Virginia began to develop its CCRI, which was intended “to prepare Virginia’s students for postsecondary education or to meet employers’ expectations of candidates for entry-level jobs” (Virginia Department of Education, “College and Career Readiness,” n.d.). To begin, the Virginia Board of Education authorized the VDOE to conduct studies to identify systemic policies and practices that affect student achievement. The VDOE requested that the College Board, ACT, and Achieve’s American Diploma Project conduct alignment studies of their respective college and career readiness standards with Virginia’s English and mathematics Standards of Learning. Based on these results and additional stakeholder feedback, the Virginia Board of Education adopted revised standards in mathematics and English. Virginia’s CCRI builds on these standards and is designed to “ensure that college and career-ready learning standards in reading, writing, and mathematics are taught in every Virginia high school classroom” (Virginia Department of Education, “College and Career Readiness,” n.d.).

### **The Southern Regional Education Board’s College and Career Readiness Initiative**

In 2008, Virginia became one of five states participating in the SREB’s College and Career Readiness Initiative, supported by a grant from the Bill & Melinda Gates Foundation. Virginia used the initiative’s framework to evaluate existing strategies and to guide the development and implementation of a state policy agenda to improve high school students’ readiness for college and careers. In 2010, Virginia hosted a statewide policy summit on college and career readiness, during which then Governor Timothy Kaine and Governor-elect Robert

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<sup>4</sup> See the Testing and Standards of Learning website (<http://www.doe.virginia.gov/testing/index.shtml>) created by the VDOE for more information on the SOL assessments required for other subjects.



McDonnell jointly appeared at a policy forum for K-16 education leaders and emphasized the importance of college and career readiness. The SREB helped to guide the forum, providing recommendations that helped Virginia to develop a focus for the next phase of the initiative. Areas of emphasis included:

- defining college and career ready performance expectations aligned to national and international college and career ready standards;
- developing elective “capstone courses” to support students who need additional instruction to meet college and career ready performance expectations before leaving high school;
- providing technical assistance and professional development to Virginia’s educators to support implementation of the revised English and mathematics standards and the college and career ready performance expectations;
- aligning the state assessments to measure student mastery of the more rigorous mathematics and English standards adopted in 2009 and 2010. Certain high school end-of-course tests will include quantitative indicators of whether students have met or exceeded the achievement levels needed to be successful in introductory mathematics and English courses in college; and
- identifying accountability measures and incentives for schools to increase the percentage of students who graduate high school having demonstrated the academic and career skills needed to be successful in postsecondary education programs (Virginia Department of Education, “College and Career Readiness,” n.d.)

The policy summit, therefore, laid the foundation for the creation of the performance expectations and capstone courses in Virginia.

### **College and Career Ready Performance Expectations in Mathematics and English**

Before the capstone courses were designed, Virginia developed performance expectations in mathematics and English based on the recommendations of the SREB. The performance expectations defined the level of mastery that students were required to reach to be academically prepared for success in entry-level credit-bearing college courses (see Appendices A and B for lists of the performance expectations in English and mathematics). Whereas the Standards of Learning were tied to specific courses, the performance expectations were terminal standards for high school completion, benchmarked to college readiness. However, the VDOE

compared the performance expectations with the Standards of Learning and found that they generally overlapped.

The performance expectations were developed by the VDOE in partnership with the State Council of Higher Education for Virginia and the VCCS. A SREB-supported consultant served as a member of the state team, helping to manage logistical and communication-related aspects of the process. To begin the process, teams for English and mathematics each developed a preliminary set of college and career ready performance expectations derived from the recently adopted Standards of Learning and the national Common Core State Standards. The state team worked to determine how Virginia could utilize previously validated college readiness standards to create a full draft of English and mathematics performance expectations. Moreover, the team decided that the college and career ready anchor standards in the Common Core State Standards would be used as reference points for Virginia's secondary English and mathematics Standards of Learning.

Next, the VDOE electronically surveyed secondary and higher education faculty to determine which of the draft performance expectations were seen as most critical for college readiness and to consider whether there were any other expectations that needed to be added to the draft. A sample of secondary English curriculum supervisors was asked to participate in the English survey; the mathematics survey process was limited to two- and four-year higher education faculty. More than 100 respondents participated in each survey. An administrator at the VDOE explained the importance of this collaboration:

If they're actually going to be called college and career ready standards, then it's very important that higher education agrees to them as well. And quite frankly, oftentimes there haven't been a lot of discussions among the three sorts of entities. This is the first sort of endeavor that I have seen in my tenure here where the three have worked together very well and actually agreed.

Another administrator concurred, remarking that "dialogue between three agencies has increased exponentially in the six or seven years this discussion has been going on. Prior to this, I don't think there was a lot of discussion between one group and the other."

Following the survey, the VDOE assembled separate English and mathematics review teams composed of two- and four-year higher education institution faculty, representatives of the State Council of Higher Education for Virginia and the VCCS, and secondary content area experts to review the compiled survey data. The review teams held meetings to analyze the survey data and make recommendations to the VDOE about the performance expectations that were considered important or critical for college and career readiness. The consensus teams also made recommendations about ways to organize the expectations and discussed what professional development training teachers would need. As a result of this process, the task

forces identified the English performance expectations, which included 51 standards, and mathematics performance expectations, with 29 standards (see Appendices A and B). The English and mathematics performance expectations documents were endorsed by the Virginia Board of Education at its regularly scheduled public meetings in November 2010 and February 2011, respectively. The three Commonwealth agencies — the VDOE, the State Council of Higher Education for Virginia, and the VCCS — signed a joint agreement that endorsed and recognized the performance expectations as the level of achievement that students must reach to be academically prepared for success in entry-level, credit-bearing college courses in English and mathematics. After the English and mathematics performance expectations were determined, the VDOE designed a curricular vehicle to help students meet these expectations: the capstone course.

## **Designing the Capstone Courses**

The VDOE, with the help of a consultant from the SREB, began the work of conceptualizing elective capstone courses to support high school students who need additional instruction to meet college and career ready performance expectations. The capstone courses were not intended as remedial coursework. They were designed for college-intending students who had passed high school coursework and SOL assessments but whose academic performance was low, as indicated by their grades or performance on the SOL tests, or who needed help in strengthening their academic reading and writing skills and/or their mathematics and analytical skills. Among SREB's recommendations for the capstone course in Virginia were the following:

- that the initial focus be on English/language arts (specifically, expository reading and writing) and mathematics;
- that the courses be explicitly based on the college readiness SOL expressed through the SOL tests;
- that successful completion of these activities should be creditable to the high school diploma;
- that these activities should be developed jointly by public school and postsecondary staff, faculty and teachers; and
- that a common assessment of student performance on these 12th-grade activities be developed to determine if the students meet readiness standards. (Southern Regional Education Board, 2009, p.18)

In the spring of 2010, the VDOE surveyed school divisions to determine which were developing capstone-like support materials and course designs and which were interested in potentially piloting capstone programs for the 2011–12 school year. Several school divisions indicated interest in joining this effort, and the VDOE staff began developing capstone course descriptions, program objectives, sample teaching strategies, and delivery options to help school divisions understand the role of the course and promote it to target students. The course development process also included collaboration with community college faculty, which provided an opportunity for the VDOE staff to examine community college syllabi and rubrics, discuss student preparation issues, and develop a fuller perspective on the knowledge and academic skills required for students to engage in freshman coursework.<sup>5</sup> Course codes for the capstone courses were assigned effective for the 2011–12 school year, and the information was shared through official VDOE communications.

The Virginia Board of Education added the mathematics capstone course to its list of courses that satisfy mathematics requirements for high school graduation on February 23, 2012. The Board of Education does not approve English courses to meet graduation requirements.

## **Mathematics**

According to the VDOE, the mathematics capstone course is designed for high school seniors who:

- have satisfactorily completed the required mathematics courses based on the Standards of Learning including Algebra, Functions, and Data Analysis or Algebra II;
- have earned at least two verified credits in mathematics; and
- are college intending, but may not be fully college ready. The course may also support students who meet the same academic requirements but plan to enter the work force (prepared for further work force training) directly after graduating from high school. (Virginia Department of Education, 2011b)

Another way to conceptualize the mathematics capstone course, according to an official with the VDOE, is to recognize that its purpose is to “re-enfranchise those disenfranchised from math.” He said:

The capstone course was . . . developed to meet a need for divisions to keep students engaged in math in their senior year and to help the transition between high school and college. And for students who wouldn’t necessarily take a

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<sup>5</sup> A future NCPR publication will discuss the VCCS developmental mathematics redesign.

senior year math course, we tried to design a course that was interesting and relevant to a student who had had an experience in math that led them to a decision to not take math in their senior year. . . . That fear of math that for some reason is socially acceptable or this “I don’t do math” sort of attitude that typically comes from a bad experience with content and of feeling that they’re not good at it. What we want to do with this course is to bring them back into that fold.

The mathematics capstone course is intended to offer students “high-interest contextualized content” to “augment skills in applied mathematical concepts through mathematical investigations targeting outcomes defined in Virginia’s College and Career Ready Mathematics Performance Expectations” (Virginia Department of Education, 2011b, p. 1). The course is also intended to help make students college and career ready by “enhancing skills in number and quantity, functions and algebra, geometry, and statistics and probability, and reinforcing readiness skills and dispositions in adaptability and flexibility, creativity and innovation, leadership, team work, collaboration, and work ethic” (Virginia Department of Education, 2011b). Moreover, “students will research, collect, and analyze data; develop and support ideas and conjectures; investigate, evaluate, and incorporate appropriate resources; and determine appropriate problem-solving approaches and decision-making algorithms in a variety of real-world contexts and applied settings” (Virginia Department of Education, 2011b).

## **English**

The English capstone course is designed for students who:

- (1) have satisfactorily completed the Standards of Learning English 11 course;
- (2) have achieved at least minimum proficiency on both the end-of-course English reading and writing assessments; and
- (3) are college intending, but may not be fully college ready. The course may also support students who meet the same academic requirements but plan to enter the work force (prepared for further work force training) directly after graduating from high school. (Virginia Department of Education, 2011a)

Like the mathematics capstone course, the English capstone course is designed to offer students high-interest, contextualized content. The VDOE described the function of the course as follows:

The course will add to students’ preparation for critical reading, college and workplace writing, and career-ready communications by enhancing skills in reading, the writing process, and creation of effective texts, and effective

communications (speaking, listening, and collaborating). (Virginia Department of Education, 2011a)

## **Professional Development and Instructional Materials**

During the summer and fall of 2010, the VDOE negotiated and funded pilot professional development centers at four state universities — two university pilot sites for mathematics and two universities working collaboratively for English — to provide curricular resources and ongoing teacher support to facilitate the instruction of the capstone courses. The professional development centers began in early 2011 and were charged with developing sample capstone course materials and program modules. The intent was that teachers, after taking this coursework, would teach existing secondary English and mathematics courses more effectively and would be better prepared to teach the senior-level capstone courses when their school divisions implemented them in 2011. The University of Virginia and Radford University developed resources for the mathematics capstone course; the College of William & Mary and James Madison University developed resources for the English capstone course.

### **Mathematics University Partners**

Radford University and the University of Virginia had pre-existing math and science partnerships with the VDOE, so it seemed a natural next step for the VDOE to work with these universities on the development of the capstone courses. Each university received a Mathematics and Science Partnership grant covering a variety of activities related to improving K-12 mathematics instruction. One of the objectives of the grant was to support the design of new instructional resources for the math capstone course. The math content in the capstone courses integrated content from other high school courses but used a unique applied approach. According to one university partner staff member, the capstone course focused on application, whereas most high school courses focused on content.

A university partner employee described the challenges experienced by teachers when they began to develop capstone course units: “The intent [of these courses] is to turn students loose. The first units that they developed were very teacher-directed.” In response, a faculty member from one university instructed the high school teachers on how to make the units more student-centered. In addition, the content of the capstone courses required a departure from the high school teachers’ usual pedagogical approaches. As another university faculty member explained, generally “math faculty are taught in a very procedural way. They have trouble thinking about applications of math.”

Radford University and the University of Virginia took different approaches in their work with high schools. Radford University offered a year-long professional development

program that provided in-service training in algebra, geometry, statistics, probability and educational technology. All courses were part of a master's degree, although participating teachers were not required to work toward a master's degree. The development of the capstone course units was a project within the professional development program. Radford University had 33 partner institutions across the state, primarily in south and southwest Virginia. In order to disseminate the capstone course material, the university developed a website that listed the capstone course units thematically to correlate with each of the performance expectations; the site provided about 200 lesson plans of 50 or more minutes. Each unit included assessment tools and strategies. The NCPR team did not visit any capstone course sites that worked with Radford University. All mathematics capstone course sites that are documented in this study partnered with the University of Virginia.

The University of Virginia offered professional development for the mathematics capstone courses through online and in-person workshops. Mathematics teachers participated in a week-long professional development workshop during the summer of 2011 to develop templates for the capstone course lessons. The University of Virginia provided the outline and goals of the capstone course, and the instructors worked together to develop the units for the curriculum.

After the summer workshop, the teachers were organized into smaller working groups that met online once monthly throughout the year. During these meetings, teachers presented their ideas and provided feedback to each other on the units that they designed in small teams. The University of Virginia provided many of the resources for this work, but teachers in the small working groups were able to bring their unique perspectives and subject matter expertise to the group so that they could collaborate and develop materials together for the course. The teachers had the freedom to choose which curricular units to teach in their classrooms, the order in which to teach them, and the pace at which to progress through the course content. Some high schools set up additional professional development opportunities for the teachers, such as observations and supplemental meetings to discuss the course.

Although there appeared to be an explicit expectation across the sites that teachers should be able to facilitate and create a student-centered classroom, there was little formal training on the pedagogy for the course. Teachers were able to share their own strategies for teaching certain lessons in their smaller working groups, but one administrator remarked that it would be helpful if the VDOE offered training to help teachers develop a more student-centered pedagogy.

Overall, the teachers at each site spoke highly of their experiences working with the University of Virginia and their partner schools. Many teachers mentioned that although the process took time out of their busy schedules, they learned a lot from each other and enjoyed coming together to share ideas. One teacher remarked:

I've learned so much just by getting together [with other teachers] and bouncing ideas around. I think that is a very important piece of developing a new course and I wish I could do it for some of my other courses.

Other teachers also mentioned that this forum for sharing ideas and gaining support was critical, especially as it was their first year teaching the capstone course.

### **English University Partners**

The College of William & Mary and James Madison University developed the English capstone course materials. The VDOE had a strong working relationship with faculty at the College of William & Mary and invited them to lead the development of course materials. Faculty at the College of William & Mary invited faculty at James Madison University to join the capstone course project.

For the English capstone course, staff at the university partners believed that students should not only be proficient readers of English literature but also be able to conduct research, write essays and research reports, and communicate orally in public settings. Instructional resources for the capstone courses were originally textbooks designed to help provide more time for students to read in the classroom. A series of four one-day meetings was held over the summer to help disseminate information and resources relating to the capstone course.

In August 2011, prior to course implementation, the teachers and administrators we interviewed at three pilot sites attended a two-day professional development workshop called the English Capstone Academy with approximately 50 other teachers from across the state. This workshop and three subsequent English Capstone Academy meetings were held at the College of William & Mary. During the initial workshop, professors from the College of William & Mary and James Madison University outlined the goals of the CCRI and performance expectations for the elective English course. Participating teachers discussed strategies for developing the reading curriculum and implementing the course in their respective schools.

The teachers interviewed for this study described the four follow-up meetings that took place throughout the 2011–12 academic school year as extremely helpful. During these meetings, teachers from the pilot schools were able to provide feedback to the rest of the academy teachers on what was working or needed improvement in their classrooms. They also discussed other curricular issues, such as how to incorporate more college-level writing into the course. Overall, the teachers enjoyed the meetings and appreciated the support they received from the university partners. A second Capstone Academy was scheduled for the following summer at James Madison University with a different set of teachers.



## 4. Implementation of the Capstone Courses

In this section, we describe the English and mathematics capstone course models piloted during the 2011–12 academic year. Although the capstone courses at different schools had much in common, they also varied considerably. We describe variations in implementation, rationale for participating in the pilot, student recruitment procedures, teacher selection, information on pedagogy and content, evidence of success, teacher and student satisfaction, school communication with the VDOE, plans for capstone course implementation in the coming year and teacher, and student recommendations for the future. Table 1 describes key features of the capstone course sites we visited.

We visited both full implementation courses and embedded unit courses in English and mathematics. Full implementation capstone courses were taught as stand-alone courses. In English, this meant that students enrolled in the capstone course in addition to their senior English course. In math, full implementation versions of the capstone course were terminal, senior-year courses open to 12th graders only. In embedded unit courses, teachers embedded capstone course units and principles into existing courses, emphasizing student-centered pedagogy and active learning activities. Capstone course units and principles were incorporated into the existing senior English course and various math courses (e.g., Advanced Functions and Modeling; Algebra, Functions, and Data Analysis) open to juniors and seniors.<sup>6</sup> The structure of the course offering (e.g., class length and frequency) was determined by the schedule at the offering high school. Table 1 summarizes the structure of the courses at both the math and English sites.

### Mathematics

As Table 1 illustrates, there was considerable variation in the design of the math capstone courses across sites and school divisions. The courses had a variety of names, formats, and locations in schools' mathematics sequences. Two of the schools we visited offered a full implementation version of the capstone course in mathematics; the remaining six embedded capstone curricular resources into pre-existing courses to lesser or greater extents.

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<sup>6</sup> In some cases, students in all grade levels could enroll, depending on how far they had advanced through the mathematics sequence.

**Table 1**  
**Key Features of Mathematics and English Capstone Sites Visited**

Site	Course type	If embedded units, course embedded in	Course length	Class frequency and duration	Students
<b>Mathematics</b>					
A	Full implementation		Year long	Daily, 50 minutes	Seniors only
B	Full implementation		Semester long	Daily, 90 minutes	Seniors only
C	Embedded units	Advanced Algebra/Trigonometry	Year long	Every other day, 90 minutes	Juniors and seniors
D	Embedded units	Advanced Algebra/Trigonometry	Year long	Every other day, 90 minutes	Juniors and seniors
E	Embedded units	Advanced Functions and Modeling	Year long	Every other day, 90 minutes	Open to all grades
F	Embedded units	Advanced Functions and Modeling	Year long	Every other day, 90 minutes	Open to all grades
G	Embedded units	Advanced Functions and Modeling	Year long	Every other day, 90 minutes	Open to all grades
H	Embedded units	Advanced Functions and Modeling	Year long	Every other day, 90 minutes	Open to all grades
<b>English</b>					
I	Full implementation		Year long	Every other day, 90 minutes	Seniors only
J	Embedded units	12th grade English	Year long	Every other day, 90 minutes	Seniors only
K	Full implementation		Year long	Every other day, 90 minutes	Seniors only

## **Rationale for Implementing the Capstone Course**

The rationale for implementing the capstone courses or units varied slightly depending on whether the course was a full implementation course or an embedded unit version. Most school- and division-level informants explained that the motivation for full implementation of a mathematics capstone course was that many students were not enrolled in a mathematics course in their senior year of high school; due to this gap in their mathematics education, students did not perform well on college placement tests. For example, the curriculum specialist in one school division explained that the rationale for implementing a full implementation capstone course in one high school was to increase the number of students who would be college prepared and college bound. This particular school served high numbers of low-income students and sent fewer students to college than other high schools in the division. The school division planned to expand the course to the three other high schools in the division in the following school year. The curriculum specialist explained that students who skip a fourth year of mathematics tend to perform poorly on college placement tests because they have taken too much time away from mathematics and go into the tests “totally cold” — that is, without any preparation or review of the mathematical concepts covered by the tests. She expressed the hope that the capstone course would appeal to students who would otherwise not enroll in mathematics during their senior year, and that it would therefore improve students’ scores on college placement mathematics tests.

In contrast, people we interviewed in schools or school divisions embedding capstone course units into existing courses reported that the intent was to help students develop the skills needed to transition from lower level mathematics to higher level mathematics. The mathematics specialist in another school division described the rationale for implementing an embedded unit version of the capstone course designed to support students in their transition from Algebra II to pre-calculus. This school division had a large population of college-bound students and considered it important for students to complete Algebra II in order to be prepared for college. The mathematics specialist considered the capstone course in this division to function like a pump, propelling students toward college-level mathematics. It should be noted that in this division, the course instructors and division administrators felt that the full capstone course was of a lower academic level than the course into which they embedded some of the capstone course units.

Although the VDOE specifies that students enrolled in the capstone course in mathematics are required to have completed Algebra, Functions, and Data Analysis or Algebra II, this was not clear to many of the people we interviewed. Multiple informants in one school division reported that they were unsure whether their schools would adopt the official, full implementation version of the capstone course because the course did not require students to have passed Algebra II. The division already had a course in the mathematics sequence that

reinforced Algebra I level skills, so the official capstone course would have been redundant in the mathematics sequence. Further, the instructors wanted to move students toward Algebra II in order to make them more competitive applicants to colleges. The school division's version of the capstone course advanced students toward this goal, but the official version of the capstone course, according to informants, did not.

### **Course Content and Pedagogy**

Capstone course content varied considerably across school divisions, but courses shared some common elements. All the versions of the capstone course that we examined focused on the review of concepts learned in Algebra I, Geometry, and Algebra II and Trigonometry. Mathematics concepts that students had learned previously were reinforced through applications in real-world, inquiry-based contexts. Because the capstone courses were not connected to SOL tests, instructors had the flexibility to pace the courses according to students' learning needs and discuss topics in greater depth when necessary. Most of these courses did not draw heavily on mathematics texts, and students were generally assessed based on their understanding of procedures and processes rather than their ability to arrive at correct answers. Across school divisions, courses also emphasized group work and student collaboration.

In Sites A and B, which used full implementation versions of the capstone course, the course curriculum was developed in partnership with the University of Virginia. Instructors described the capstone course units as being of three types — task-based, problem-based, and project-based — defined as follows:

A Task-Based Unit is designed for 3 to 8 hours of class time and generally includes more teacher direction along with students working collaboratively in pairs or groups of three.

A Project-Based Unit is designed for more than 8 hours of class time with limited teacher direction during the project. There is an expectation that students will work independently and will engage in research and data collection during the unit.

A Problem-Based Unit is one that entails giving students a real world problem, and asking them to do their best to develop a solution on their own or in groups, using research and problem solving skills, over a period of 3–4 weeks. The teacher is a coach/advisor throughout the project, but this is totally student-centered. It may be considered a culminating activity for the course. (Virginia Department of Education, n.d., "Mathematics Capstone Course")

Students began the semester working on task-based units and moved to the problem-based units at the end of the semester. During our site visit, we observed an example of a project-based unit. Students were charged with creating a more eco-friendly design for Vitamin Water bottles that would minimize waste, maximize volume, and be designed for easy shipping. When we visited the class, students were midway through the project. They sat down in groups of four to work with no lecture or guidance from the teacher. Each student had a laptop to use during the class to research bottle designs and complete mathematics journals using an online platform. The course instructor moved around the room throughout the class, answering students' questions and reminding them to consider certain aspects of the project, such as the need to pay attention to the shape of the bottles for shipping.

At Site B, the course was designed so that students completed their work in class and were not required to do any homework. The mathematics curriculum specialist assumed that students enrolled in other demanding senior year courses would not be willing to do a lot of homework for the capstone course, which was not required for graduation. Various informants across sites spoke about the challenge of getting students, especially seniors, engaged and motivated in this elective course.

At Sites A and B, collaborative group work was the norm in the capstone course. At Site B, students worked in groups of four that they selected at the beginning of the term and remained in throughout the semester. This classroom setup created a student-centered environment and helped students to develop communication and collaboration skills. Students in these courses were required to complete a mathematics journal, in which they wrote entries using an online platform; this helped them to reflect on the work they completed in class.

In Sites E–H, which implemented embedded capstone course units, the course content was hands-on and project-based in the first semester of the course. In the second semester, a more traditional “chalk and talk” approach was used for instruction in trigonometry. In the first semester, students reviewed concepts that they learned in Algebra I and II using lab simulations and data collection. Teachers at these sites tended to incorporate official capstone course material into the course during the first semester to provide mathematical modeling and application-based exercises for students. The curriculum of this version of the capstone course was developed by a group of teachers in the school division under the direction of the division's mathematics supervisor. The curriculum was developed based on 21st-century college and career readiness standards and was designed as an inquiry-based approach to learning that would revolve around students conducting experiments in class. This division's version of the capstone course, designed to be contextual and hands-on, included themes such as forensics and blood drop analysis to get students excited about and engaged in mathematics. Classes consisted of a lot of group work with the expectation that students would teach one another, look to each other for guidance on how to approach the problems, and work collaboratively.

A teacher at Site E described a typical class in the first semester of the course as beginning by introducing a problem, presenting the students with data, and holding a brainstorm session where students would come up with mathematical strategies for solving the problem. She believed that it was important for students to be able to justify why they used a particular strategy to answer a question or problem. Use of textbooks in the course was limited. When instructors used texts, such as *Advanced Algebra with Trigonometry*, they did so in order to provide practice sets for students.

Sites C and D, which also implemented embedded unit versions of the capstone course, specifically discussed using the capstone course to address both college and career readiness. Instructors concluded that college readiness would be addressed through the inclusion of certain academic material and career readiness through the ways that students would work with the material. College readiness was defined as proficiency with Algebra I, Algebra II, and geometry and statistics content. Career readiness would be promoted through the use of spreadsheets, group work, responsibility for products, self-evaluation, and peer evaluation.

### **Criteria for Student Participation and Recruitment**

Most schools involved in the capstone course pilot used students' performance in a previous mathematics course to determine their eligibility for enrollment in the capstone course. Eligibility requirements differed between schools that embedded capstone course curriculum into other mathematics courses and schools that offered full implementation capstone courses. Schools using the embedded curriculum model generally targeted students with poor performance (defined as C or lower) in Algebra II for course enrollment, and schools offering a full implementation version recruited seniors who were not enrolled in another mathematics course. Recruitment for the course was conducted through outreach to families and presentations to students about the course, as well as via school counselors.

At Sites E–H, where the capstone course served as a bridge course between Algebra II and pre-calculus, student eligibility was based on students' performance in Algebra II and teacher and counselor recommendations. Students who earned a C or lower in Algebra II were referred to the capstone course. In addition, students who initially enrolled in pre-calculus but found it too rigorous were able to switch into the capstone course. One instructor said that his school encouraged seniors to take pre-calculus instead of the capstone course because many four-year colleges require students to have taken pre-calculus for admissions.

Informants at several of these sites described other students who would be well suited to the capstone course, including students who do not thrive in traditional, teacher-centered classrooms and students who prefer an applied approach to mathematics. At Sites C and D,

which also implemented an embedded units approach, informants said that they would like more information from the Commonwealth on which students to target for the course.

At Sites A and B, which implemented freestanding versions of the capstone course, the course was marketed to seniors who were not enrolled in a mathematics course (about 40 percent of seniors at both sites). In order to be eligible for enrollment, students were required to be seniors who had not enrolled in mathematics and who had completed Algebra II or Algebra, Functions, and Data Analysis.

In order to recruit students at Site B, the capstone course instructor and the mathematics curriculum specialist obtained a list of seniors not enrolled in a mathematics course and sent letters to their homes to provide information about the capstone course. The course instructor made a presentation about the course in all of the senior homerooms. In addition, the course had a table at the school's elective fair, and the instructor asked enrolled students to recruit their friends into the course. Site B publicized the course as a nontraditional mathematics course with lots of collaborative work and projects. One challenge related to recruitment was that because the course was new, students were not able to get feedback about it from other students who had already taken it. Another challenge, according to an instructor, was that students were nervous about the group work component of the course, which would force them out of their "comfort zone."

### **Teacher Selection**

The majority of course instructors we interviewed were selected to teach the capstone course by the mathematics department chair in their school, or occasionally by an administrator at the school division level. A few teachers we interviewed did not know why they were chosen to teach the course, or stated that they became capstone course instructors as a matter of logistical convenience. In such cases, frequently the previous capstone course teacher had left, and only one person at the school was available to teach the course.

Most teachers who were selected to teach the course felt that they were selected due to their teaching philosophy and style, which were aligned with the goals of the capstone course. The instructors described themselves as taking a student-centered, applied approach to teaching mathematics. A couple of instructors had taught applied, hands-on mathematics courses in the past. They described themselves as having a facility with helping students understand mathematics concepts, creating collaborative learning environments, and supporting weaker mathematics students in developing confidence with mathematics. Rather than training teachers how to instruct in the student-centered style emphasized in the capstone course model, schools and school divisions often selected teachers who already exhibited this style of teaching. Some teachers for whom this pedagogical style came less naturally discussed struggling to adapt to this "looser" approach to instruction.

One administrator described good capstone course teachers as instructors who felt comfortable operating in a louder, more chaotic classroom. Another administrator said that a good capstone course teacher is one who facilitates rather than lectures, asking leading questions and allowing students to struggle through the material. Most teachers, according to this informant, would want to immediately offer students strategies for solving problems, but a good capstone course teacher would allow students to puzzle through the material on their own.

### **Teacher/Administrator Communication With VDOE**

There was some variation in division-level administrators' amount of communication with the VDOE, but communication was fairly limited overall. Most of the communication between administrators and VDOE personnel occurred through intermittent email and conference calls. Even so, the administrators we interviewed spoke highly of the support they received to implement the course and were excited to be working with the VDOE on this project. The mathematics teachers we spoke with described an indirect communication chain with the VDOE whereby they would converse with their university partners, who would in turn communicate with the VDOE.

### **Student Satisfaction**

Most students were highly satisfied with the course. Common themes that emerged from the student focus groups included the pace, flexibility, and collaborative nature of the course, the relevancy of the course material to “real-world” issues, and the supportiveness of the teacher. Together, these factors created an effective and satisfying learning environment for students to refresh their mathematics skills or learn new ones. Students said that they appreciated that the course curriculum provided them with opportunities to be creative, such as the bottle design assignment described above, and encouraged them to “think outside the box.”

Many of the students in each school mentioned that they liked the “stress-free” nature of the course and how it gave them a flexible environment to learn mathematics. This was in large part due to the fact that students did not have to prepare for the SOL test and had very little homework for the course. Some students reported that the course environment made them feel more comfortable with the subject matter and learning new skills. Some students felt that they were free to “make mistakes” while learning to apply their mathematics skills on projects. A male student at Site E mentioned:

We, like, have no homework or tests, really, maybe a few quizzes, so I feel more comfortable learning at my own pace and am not so anxious about making mistakes in my work every day like I am in other classes.



The course's emphasis on collaboration and student group work also appeared to be related to these feelings of comfort. Although a minority of students voiced concerns about group work and said that sharing the workload was problematic at times, a majority claimed that they enjoyed the group work because they could rely on each other for guidance. When asked how the course was similar to or different from other mathematics courses they have taken or were taking, a female student at Site A responded:

This class is different because we work together and can help each other. Like today in the computer lab we can work in pairs but then get up and help each other. I don't have to ask permission to get up and ask a friend for help; it's actually, like, expected.

This sense of community and support between the students was apparent during both the classroom observations and the focus groups.

In many of the focus groups, students asserted that their teacher was the primary reason for their positive perceptions of the course. A majority of students felt that they could approach their teacher with any questions or concerns and liked how classes were facilitated. One female student at Site E said:

He [the teacher] is so laid back and actually does the work with us. Sometimes the problems are worded weirdly or wrong and he sits down and tries to figure it out with us . . . it makes us feel like it's okay to make mistakes because he makes mistakes.

Many students spoke about the caring environment that the teacher had created in the classroom and how, as a result, they felt more comfortable with the material.

Although the student perceptions of the course were generally positive, there were a few concerns that were consistently raised in the focus groups, particularly related to the clarity of the course assignments. Some students remarked that the projects they worked on seemed disjointed. Students at one particular school were frustrated with how they would start one question or assignment and never finish it, and then be forced to begin another assignment or project. A male student at Site A said, "We jump around every week. I was really hoping to find out how to answer a project we were working on with a Coke bottle but we moved on to a different assignment before we could finish." Students at Sites D and E, where the capstone course consisted of integrated units rather than a stand-alone course, mentioned that the course seemed to be disjointed and that the first and second half of the year could have been integrated better. They believed there could have been a more seamless transition between the topics covered in class.

In terms of the course's ability to prepare them for college, students by and large felt that the course would help them maintain and refresh their skills for placement tests. A few students, however, voiced their concern that the course would not be enough to prepare them for pre-calculus because it was mostly review. One male student at Site E stated:

The majority of the class is review and I'm not sure I'll be ready to take the next step and to do well in college if I have to take a math class. There are parts [of the course] that are too slow, and I wish we talked more about what I'll need to know next year.

Despite a small number of reservations about the usefulness of the course in preparing them for college, a large majority of students said they liked the course and would recommend it to their friends.

### **Teacher Satisfaction**

A few common themes emerged from our interviews with teachers. Teachers at almost every site were excited with how the course curriculum allowed students to see the applicability of mathematics. For instance, two instructors who co-taught the course were pleased that they could incorporate different subjects, such as engineering, into the curriculum so that students could see how mathematics is used in the real world. They referenced a project where students worked together to build a solar panel as one way that the course allowed students to apply their skills in different contexts. In addition, teachers spoke highly of the course's flexible, student-centered structure and its ability to allow students to work through problems and learn material at their own pace. One teacher asserted that he supported the learning process that students went through, in which they worked out problems and were not afraid to make mistakes.

Some teachers mentioned that they would like the course to have more structure and cover more topics, such as trigonometry, that would better prepare students for college. Even so, these teachers acknowledged that this was the first time the capstone course material was incorporated into their courses, so they expected improvements in the future. Despite their concerns, almost all teachers felt that the course was a valuable addition to the curriculum and provided students who needed more help with mathematics an opportunity to improve their skills. Teacher recommendations for improving the course in the following year included better use of the capstone course resources that were developed in the first year in more hands-on projects; the development of formative and summative assessments to evaluate student progress in the course; and better coordination with other offices, such as the guidance department, to encourage students to take four years of mathematics and better prepare for college.

## **Future Plans and Recommendations**

Staff at many of the sites planned to offer the capstone course — or another mathematics course with the capstone course material incorporated, such as Advanced Functions and Modeling — the following year. The same teachers would most likely teach these courses. Staff members at a few sites mentioned the possibility of offering another capstone course in the district or offering the course for a full year rather than for one semester. Administrators at sites that used the capstone course material as a supplement to an existing course mentioned that teachers would have to continue to pick which units to incorporate in the future, as they would not be offering a full, freestanding capstone course. An administrator at one site that used embedded units claimed they would continue to do so rather than offering a full implementation course the following year because of a concern that the capstone course could supplant existing, valued math courses.

## **English**

Five pilot English courses were developed in the state — two full implementation pilot courses and three courses in which units of the pilot were embedded in an existing course. Schools offering the full implementation pilot courses each received a \$3,500 stipend from the university partners for acquiring materials, such as books that students chose to read.

### **Rationale for Implementing the Capstone Course**

Among school divisions and high schools, the rationale for offering the English capstone course was simple: to prepare students for entry-level college coursework. Both teachers and school division personnel reported that the overall goal of the course was to empower students to begin college-level work when they enrolled in college, whether at a two-year or four-year institution. Within the classroom, teachers stated that the goal was to help students who recently passed the 11th grade English SOL assessments to gain and strengthen skills necessary to be successful in college. The course, according to one Site I teacher, was designed to accomplish this by “helping [students] bridge the gap between the types of reading and writing” they encounter in high school and college, enhancing their reading comprehension, research skills, writing skills, and critical thinking. A related goal of the course was to increase students’ confidence that they can succeed in college. A teacher at Site I reasoned, “If those kids have that self confidence now, then maybe they will do better in college.” Teachers and school division personnel consistently spoke of the course goals in terms of college readiness and rarely mentioned career readiness explicitly.

School division personnel from the two full implementation sites reported that a factor in their decision to offer the course was that they had a preexisting relationship with one of the

university partners. When the pilot was announced and division leaders learned of the university partners involved, they became more interested in offering the course. In addition, division personnel made clear that the principals from these two schools were especially interested in increasing the college readiness of all students at the school; they viewed the capstone course as an opportunity to advance that agenda.

### **Course Content and Pedagogy**

The three sites offering embedded unit courses followed the standard 12th grade English curriculum. Neither of the two full implementation pilot sites was guided by any official curriculum or other official instructional resources, which were scheduled to be made available in the 2012–13 academic year. As part of the Capstone Academy, approximately fifty teachers worked with the two university partners to design exemplar capstone course units to post online for any teacher in the Commonwealth to access.

Teachers guided discussions based on topics from current events or readings chosen by the students. One full implementation course teacher frequently utilized technology to introduce new concepts to the students. The class then had a group discussion that centered on this topic and how it related to students' selected readings. Rather seeking one "right" answer, students were encouraged to draw examples from and make connections with outside readings and other subjects that supported their views. In the class we observed, students engaged in a discussion on whether empathy, cooperation, fairness, and reciprocity are necessary for a society to function. Connections to outside readings were included; however, we noted that students provided more examples from popular culture and movies than from literature they had read.

One difference between the two full implementation sites (Sites I and K) was that the emphasis of Site I's readings shifted during the second semester toward nonfiction and higher level literature as opposed to the young adult fiction that dominated the first semester. Although students still chose what they read, the instructor encouraged students to read texts that they might encounter in an introductory college course. Furthermore, during the spring term, the teacher from Site I began to focus on improving students' skills in research and writing. Site I students spent a day attending a college class and researching a paper topic at a university library. In contrast, we observed that Site K maintained a focus on young adult literature and classroom discussions of materials.

Despite their differences, both the full implementation sites and the embedded unit sites incorporated a student-centered pedagogy into their English capstone courses. This student-centered pedagogy placed the onus for learning on the students and encouraged more active, student-led discussions and collaboration as opposed to teacher-assigned material or lectures. The student-centered nature of the course was also evident in the curriculum. Students selected

books to read rather than being assigned material. All three teachers we spoke with stressed the importance of student choice in determining course content. The teacher from Site I described the flexibility of her course:

You need to be okay when things don't go exactly as planned for that day. You had planned this great lesson, and the kids come in and they want to talk about something that just recently happened — a current event. Be open to having that discussion, and then it is up to you as the teacher — if you want to spend 15 minutes on it or 30 minutes if it is a valuable discussion.

### **Criteria for Student Participation and Recruitment**

At both the embedded unit sites and the full implementation pilot sites, all students were required to pass their junior year SOL assessments in English. This requirement ensured that the course would not serve as a remedial course — an important distinction mentioned by the teachers and echoed by school division and VDOE personnel.

Because all seniors were required to take 12th grade English, the three embedded unit sites did not recruit students. The teachers simply decided to embed capstone course principles and units into their courses. Teachers at the two full implementation sites took similar approaches to student recruitment. The capstone course teachers, both English teachers, spoke to their schools' 11th grade English teachers to identify students who might be interested or whom the teachers would recommend for such a course. They also worked with administrators to obtain a list of the students who achieved a score between 400 and 499 on their 11th grade English SOL assessment. Because students take SOL end-of-course examinations near the end of the academic year, scoring information was not available when students' initial senior-year schedules were compiled by guidance counselors during the winter of their junior year. As a result, most student recruitment was conducted during the summer months between the students' junior and senior years. After identifying potential students, teachers and counselors telephoned and sent letters to these students and their parents during the summer. Additionally, teachers partnered with the counselors to target eligible students who were altering their schedules over the summer. The most difficult aspect of student recruitment, according to teachers and echoed by students, was to convince students to take the full implementation capstone course for elective credit; students initially believed it was simply another English course.

### **Teacher Selection**

Teachers at the two full implementation sites were purposefully selected because of their comfort with student-centered learning in their classrooms. The teacher at Site K, a full

implementation site, had previously taught a student-centered leadership course and was described by the district-level administrator as “innovative with technology . . . with allowing students to choose their own path. . . . She supports students in a direction in which they want to go. But the other side is that she opens doors and makes suggestions when they are needed.” This teacher was comfortable with giving students the freedom to choose individualized readings and then guiding discussions around emergent themes. The teacher of the full implementation course at Site I was selected due to her success as an Advanced Placement (AP) English teacher. According to a school division administrator, the higher level critical thinking, reading, and writing skills needed to perform well on the AP test were seen as important for the capstone course students; however, the material had to be carefully scaffolded to support students. Administrators at both the division and state levels, as well as teachers, emphasized the importance of finding the right teacher to lead a successful capstone course.

The three teachers of the embedded unit courses were selected from a group of applicants to attend a statewide English professional development event called the Capstone Academy (see Section 3 for more details). The university partners charged with implementing the English Capstone Academy indicated that two factors guided their teacher selection decisions. First, they wanted to have adequate geographical representation from around the state. Second, applicants were asked to write a short essay describing their interest in participating in the capstone course initiative, and their responses informed the university partners’ decisions.

### **Evidence of Success**

In the English capstone courses, students were evaluated much as they were in traditional courses, although they were not given tests or quizzes. Students generally had one larger project during each grading period and smaller graded projects. Students were also given participation grades as a way to encourage and assess their contributions to discussions. Students were not required to read a certain number of books, and the number of books they read did not factor into their course grades.

There was no assessment of students’ progress toward college readiness either before or after the course, although the teachers, school division–level administrators, and VDOE personnel indicated that it would be desirable to measure students’ progress. All of the above stakeholders mentioned that they planned to systematically assess students’ college readiness in some way during the next academic year but did not provide specific information about how this would be done.

## **Teacher/Administrator Communication with VDOE**

Teacher communication with the VDOE was indirect and somewhat limited. The teachers we spoke with expressed that the university partners communicated with individuals at the VDOE and then relayed information to them during the English Capstone Academy meetings. The school division–level administrators’ communication with VDOE varied by division and was mainly driven by structural forces. One district was much larger than the other. The smaller district had one individual (the director of instruction) responsible for instruction in grades K-12. In contrast, the larger district had an English supervisor who was responsible for English in grades 6-12. As a result, the larger district had more frequent communication with the VDOE about this high school–oriented project.

## **Student Satisfaction**

Students generally reported that they liked the course. Specifically, they appeared to value the choice and autonomy that they were given in selecting reading materials and the lack of a prescribed curriculum. Many said that they were more motivated to read material on topics they could choose and with which they identified. One male student said, “The best is you get to read what you want to read and you’re not forced into something you don’t want to read.” Students spoke about how their elevated interest in reading resulted in greater academic confidence overall, and many indicated that developing better reading comprehension and writing skills helped them to feel more prepared for college. When asked whether she had gained any skills that could help her in other courses, a female student answered, “One day I was taking my dual enrollment class for my Thomas Nelson [Community College] course and I realized I understand key points of topics of summaries, critical thinking. I see it myself, I can actually understand better.” Although almost all students supported the flexible curriculum, a few recommended that future courses set clearer expectations concerning how much reading and writing is required. One Site J student asserted, “We should be given a syllabus in the beginning; that way we know what the work load will be. Right now it is just week to week.”

Not all students found the course to be helpful, however. A few students at each site demonstrated a more apathetic attitude toward education and indicated that they still found reading in other courses, such as science and history, to be “boring” and would not be likely to read more in those courses as a result of taking the English capstone course. A male student asserted:

With me it’s different. With me if it’s something I don’t need I’m not going to read it. Unless I was, like, to read it for an answer for a government question I might read it. But if it is something I have no need for using later on in life, why waste my time?

Although students appeared to have differing perceptions of whether the course was preparing them to read more and become college ready, almost all voiced support for their teachers and spoke candidly about how they believed their teachers were of critical importance to the success of the course. Students at all sites said that their teachers seemed generally interested in their thoughts and feelings on subjects and that they felt free to express themselves. They also seemed to appreciate the personalized attention they received. One male student at Site I stated that his English capstone course teacher was “the first teacher I’ve ever had to sit down and explain: this is how you write an essay, this is how you do it.” Another student at that site expressed similar sentiments: “I can tell that [the teacher] really cares about whether I’ll be ready [to go to college] and has taken time to work with me on my essays and writing.” Overall, students indicated that they found the capstone course to be a positive experience.

### **Teacher Satisfaction**

The three teachers we interviewed provided mostly positive depictions of their experiences implementing and teaching the English capstone course. Their satisfaction with the course stemmed from its ability to engage students in reading and from its student-centered format, which created an intimate, discussion-based learning environment.

All three teachers believed that the course allowed students to be more engaged with reading and to become better readers. This was mostly due to the way that the course allowed students to choose what they read, provided structured time for reading, and employed a flexible curriculum. One teacher mentioned that she heard her students talk about books more than in previous years and that they appeared more engaged with reading than students in her other classes. Another teacher spoke about how her students seemed more comfortable with reading, discussing what they have read, and making connections to larger themes.

All three teachers also endorsed the course’s student-centered pedagogy and discussion-based format, which allowed them to facilitate learning as students read books individually and worked together on group projects. One teacher asserted that the student-centered nature of the course would help students learn to be more self-directed. Another spoke of the sense of community that was created as a result of the student-centered environment. This sense of community in the classroom seemed important to all three teachers. When asked what characteristics a teacher should have to successfully teach this course, one teacher said:

You have to be the kind of teacher who is comfortable giving up control. If you are the type of teacher who has control issues, that is not going to be the type of class for you. You have to be someone who can adapt well.

According to the teachers we interviewed, the course could be improved by creating assessments that would evaluate student learning and skill development and establishing more



uniform expectations for the amount all students should be reading. At two of the three sites we visited, the teachers mentioned that some students read many more books than others. The teachers seemed most dissatisfied with the difficulty in using technology to support student learning in the classroom. One teacher remarked that her school division blocked certain blogging and Google platforms, so her options for incorporating technology into lessons were limited. Another obstacle to offering the course in the following year was the amount of funding teachers would have for acquiring materials, such as books, for the students.<sup>7</sup> Pilot teachers would not be given the \$3,500 stipend again. One teacher said:

I really like the way my class runs, but I am concerned about lack of funding. When I don't have the stipend again next year, I don't know how I am going to be able to provide the books that students want to read.

### **Future Plans and Recommendations**

At the three sites we visited, staff members stated that they planned to offer the English capstone course again the next year. Staff members at one site also spoke about the possibility of expanding the course to at least one other high school in their school division.

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<sup>7</sup> Book stipends were a part of the professional development model adopted by James Madison University and the College of William & Mary and were not included as a part of the grant provided by the VDOE.



## **5. Discussion and Conclusion**

Virginia’s capstone courses were developed as a way to address the disconnect between the high school curriculum and college expectations and in response to concerns about large numbers of students placing into remediation in college. The courses were built upon a set of performance expectations outlining what students in Virginia should know and be able to do in order to be considered college ready. The performance expectations provided important guidance to those involved in the capstone course development process.

At the time of our study, the capstone courses were still under development. During the 2011–12 academic year, large numbers of curriculum units in mathematics and English were being developed. Several high schools agreed to serve as pilot sites and began using at least some of the units as they were created. The pilot sites we studied fell into two categories: schools that implemented a full course in math (2 schools) or English (2 schools) based on existing capstone course guidelines or materials; and schools that implemented embedded units or portions of units in math (9 schools) or English (3 schools), developed by or with the four university partners involved with this initiative.

In our research, we interviewed people involved in both kinds of implementation in both mathematics and English, including capstone course instructors and other high school staff, school division–level administrators, individuals employed by the university partners, and VDOE staff members. We used data from these interviews and observations made during our site visits to participating high schools and school divisions to learn about how the capstone courses were implemented during the pilot year. This process allowed us to raise and reflect on questions related to the capstone course initiative and how it may be expanded from a pilot to an effective and sustainable part of Virginia’s education system.

### **Considerations for Practitioners**

#### **Clarifying the Aims of the Capstone Courses**

Although the overall goal of Virginia’s capstone course initiative was to increase college readiness, stakeholders varied in their perspectives on why capstone courses may lead to improvements in student performance. These varying perspectives were not necessarily mutually exclusive, but they did have implications for the degree to which certain aspects of course implementation were prioritized.

Some stakeholders were concerned that too many students were entering college underprepared, as indicated by college placement test results, and believed that time spent

explicitly teaching math and English content in high school would increase students' college readiness and potentially reduce their need for remediation in college. The VDOE superintendent of public instruction said that the capstone courses in English and mathematics were developed to support students who needed to reach higher levels of achievement to be successful in entry-level credit-bearing courses in college. Similarly, an English teacher who was interviewed said, "The goal of the capstone course is to give these students the college and career readiness skills that make them critical thinkers and the skills they need to successfully go to college without having to take the developmental courses." A number of people we spoke with believed that reinforcing students' math and English skills would help support students' college readiness more generally.

Other stakeholders suggested that a primary function of the capstone courses was to increase levels of student motivation. Some hypothesized that students spend little time on reading and mathematics because they do not find these subjects sufficiently enjoyable or engaging, and as a result, they do not attain the knowledge and skills required to be considered college ready. To address this issue, stakeholders emphasized that the capstone course should focus on intrinsically interesting material, such as student-selected books (in English) or problems with real-life applications (in mathematics). The VDOE (2011a, 2011b) described the math and English capstone courses as involving "high interest content." And a staff member at one of the university partners who was interviewed commented, "The capstone courses in math take students who were sitting in class and had the capability but not the interest in math. By changing the way we teach math, we can engage and motivate these students."

A third stakeholder perspective that emerged from our interviews was that students who learn to apply what they have learned in mathematics and English will have deeper knowledge of these subjects and will be more able to transfer knowledge learned in one context to new and different settings. A university partner staff member we interviewed stated:

Capstone courses allow students to explore math in a way that is different from any other high school courses. They are designed to engage students in real-life situations and solve real problems. This is the kind of analysis that is necessary to succeed in college-level course work.

This variety of perspectives on what college readiness means and how best to help students attain it is present not only in Virginia but also in discussions taking place at a national level. There is no broad consensus among researchers, practitioners, and policymakers about the definition of college readiness, although frameworks for college readiness have been developed in the Common Core State Standards, in David Conley's (2010) work, in Virginia's CCRI performance expectations, and in the guidelines for certain college placement tests (e.g., ACCUPLACER, COMPASS). Colleges tend to be most concerned with the number of students

who need remediation on entry, and high schools tend to be most concerned with getting their students to graduation, at which time they are assumed to be ready for college. The lack of communication and coordination between the high school and college sectors makes it challenging to arrive at a definitive view of college readiness. There is also a lack of consensus on how to help students attain college readiness, especially on a short timeline.

Without a consensus about what constitutes college readiness, there is a greater chance that the design of the capstone courses will be heavily influenced by stakeholders' views of how to improve education in general. In the case of Virginia, the capstone courses were infused with hands-on, project-based learning as a result of stakeholders' priorities. Virginia may need to arrive at an operational definition of college readiness to more firmly ground capstone course aims and activities.

Because our study took place during the pilot year of the capstone courses, while they were still developing, it is not possible for us to offer an assessment of how well the courses are accomplishing their intended aims. Ultimately, schools implementing the capstone courses or units will want to assess whether they are improving students' progress toward the desired definition of college readiness. In defining college readiness, stakeholders will need to consider the gap between the secondary high school completion benchmarks and postsecondary education expectations, and whether it is possible for students to be considered college ready by one definition and still place into developmental courses in college. More generally, high schools may also want to consider what role local colleges or other institutions of higher education — especially their faculty in math and English — might play in guiding the schools toward preparing students for college.

High schools implementing capstone courses — in Virginia and elsewhere — should also consider the courses' potential to contribute to students' career readiness. In our interviews and site visits, there was little evidence that career readiness was a focus of the capstone course or unit implementation. A prevailing argument is that college readiness and career readiness require similar knowledge and skills (Conley & McGaughy, 2012; Achieve, Inc., n.d.). If so, an explicit focus on career readiness in addition to college readiness may not result in a substantial difference in student outcomes. However, some of those we interviewed considered college readiness and career readiness to have some different dimensions and believed that different capstone units emphasized one or the other. More research is needed to determine whether college readiness and career readiness are identical or overlapping constructs. In the meantime, high schools implementing capstone courses may wish to consider whether there are ways to infuse learning opportunities that explicitly aim to improve career readiness.

## **Balancing Content and Depth**

Some interviewees discussed the tension between the need to cover a broad range of material with the need to spend time discussing topics in depth — an issue that has long been discussed in education circles (e.g., Newmann, 1988). Schools that have implemented or are seeking to implement capstone courses will need to consider how to balance these conflicting priorities. The capstone courses we studied encouraged students to dig deeply into important topics by solving complex problems, conducting research, and engaging in meaningful group work. Teachers were asked not to provide answers too quickly but to give students time to arrive at answers on their own. A student-centered approach like this may necessitate more time spent on a single topic than a more traditional, teacher-directed approach to learning. This may make it difficult for teachers to incorporate into the courses the wide range of material that must be covered to meet the performance expectations established by Virginia. Teachers perceived considerable pressure to cover a large amount of important material before students graduate.

Teachers who implemented math units in existing courses struggled with the length and depth of the capstone course units. They appreciated the opportunity the units created for students to learn by doing, but they noted that the units were difficult to implement in short class periods and could require many days to complete. Some opted to implement portions of units rather than complete units. Teachers worried about the extent to which other important material would be left uncovered or insufficiently covered if they incorporated too many capstone course units into their existing courses.

What is more, few K-12 teachers have much training in student-centered instruction utilized in the capstone courses. We frequently heard in interviews and on site visits that capstone course teachers were hand-picked because of their facility with student-centered pedagogy. However, even those who were carefully selected for their teaching style struggled with how to best implement units that called for less direct instruction and more opportunities for students to struggle or make mistakes. Further, it is clear that college and university faculty seldom use student-centered approaches to teaching (Kain, 2003). This raises questions about what instructional approaches will best serve students in the year before they transition to college classrooms.

There are no easy solutions to these issues. However, they point to the need for discussions that go beyond the capstone courses and deal with the full senior year experience, as former Virginia Governor Warner has advocated, or even the full high school experience.

## **Determining the Future of Capstone Courses**

We talked extensively with school division administrators and high school faculty about the future implementation of the capstone courses. Although there was widespread support for

their use, we identified a number of barriers to full implementation for both the mathematics and English courses that would need to be addressed in order to allow more students to have access to capstone course experiences.

For one thing, there is little understanding of — or agreement on — which students the mathematics capstone courses should and could best serve. Interviewees had different ideas of the VDOE guidelines on this matter. Some thought that the mathematics course should be offered to students who had completed Algebra II. Others considered it to be a bridge course between Algebra I and II. Some considered it an appropriate senior year course for students who would not be expected to succeed in Algebra II. Clarifying how the capstone course fits into the high school curriculum would help schools to assess whether the course would be a valuable addition to their course offerings. In some schools, the current mathematics sequences appear to meet the needs of seniors of diverse math abilities; in others, this is not the case. High schools considering implementing the capstone courses may want to consider whether students would be equally well served by being required to take four years of math, using the existing course options.

With regard to the English capstone courses, students are required to take the standard 12th grade English course. Thus, many of them perceive the capstone course as a second English course, not usually necessary for graduation, and opt not to take it. High schools offering English capstone courses should consider how they complement the existing senior year English course and ensure that students are aware of the added benefits of the capstone course experience.

In all cases, there are limits on the number of courses that schools can offer due to budget constraints. When there are undersubscribed courses, teacher time is not used to maximum effectiveness. The capstone courses we observed were generally smaller than average, which is ideal for instruction but more costly on a per-student basis. This caused concern for some school division-level administrators struggling with diminishing resources. Issues of cost-effectiveness would need to be explicitly addressed in order for capstone courses to be widely implemented.

### **Establishing Instructional Priorities in the English Capstone Courses**

During the 2011–12 academic year, teachers of the English capstone courses did not have the benefit of ready-made capstone materials. Rather, teachers organized the courses around core capstone ideas related to the student-centered approach to teaching, such as encouraging students to read books of their choosing. This particular teaching strategy was based on the theory that students who read more will develop better reading skills and therefore become more college-ready, and it assumed that students who got to choose their reading materials would tend to read more. Teachers generally were pleased when students showed excitement about reading

and when they read many books. However, they generally did not have systems in place to assess whether students were making progress toward college or career readiness.

The VDOE expressed concern about the lack of emphasis on nonfiction texts and about the sparse opportunities for writing in the English capstone courses as they were implemented during the pilot year. Along with many researchers, practitioners, and policymakers concerned with college readiness, the VDOE believes that students need more opportunities to grapple with complex texts and write in structured ways (a priority in the Common Core State Standards). However, a number of English faculty members around the country have expressed the opinion that literature has great intrinsic value and may be marginalized under paradigms that emphasize college and career readiness (e.g., Pondiscio, 2011). In the process of continuing to develop the capstone courses, high schools will need to seek the right blend of instruction in literature, nonfiction reading, and writing within the 9–12 grade high school English curriculum. They may also want to consider if the English capstone course should place a greater emphasis on writing. A capstone course in college writing would be distinct from other existing senior English courses, offering focused instruction on writing and analysis skills — which are generally considered vital to college success.

## **Implications for Future Research on Capstone Courses**

At the time our study was conducted, Virginia’s capstone course initiative was still in the pilot stage. As the courses mature and are implemented in a range of high schools, rigorous research will be able to assess the initiative’s effects on student outcomes. However, researchers could take measures while the initiative is still developing to make future research more feasible. Particularly, finding a group of school divisions and/or high schools interested in piloting the capstone courses using an agreed-upon, optimal design would have two important advantages. First, these sites would serve as models for the rest of the state, demonstrating what full implementation looks like. Second, a consistent, high-quality model implemented across a number of schools would provide the ideal setting for a rigorous evaluation design that could result in clear evidence on whether student outcomes can be attributed to participation in capstone courses.

In addition, we contend that it would be helpful to conduct further research on capstone course implementation. As the capstone course units become fully developed, it will be important to learn about:

- which units are selected by teachers in embedded unit courses and the reasons they are selected;
- how capstone course and unit assessment is handled;



- whether students report deeper learning, more engagement, and better preparation for college and careers during and after capstone course participation; and
- how school divisions and teachers overcome barriers to capstone course or unit implementation.

## **Concluding Thoughts**

Virginia's CCRI and its capstone course initiative are important undertakings. The state has made an impressive commitment to preparing all students to demonstrate college and career readiness by the time they graduate. In this endeavor, the VDOE has partnered with the State Council of Higher Education for Virginia and the VCCS as well as four highly respected universities. The involvement of these higher education institutions increases the chance that the capstone courses will be able to impart valuable college readiness skills to students. Further, as a result of the VDOE's interest in undertaking research and documentation projects, feedback on the capstone courses can be used to support and scaffold the work of high schools and school divisions engaged in this initiative. With attention given to implementation issues such as those we have highlighted and to other issues as they emerge, this initiative has the potential to mature in positive ways. The resulting mathematics and English capstone courses could provide valuable support to students who intend to go to college but need a boost to enter college well prepared.



# Appendix A: English Performance Expectations

## Virginia's College and Career Ready English Performance Expectations

The **English Performance Expectations** define the content and level of achievement students must reach to be academically prepared for success in entry-level, credit-bearing English courses in college or career training. The expectations were developed through a process that involved faculty from Virginia's two- and four-year colleges and universities, members of the business community, and high school English educators.

### READING

#### VOCABULARY

1. Use structural analysis of roots, affixes, synonyms, antonyms, and cognates to understand complex words.
2. Apply knowledge of word origins, derivations, and figurative language to extend vocabulary development in authentic texts.
3. Demonstrate understanding of word relationships and nuances in word meanings.
4. Discriminate between connotative and denotative meanings and interpret the connotation.
5. Use context, structure, and connotations to determine meanings of words and phrases.
6. Expand general and specialized vocabulary through speaking, reading, and writing.

#### NONFICTION READING

7. Read and analyze a variety of nonfiction texts.
8. Use reading strategies throughout the reading process to monitor comprehension.
9. Identify author's main idea and purpose.
10. Summarize text relating supporting details.
11. Use knowledge of the evolution, diversity, and effects of language to comprehend and elaborate the meaning of texts.
12. Interpret and use data and information in maps, charts, graphs, timelines, tables, and diagrams.

#### LITERARY READING

13. Read, comprehend, and analyze a variety of literary texts including narratives, narrative nonfiction, poetry, and drama.
14. Explain the relationships between and among elements of literature: characters, plot, setting, tone, point of view, and theme.
15. Explain the influence of historical context on the form, style, and point of view of a written work.

#### READING ANALYSIS and CRITICAL READING

16. Analyze two or more texts addressing the same topic to identify authors' purpose and determine how authors reach similar or different conclusions.
17. Draw conclusions and make inferences on explicit and implied information using textual support.
18. Make sense of information gathered from diverse sources by identifying misconceptions, main and supporting ideas, conflicting information, point of view or bias.
19. Evaluate how an author's specific word choices, syntax, tone, and voice shape the intended meaning of the text, achieve specific effects and support the author's purpose.

20. Evaluate sources including advertisements, editorials, blogs, Web sites, and other media for relationships between intent, factual content, and opinion.
21. Critically evaluate the accuracy, quality, and validity of the information.

### WRITING

#### COMPOSING

22. Write clear and varied sentences, clarifying ideas with precise and relevant evidence.
23. Arrange paragraphs into a logical progression.
24. Clarify and defend a position with precise and relevant evidence.
25. Draw evidence from literary or informational texts to support analysis, reflection, and research.
26. Generate, gather, plan, and organize ideas for writing to address a specific audience and purpose.
27. Produce arguments in writing developing a thesis that demonstrates knowledgeable judgments, addresses counterclaims, and provides effective conclusions.
28. Analyze, evaluate, synthesize, and organize information from a variety of sources to produce a research product.
29. Synthesize information to support the thesis and present information in a logical manner.
30. Develop narrative, expository, and persuasive writings for a variety of audiences and purposes.
31. Develop a variety of writing to persuade, interpret, analyze, and evaluate with an emphasis on exposition and analysis.
32. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

#### REVISION and EDITING

33. Write and revise correspondence to a standard acceptable both in the workplace and in postsecondary education.
34. Revise writing for clarity of content, depth of information and technique of presentation.
35. Self- and peer-edit writing for correct grammar, capitalization, punctuation, spelling, sentence structure, and paragraphing.

36. Apply grammatical conventions to edit writing for correct use of language, spelling, punctuation, and capitalization.
37. Use computer technology to plan, draft, revise, edit, and publish writing.

#### DOCUMENTATION and ETHICS

38. Cite sources for both quoted and paraphrased ideas using a standard method of documentation, such as that of the Modern Language Association (MLA) or the American Psychological Association (APA).
39. Define the meaning and consequences of plagiarism and follow ethical and legal guidelines for gathering and using information.

### COMMUNICATING

#### SPEAKING

40. Use grammatically correct language, including vocabulary appropriate to the topic, audience, and purpose.
41. Use details, illustrations, statistics, comparisons, and analogies to support the presentation.
42. Present evidence clearly and convincingly.
43. Use media, visual literacy, and technology skills to create and support the presentation.

#### LISTENING

44. Use a variety of listening strategies to analyze relationships among purpose, audience, and content of presentations.
45. Monitor listening and use a variety of active listening strategies to make evaluations.
46. Analyze, produce, and examine similarities and differences between visual and verbal media messages.
47. Determine the author's purpose and intended effect on the audience for media messages.
48. Analyze and interpret others' presentations.

#### COLLABORATING

49. Participate in, collaborate in, and report on small-group learning activities.
50. Collaborate with others to exchange ideas, develop new understandings, make decisions, and solve problems.
51. Demonstrate the ability to work effectively with diverse teams to accomplish a common goal.



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# Appendix B: Mathematics Performance Expectations

## Virginia's College and Career Ready Mathematics Performance Expectations

The **Mathematics Performance Expectations** (MPE) define the content and level of achievement students must reach to be academically prepared for success in entry-level, credit-bearing mathematics courses in college or career training. They were developed through a process that involved faculty from Virginia's two- and four-year colleges and universities, members of the business community, and high school mathematics educators. The MPE are organized into four interacting and overlapping strands that include content in the areas of algebra and functions, statistics, geometry, mathematical analysis, and trigonometry. This particular strand structure is one of several ways the performance expectations can be organized. The structure is not intended to be a curriculum organizer, as each expectation interacts with many others in a range of problem-solving, modeling, and decision-making situations.

### PROBLEM SOLVING, DECISION MAKING, AND INTEGRATION

Students will apply algebraic, geometric, and statistical concepts and the relationships among them to solve problems, model relations, and make decisions using data and situations within and outside of mathematics. In accomplishing this goal, students will develop and enhance a repertoire of skills and strategies for solving a variety of problem types.

- 1) Solve practical problems involving rational numbers (including numbers in scientific notation), percents, ratios, and proportions.
- 2) Collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.
- 3) Use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include
  - a) investigating and using formulas for finding distance, midpoint, and slope;
  - b) applying slope to verify and determine whether lines are parallel or perpendicular;
  - c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and
  - d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.
- 4) Verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.
- 5) Solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.
- 6) Use formulas for surface area and volume of three-dimensional objects to solve real-world problems.
- 7) Use similar geometric objects in two- or three-dimensions to
  - a) compare ratios between side lengths, perimeters, areas, and volumes;
  - b) determine how changes in one or more dimensions of an object affect area and/or volume of the object;
  - c) determine how changes in area and/or volume of an object affect one or more dimensions of the object; and
  - d) solve real-world problems about similar geometric objects.
- 8) Compare distributions of two or more univariate data sets, analyzing center and spread (within group and between group variations), clusters and gaps, shapes, outliers, or other unusual features.
- 9) Design and conduct an experiment/survey. Key concepts include
  - a) sample size;
  - b) sampling technique;
  - c) controlling sources of bias and experimental error;
  - d) data collection; and
  - e) data analysis and reporting.
- 10) Investigate and apply the properties of arithmetic and geometric sequences and series to solve real-world problems, including writing the first  $n$  terms, finding the  $n^{\text{th}}$  term, and evaluating summation formulas. Notation will include  $\Sigma$  and  $a_n$ .
- 11) Use angles, arcs, chords, tangents, and secants to
  - a) investigate, verify, and apply properties of circles;
  - b) solve real-world problems involving properties of circles; and
  - c) find arc lengths and areas of sectors in circles.
- 12) Transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, tables, and words. Select and use appropriate representations for analysis, interpretation, and prediction.
- 13) Investigate and describe the relationships among solutions of an equation, zeros of a function, x-intercepts of a graph, and factors of a polynomial expression.
- 14) Recognize the general shape of function (absolute value, square root, cube root, rational, polynomial, exponential, and logarithmic) families and convert between graphic and symbolic forms of functions. Use a transformational approach to graphing. Use graphing calculators as a tool to investigate the shapes and behaviors of these functions.
- 15) Use knowledge of transformations to write an equation, given the graph of a function (linear, quadratic, exponential, and logarithmic).
- 16) Investigate and analyze functions (linear, quadratic, exponential, and logarithmic families) algebraically and graphically. Key concepts include
  - a) continuity;
  - b) local and absolute maxima and minima;
  - c) domain and range, including limited and discontinuous domains and ranges;
  - d) zeros;
  - e) x- and y-intercepts;
  - f) intervals in which a function is increasing or decreasing;
  - g) asymptotes;
  - h) end behavior;
  - i) inverse of a function;
  - j) composition of multiple functions;
  - k) finding the values of a function for elements in its domain; and

### UNDERSTANDING AND APPLYING FUNCTIONS

Students will be able to recognize, use, and interpret various functions and their representations, including verbal descriptions, tables, equations, and graphs to make predictions and analyze relationships in solving complex, real-world mathematical problems.



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- l) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.
- 17) Determine optimal values in problem situations by identifying constraints and using linear programming techniques.

## PROCEDURE AND CALCULATION

Students will be able to perform and justify steps in mathematical procedures and calculations and graph and solve a range of equations types. Students will reason from a variety of representations such as graphs, tables, and charts and will use displays of univariate data to identify and interpret patterns. Students will be able to calculate probabilities and analyze distributions of data to make decisions.

- 18) Given rational, radical, or polynomial expressions,
- a) add, subtract, multiply, divide, and simplify rational algebraic expressions;
  - b) add, subtract, multiply, divide, and simplify radical expressions containing rational numbers and variables, and expressions containing rational exponents;
  - c) write radical expressions as expressions containing rational exponents and vice versa; and
  - d) factor polynomials completely.
- 19) Graph linear equations and linear inequalities in two variables, including
- a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line; describing slope as rate of change and determine if it is positive, negative, zero, or undefined; and
  - b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.
- 20) Given a point other than the origin on the terminal side of an angle, use the definitions of the six trigonometric functions to find the sine, cosine, tangent, cotangent, secant, and cosecant of the angle in standard position. Relate trigonometric functions defined on the unit circle to trigonometric functions defined in right triangles.
- 21) Given the coordinates of the center of a circle and a point on the circle, write the equation of the circle.
- 22) Analyze graphical displays of univariate data, including dotplots, stemplots, and histograms, to identify and describe patterns and departures from patterns, using central tendency, spread, clusters, gaps, and outliers. Use appropriate technology to create graphical displays.
- 23) Analyze the normal distribution. Key concepts include
- a) characteristics of normally distributed data;
  - b) percentiles;
  - c) normalizing data, using z-scores; and
  - d) area under the standard normal curve and probability.
- 24) Describe orally and in writing the relationships between the subsets of the real number system.
- 25) Perform operations on complex numbers, express the results in simplest form using patterns of the powers of  $i$ , and identify field properties that are valid for the complex numbers.
- 26) Solve, algebraically and graphically,
- a) absolute value equations and inequalities;
  - b) quadratic equations over the set of complex numbers;
  - c) equations containing rational algebraic expressions; and
  - d) equations containing radical expressions. Use graphing calculators for solving and for confirming the algebraic solutions.
- 27) Given one of the six trigonometric functions in standard form,
- a) state the domain and the range of the function;
  - b) determine the amplitude, period, phase shift, vertical shift, and asymptotes;
  - c) sketch the graph of the function by using transformations for at least a two-period interval; and
  - d) investigate the effect of changing the parameters in a trigonometric function on the graph of the function.
- 28) Find, without the aid of a calculator, the values of the trigonometric functions of the special angles and their related angles as found in the unit circle. This includes converting angle measures from radians to degrees and vice versa.
- 29) Investigate and identify the characteristics of conic section equations in  $(h, k)$  and standard forms. Use transformations in the coordinate plane to graph conic sections.
- 30) Using two-way tables, analyze categorical data to describe patterns and departure from patterns and to find marginal frequency and relative frequencies, including conditional frequencies.
- 31) Calculate probabilities. Key concepts include
- a) conditional probability;
  - b) dependent and independent events;
  - c) addition and multiplication rules;
  - d) counting techniques (permutations and combinations); and
  - e) Law of Large Numbers.
- 32) Use the relationships between angles formed by two lines cut by a transversal to
- a) determine whether two lines are parallel;
  - b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and
  - c) solve real-world problems involving angles formed when parallel lines are cut by a transversal.
- 33) Given information in the form of a figure or statement, prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.
- 34) Given information in the form of a figure or statement, prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs.
- 35) Construct and justify the constructions of
- a) a line segment congruent to a given line segment;
  - b) the perpendicular bisector of a line segment;
  - c) a perpendicular to a given line from a point not on the line;
  - d) a perpendicular to a given line at a given point on the line;
  - e) the bisector of a given angle,
  - f) an angle congruent to a given angle; and
  - g) a line parallel to a given line through a point not on the given line.
- 36) Verify basic trigonometric identities and make substitutions, using the basic identities.

## VERIFICATION AND PROOF

Students will recognize verification and proof as fundamental aspects of mathematical reasoning. Students will integrate and apply inductive and deductive reasoning skills to make, test, and evaluate mathematical statements. This applies equally through simple mathematical calculations, in geometric applications, and more abstract statistical and algebraic processes. Students will use logical reasoning to analyze an argument and to determine whether conclusions are valid.



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