

High School Capstone Courses:
A Review of the Literature

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Background

High school “capstone courses” are a relatively recent trend in education reform, appearing in some school reform programs in the late 1990s. Derived from the term *capstone*, defined as a “high point” or “crowning achievement,”¹ these courses were intended to be just that—a culminating project for high school seniors. While high school capstone courses do not appear to have been widely implemented over the last 20 years, the notion of unique, senior year courses has recently re-emerged as part of a national focus on college- and career-readiness. In the past, college preparation and career-track programs were viewed as separate paths students might take depending on their academic abilities. Current thinking is that students need the same kinds of knowledge and skills to succeed in higher education and the workforce (Alliance for Excellent Education, 2008). The American Diploma Project (ADP)—an initiative of Achieve²—asserts that “...regardless of whether students go on to college or into the workforce after graduation, they still need the same knowledge and skills, particularly in English and mathematics.”³ Capstone courses, then—broadly defined—are designed to prepare students for college and the workforce.

While high school capstone courses have been around in some form for the past 20 years, a web-based search for research on high school capstone courses produced numerous references to capstone courses in higher education, but virtually no research on high school capstone courses. Similarly, in 2009, the Northeast & Islands Regional Educational Laboratory attempted to conduct a research review on capstone courses for the state of Connecticut, and reported that minimal information and no research on the effects of capstone courses could be located. Consequently, this report (Kannapel, 2012) drew on four sources: (1) descriptions of and research on capstone courses in higher education; (2) descriptions of senior year courses on state education department websites; (3) phone conversations with state department of education officials in states offering senior year courses; and, (4) phone conversations with staff at Achieve.

Available information suggests that senior year, capstone-like courses have developed along three trajectories in the past several years. One trajectory has been the development of senior capstone projects that mirror similar projects in higher education, in which seniors develop a culminating, thesis-like project that applies the knowledge gained throughout their schooling to a topic of interest to the student. A second trajectory has been the development of senior year “transition” courses that prepare students to succeed in entry-level college courses. These transition courses are focused on specific subjects and tend to be classroom-based. The third trajectory concerns the identification or development of fourth-year mathematics capstone courses as the pressure mounts for high school students to take four years of mathematics in order to meet college-ready benchmarks.

¹ See <http://www.merriam-webster.com/dictionary/capstone>

² Achieve is a Washington, D.C.-based, independent, bipartisan, non-profit education reform organized created by governors and corporate leaders in 1996 to support college and career readiness initiatives. For more information go to: <http://www.achieve.org/>

³ See website of the American Diploma Project: <http://www.achieve.org/GradRequirements>

The literature review that follows begins with a brief history of capstone courses, then discusses the three types of capstone experiences referenced above: capstone-like projects, transition courses, fourth-year mathematics capstone courses. Examples of efforts to develop each type of capstone experience are also provided.

A Brief History of Capstone Courses

Higher Education

The notion of capstone courses appears to have originated in higher education—particularly within the fields of science, technology, engineering, and mathematics (STEM). The impetus behind this development was the need to prepare students to tackle complex problems they would encounter in their careers. Within the field of engineering, for instance, a post-World War II emphasis on helping engineering students understand complex principles behind modern technological developments led toward an increasingly theoretical approach to engineering programs. Over time, complaints began to emerge from employers that graduates of engineering schools were ill prepared to work in industry. In response, the Accreditation Board for Engineering and Technology began to push for a practical focus to engineering programs, including capstone design courses for college seniors that emphasized solving real-world, open-ended engineering problems (Dutson et al., 1997; Todd et al., 1995).

Similarly, undergraduate computer science programs began to emphasize senior-level design courses or capstone research projects that would provide students with hands-on experience solving significant, real-world problems or exploring contemporary research issues (Tucker et al., 1996). In a comparable manner, the Conference Board of the Mathematical Sciences recommended in 2001 that mathematics departments support the development of a capstone course sequence for pre-service high school mathematics teachers in which “conceptual difficulties, fundamental ideas, and techniques of high school mathematics are examined from an advanced standpoint” (Hill & Senk, 2004, p. 8).

According to Fanter (n.d.), the use of capstone courses in higher education has expanded beyond STEM fields, and is now often required by universities before students graduate. In some cases, capstone courses are meant to prepare students for future coursework. In other cases, the capstone course is a culmination of the college experience, meant to provide students with an opportunity to integrate what they have learned by pursuing an in-depth project as the focus of a one- or two-semester course intended to ensure that the learning objectives of the program have been met (Fanter, n.d.).

High School Capstone Courses

The notion of high school capstone courses appears to have emerged in the late 1990s, modeled on the higher education capstone experience. An early example appeared in the National Center on Education and the Economy’s (NCEE) America’s Choice School Design, a K-12 whole school reform model. The America’s Choice model operationalized a vision of high school reform described by NCEE founders Marc Tucker and Judy Codding (1998) in which high school students

would complete “lower division” basic course requirements in the first two years of high school; then begin an “upper division” program that might include college-level or dual-credit courses, culminating in a capstone project featuring research and student presentations (Regional Educational Laboratory Northeast & Islands, 2009).

Since the 1990s, another NCEE initiative –the New Commission on Skills of the American Workforce – brought together business, government, civil rights, and education leaders to develop a framework designed to ensure that students acquired the skills needed to succeed in the global economy. These skills included making connections across disciplines, applying knowledge to real-life problems, increasing higher-order thinking and analytical abilities, building intercultural competencies, and organizing and utilizing information (New Commission on the Skills of the American Workforce, 2006). Helping students acquire these sorts of skills requires engaging them actively in learning tasks that are meaningful, interesting, and based on real-life problems (Furco, 2007). The call for designing such learning tasks has provided a rationale for offering a capstone-like experience at the high school level (Tennessee Department of Education, 2008).

The culminating capstone experience continues to be developed in states across the country. At the same time, a different type of senior-year experience has emerged in the last five years as states prepare for the increased rigor of the Common Core standards and pressures to ensure that all students are college and career ready. One of these new models is the senior year transition or “bridge” course intended to prepare students who have not yet met college-ready benchmarks to succeed in entry level English and mathematics courses. Also emerging are attempts to identify or develop fourth-year mathematics capstone courses for students who have met college-ready benchmarks in mathematics by the end of their junior year but may want alternatives to calculus. Each of the three approaches to senior year courses is detailed below.

Capstone Project as Culminating Experience

Capstone courses designed as culminating experiences typically occur during the senior year—although some guidelines suggest that students begin planning these courses and/or projects during their junior year. The literature on higher education courses, as well as guidelines for high school capstone courses found on state department of education websites, suggests that capstone courses should have the following characteristics (see Dutson et al, 1997; Fanter, n.d.; Todd et al, 1995; and state websites shown in the footnote)

- engages students as active participants in the learning process;
- centers on students rather than teachers;
- promotes the development of higher-order thinking and problem-solving;
- emphasizes making connections across disciplines;
- bridges theory with practice;
- may be completed in student teams;
- involves teachers as advisors and community members as mentors; and,
- involves a final presentation before a panel that evaluates the project.

States or districts that offer capstone experiences having these characteristics often suggest particular formats that the capstone project might take, including

- portfolio of best work;
- curriculum-based, research project;
- set of experiments organized around a central problem;
- community service project or service learning activity;
- internship in a local business or organization;
- designing a product, service or system; or,
- planning and organizing an event or activity.⁴

Examples of Culminating Capstone Experiences

Connecticut's Capstone Experience. Connecticut's high school reform plan, proposed in 2009 and in various stages of piloting through 2014, includes a capstone experience, with the exact requirements to be determined locally. The capstone experience will be required of all students effective with the class of 2020 (S. Shuler, Connecticut State Department of Education, personal communication, February 27, 2012). The capstone experience is defined as

- a culminating activity completed in senior year;
- project focused on student's personal interest, career path, or academic pursuit; or
- synthesizes classroom study and real world perspective (SERC, n.d.).

The essential skills and dispositions to be demonstrated by the Connecticut capstone experience are critical thinking and creativity, flexibility and initiative, analysis and research, communicating ideas through multiple modalities, and using technology effectively. Students will be required to develop an action plan, conduct research, work with an advisor/mentor, present or exhibit their work using multiple modalities, and reflect/self-evaluate (SERC, n.d.). Students have several choices for completing the capstone experience, including developing a portfolio of best work, completing a set of experiments organized around one or more scientific problems, doing community service, or working as an intern in a local business. Capstone projects must include research as well as written and presentation components, with advisors or mentors helping each student complete the capstone experience successfully (Connecticut State Department of Education, n.d.).⁵

Kentucky's Performance-Based Credits. In Kentucky, high school graduation credit may be awarded in either of two ways: Carnegie units (defined as at least 120 hours of instructional time in one subject) OR *performance-based credits*, defined at the local level. Performance-based credits are earned by a student outside of the traditional structure of a 120-hour instructional

⁴ See for example: Connecticut State Department of Education, n.d.; Rhode Island Skills Commission, 2005a, 2005b; Tennessee Department of Education, 2008.

⁵ Additional information about Connecticut's capstone experience, featuring videos from three participating high schools, can be found at: http://ssr.ctserc.com/capstone/?page_id=2

course. In order to award such credits, districts must establish a policy for a performance-based system that meets specified requirements. Performance-based credits may be awarded for several types of standards-based courses, including portfolios, senior year or capstone projects, online or other technology-mediated courses, dual credit or other equivalency courses, or internships/cooperative learning experiences in the school or community.⁶ A Kentucky Department of Education official reported that most districts use the performance-based credit option in some manner, and that the Department encourages its use to allow for more creativity and flexibility in schools (A. Patterson, Kentucky Department of Education, e-mail communication, February 28, 2012).

North Carolina’s Graduation Project. North Carolina does not require a capstone experience for high school students, but provides guidance for local districts that wish to pursue a “graduation project” requirement. The North Carolina Graduation Project is described on the state website as “a multi-faceted, multi-disciplinary performance assessment completed over time.” Specific features of the project are that it

- provides students the opportunity to connect content knowledge, acquired skills, and work habits to real world situations and issues;
- engages students in various specific skills that include: computer knowledge, employability skills, information-retrieval skills, language skills, writing, teamwork, and thinking/problem-solving skills;
- consists of four components: a research paper, product, portfolio, and an oral presentation that culminates in a student's final year of high school; and,
- demonstrates the integration of knowledge, skills, and performance.⁷

Rhode Island’s applied learning requirement. The Rhode Island High School Diploma System, adopted in 2005, has an applied learning component that requires students to apply their learning to their own interests and passions. Each district may use two of three strategies to assess applied learning: portfolio, exhibition, or comprehensive assessments. Each of these is “capstone-like” in some respects. The *graduation portfolio* is a subset of collected student work that demonstrates proficiency in meeting state and local requirements. It must contain a sufficient number and type of entries to demonstrate proficiencies in the areas required by the district/school, formative student reflections, evaluation of each entry, and an oral presentation in a final review process. The *exhibition* requires a self-selected student topic, involvement with supportive adults, written proposal, reflective narrative writing, oral presentation, appropriate technology, content, applied learning, and research. *Comprehensive course assessments* are developed by districts or schools to reflect a curriculum aligned with state standards; at least 50 percent of the assessment must be performance-based to allow students to demonstrate their

⁶ See Kentucky Department of Education website:
<http://www.education.ky.gov/kde/instructional+resources/secondary+and+virtual+learning/credit+based+transitions/performance-based+credit.htm>

⁷ See North Carolina Department of Public Instruction website:
<http://www.dpi.state.nc.us/graduationproject/overview/>

ability to apply the knowledge and skills learned in the content area (Rhode Island Department of Education, 2005; S. Lee, Rhode Island Department of Education, email communication, February 29, 2012)⁸.

Tennessee’s Capstone Project. Beginning with students who enrolled in high school in 2009, a capstone project is recommended (but not required) for seniors in which they demonstrate their ability to apply what they learned during 12 years of study and explore their readiness for college and the workplace. Requirements for the capstone project are to be determined locally, but projects may include (but are not limited to) the following categories: senior project, virtual enterprise, internship, externship, work-based learning, service learning, or community service. Schools must formulate individual approaches to the capstone project based on district and on-site requirements. The capstone project must have five core components: (1) an approved proposal containing the research question; (2) documented research and contact hours with a mentor; (3) a short written paper; (4) an oral presentation that demonstrates the research and knowledge learned; and (5) a review panel that evaluates the project. Students are expected to spend at least 15-40 hours of work on their capstone project (Tennessee Department of Education, 2008, 2010).

Senior-Year Transitional Courses

The emergence of the senior-year transition experience has gained momentum through national, regional, and state college and career readiness initiatives, many of them supported by the Bill & Melinda Gates Foundation—such as the ADP, a college and career readiness initiative launched by Achieve in 2005; and the Southern Regional Education Board’s (SREB) *Strengthening Statewide College/Career Readiness Initiative*. The ADP network, which received Gates funding beginning in 2008, currently includes 35 states,⁹ and involves “governors, state education officials, post-secondary leaders, and business executives working together to improve post-secondary preparation by aligning high school standards, graduation requirements, and assessment and accountability systems with the demands of college and careers” (Achieve, 2011, p. 1). SREB, also with funding from the Gates Foundation, began in 2008 to work with six states on its multi-year college and career ready initiative. A key component of this initiative is the development of senior year transition courses (Barger, Murray, & Smith, 2011). Currently, several states (many of them part of the ADP network and/or SREB initiative) are developing or have developed capstone or senior-year transition courses.

Transitional courses are a kind of capstone experience focused on college preparation. Like the “culminating” capstone experience, the transitional course has the over-arching goal of

⁸ See also the website for the Rhode Island Diploma System:

<http://www.ride.ri.gov/HighSchoolReform/DSLAT/>

⁹ The 35 states in the ADP Network are Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Nebraska, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Virginia, Washington and Wisconsin.

preparing students to transition out of high school into the next phase of their education. Transitional courses, however, are typically focused on a particular content area—usually English language arts and/or mathematics. Transitional courses are more likely to occur in a traditional classroom setting led by a classroom teacher than are the capstone or senior projects.

A review of senior-year transitional courses by SREB indicates that the purpose of such courses is to prepare students to succeed in their first credit-bearing English and mathematics college courses (Barger, Murray, & Smith, 2011). Transitional courses are not intended to remediate but to teach high-level content and skills through real-life application and problem-solving activities that connect with student interests and that may involve student research or projects. Several states and jurisdictions—many of them part of the ADP Network—have implemented or plan to implement capstone experiences or transitional courses. A brief overview of some of these programs is provided below.

Kentucky’s Senior-Year Transitional Courses. In response to legislation enacted in 2009, Kentucky has developed a College and Career Readiness Delivery Plan that requires districts to offer intervention programs for high school seniors who fall below ACT benchmarks. The Kentucky Department of Education has developed senior-year transitional courses in English language arts and mathematics that districts and schools may use for this purpose—although they may use another form of intervention. The transitional courses are available for download on the Kentucky Department of Education website, with webinars and/or PowerPoint presentations available to train educators on use of the courses. Districts and schools may offer the transitional courses as full-semester courses for credit or as before- or after-school intervention programs, selecting modules based on student needs. Transitional courses in science and social studies will be developed after standards are updated in these subject areas (Kentucky Department of Education, 2011; Kentucky Department of Education and Kentucky Council on Postsecondary Education, 2010; A. Patterson, Kentucky Department of Education, email communication, February 28, 2012).¹⁰

Tennessee’s Bridge Math Course. Tennessee’s High School Transition Policy calls for the development of a “Bridge Math” course that would be required for students who have not scored 19 or higher on the ACT by the beginning of their senior year. The intent is that successful completion of this course will ensure that students are ready for college-level math without the need for a college-level developmental course (Tennessee Department of Education, 2010).

Virginia’s Capstone Courses. Virginia began developing senior year capstone courses through participation in the SREB’s *College and Career Readiness Initiative*. The English Language Arts and mathematics capstone courses are targeted toward students who have completed the necessary coursework and passed English III and either Algebra II or Algebra Functions and Data Analysis assessments, but not at a level sufficient to ensure success in credit-bearing college courses. The courses are designed to help students master the state’s College and Career Ready

¹⁰ Information also taken from the Kentucky Department of Education website: <http://www.education.ky.gov/KDE/Instructional+Resources/Secondary+and+Virtual+Learning/Transitional+Courses.htm>

Performance Expectations, which are aligned to skills necessary for success in entry-level, credit-bearing college courses or career training. The intent of the capstone courses is to design highly engaging tasks rather than remediate basic skills in isolation. Schools are piloting the courses in 2011-2012; the Virginia Department of Education is working with the University of Virginia to study the pilot and use lessons learned to inform full implementation of the courses in fall 2012 (Barger, Murray, & Smith, 2011; Virginia Department of Education, 2011a, 2011).

West Virginia’s College Transition Mathematics Course. West Virginia’s graduation requirements, which took effect for students entering grade 9 in 2008-2009, and thereafter, specifies that students must take four credits of mathematics in high school. Students who do not achieve the state assessment college readiness benchmark for mathematics are required to take a college transition mathematics course during their senior year (West Virginia Department of Education, n.d.).

Fourth-Year Mathematics Capstone Courses

The identification and development of fourth-year mathematics capstone courses has occurred in response to national pressures to require all students to complete four years of high school mathematics in order to ensure that they are college and career ready. Achieve developed ADP benchmarks in mathematics that illustrate the intellectual requirements that students will face in the workplace or in first-year, credit-bearing college mathematics courses. Achieve advises that high school course requirements should include four years of rigorous mathematics courses that include the content found in Algebra I, Geometry and Algebra II or their equivalents, as well as data analysis and statistics. Currently, at least 21 states have raised graduation requirements to include four years of rigorous mathematics.¹¹

As more states require four years of high school mathematics for all students, a need has developed to offer fourth-year course options besides calculus, which has traditionally been the fourth-year mathematics course for the highest achieving students. The Charles A. Dana Center at the University of Texas at Austin notes that excellent advanced fourth-year mathematics courses already exist for students interested in postsecondary training or careers in STEM fields, such as ACT’s pre-calculus course, Advanced Placement Calculus, and International Baccalaureate’s Higher Level Mathematics. However, an alternative “capstone” experience is needed for students who, in the past, might not have taken a fourth-year mathematics course. These students “...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 precalculus or calculus course” (Charles A. Dana Center, 2008, p. 1).

The Charles A. Dana Center, working with the ADP, has developed criteria for evaluating the quality of fourth-year mathematics capstone courses (K. Blosveren, Achieve, personal

¹¹ The states are Alabama, Arizona, Arkansas, Delaware, the District of Columbia, Florida, Georgia, Indiana, Kentucky, Michigan, Minnesota, Mississippi, New Mexico, Nebraska, North Carolina, Ohio, Oklahoma, South Dakota, Tennessee, Texas, and Utah. See <http://www.achieve.org/raise-high-school-graduation-requirements>

communication, April 5, 2012). The Dana Center identifies a number of existing courses that meet these criteria, including courses from the International Baccalaureate (IB) program and the College Board's Advanced Placement (AP) program that are problem-focused in orientation; for instance, IB's *Mathematical Studies Standard Level*, and the College Board's *Advanced Placement Computer Science A* and *Statistics* courses. Other examples include courses developed by various states, including North Carolina's *Advanced Functions and Modeling*, Virginia's *Discrete Mathematics*, and Ohio's *Modeling and Quantitative Reasoning* (Charles A. Dana Center, 2008).

Conclusion

This literature review on high school capstone courses found that, while the idea of such courses has been around since the 1990s, such courses have not been widely implemented and virtually no research exists on their effectiveness. Nevertheless, several high schools around the country have implemented senior culminating projects in which high school seniors, under the direction of an advisor or mentor, undertake an in-depth project on a topic of interest, utilizing the knowledge gained throughout high school, and presenting their work to a panel of judges near the end of the senior year. Descriptions of these experiences can be found on district and school websites.

At the same time, a relatively new concept of capstone courses developed in the last five years, fueled in part by the work of the ADP, which supports state efforts to ensure that all students are college and career ready. Two types of capstone course fall under this umbrella: (1) senior-year transitional courses designed to prepare students who are not quite college-ready to succeed in entry-level college courses, and (2) fourth-year mathematics capstone courses for students who have met college-ready benchmarks by the end of junior year. These types of capstone courses, unlike the culminating project, focus on a specific content area and are likely to be classroom-based.

The three types of capstone experiences described in this review are similar in that they are designed to build on what students have learned in high school while also preparing them for the challenges they will confront beyond high school, whether in college or the workforce. With the current national focus on college and career readiness, it is likely that capstone projects and courses will become increasingly common across the nation. As this occurs, research such as that being conducted in Virginia is strongly needed to document the implementation and impact of these courses.

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