

STEM Senior Capstone Course Essential Standards

Course Description

The *Senior Capstone Course* is meant to be a graduation requirement course for a STEM program by having students apply the skills and knowledge gathered through completion of the STEM program through a series of activities and projects. Students should develop professional and ethical methods of problem solving for the 21st century workplace. These methods should be refined through further enhancement of the research, analysis, teamwork, and project management skills that they have previously attained in the STEM program.

Course Units

Unit 1: Engineering Principles

Description: Students should deepen their understanding of engineering principles through implementation of the eight practices of science and engineering¹. Skills developed should include an understanding of and ability to manipulate the Engineering Design Process, understanding of the importance of efficiency in terms of engineering, and the ability to reverse engineer.

Learning Goals:

- 1.1 Define problems for engineering¹
- 1.2 Develop and use models¹
- 1.3 Plan and carry out investigations¹
- 1.4 Analyze and interpret data¹
- 1.5 Use mathematics and computational thinking¹
- 1.6 Design solutions for engineering problems¹
- 1.7 Engage in argument from evidence¹
- 1.8 Obtain, evaluate, and communicate information¹

Unit Outcomes: By the end of this unit, students should be able to apply engineering strategies to solve real world problems. Evidence of this outcome should be measured as part of the problem solving logic applied when completing projects in Unit 3 and Unit 5.

Unit Timeline: Lessons for this unit will be strategically placed throughout the semester, with 9 instructional periods divided as necessary to complete goals. Engineering principles should be introduced at the beginning of the class and reinforced throughout.

NOTE: timeline is based on 90 instructional periods.

Unit 2: Professional Preparedness

Description: Students should develop skills that make them capable of contributing in the 21st Century workplace. These skills include a thorough knowledge of technology and the

responsibility that comes with its use, the ability to clearly communicate information in a professional manner, and the skills needed to collaborate with others in an expressive manner.

Learning Goals:

- 2.1. Understand technological principles: focus on students' knowledge and understanding of technology and their capacity to think and reason with that knowledge³
- 2.2. Communicating and collaborating: center on students' capabilities to use contemporary technologies to communicate for a variety of purposes and in a variety of ways, working individually or in teams³
- 2.3. Evaluate resources needed to solve a given problem (HS.S1.1)⁴
- 2.4. Use technology and other resources for assigned tasks (HS.TT.1)⁴
- 2.5. Analyze issues and practices of responsible behavior when using resources (HS.SE.1)⁴

Unit Outcomes: By the end of this unit, students should be able to articulate their future goals and the means with which they plan to achieve them. Students should also be able to successfully integrate themselves into a 21st century workplace. Evidence of this outcome can be seen in the form of planned career paths, professional resumes, demonstration of responsibility while using the internet, use of current technology, and any other applicable means.

Unit Timeline: Professional preparedness should be addressed early in the class, with 5 instructional periods divided as necessary to complete goals. All learning goals for professional preparedness should be completed by the half way point of the semester in order to leave sufficient time for the Unit 5 Capstone Project.

NOTE: timeline is based on 90 instructional periods.

Unit 3: Project Management

Description: Students should be able to evaluate a problem, break it down into parts, and provide a solution using engineering methods. This unit is meant to focus on student group work and collaboration with defined roles and set goals. Students should collaborate with classmates to determine the best possible solution to an engineering problem and provide a clear set of steps that lead to a viable solution. The Engineering Grand Challenges set forth by the National Academy of Engineering should be a focus of projects designed for this unit.

Learning Goals:

- 3.1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants (HS-ETS1-1)²
- 3.2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering (HS-ETS1-2)²
- 3.3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as social, cultural, and environmental impacts (HS-ETS1-3)²
- 3.4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem (HS-ETS1-4)²

- 3.5. Develop solutions and achieve goals: refer to students' systematic application of technological knowledge, tools, and skills to address problems and achieve goals presented in societal, design, curriculum, and realistic contexts³
- 3.6. Design project-based products that address global problems (HS.RP.1)⁴

Unit Outcomes: By the end of this unit, students should be able to use engineering principles to solve complex problems while working in a collaborative environment. They should also be able to present their solutions in a manner that is simplistic enough for the public to understand. Students can successfully demonstrate this outcome through numerous completed projects with alternating group members.

Unit Timeline: Project management should be addressed in the beginning half of the semester with 30 instructional periods. These periods should be split between multiple projects (minimum of 4) of varying length, to be determined by the teacher. 1-2 of these instructional periods should be used to continue capstone project work from previous courses in preparation for the second half of the semester. The capstone project should be introduced before the start of this course in order for students to begin the brainstorming process involved with choosing a topic. NOTE: timeline is based on 90 instructional periods.

Unit 4: Career Development and Workplace Exposure

Description: Students should leave this capstone class with skills that prepare them for higher education and/or the workplace. These skills include life planning, the ability to communicate future plans, and the methods required to make major life decisions. Students should also be exposed to higher education settings and the workplace as examples of future possibilities. This exposure can include, but is not limited to, campus tours, career fairs, guest speakers, mentoring possibilities, and professional job touring.

Learning Goals:

- 4.1. Develop understanding of oneself to build and maintain a positive self-concept (PS1)⁵
- 4.2. Develop positive interpersonal skills including respect for diversity (PS2)⁵
- 4.3. Integrate personal growth and change into your career development (PS3)⁵
- 4.4. Balance personal, leisure, community, learner, family, and work roles (PS4)⁵
- 4.5. Attain educational achievement and performance levels needed to reach your personal and career goals (ED1)⁵
- 4.6. Participate in ongoing, lifelong learning experiences to enhance your ability to function effectively in a diverse and changing economy (ED2)⁵
- 4.7. Create and manage a career path that meets your career goals (CM1)⁵
- 4.8. Use a process of decision-making as one component of career development (CM2)⁵
- 4.9. Use accurate, current, and unbiased career information during career planning and management (CM3)⁵
- 4.10. Master academic, occupational, and general employability skills in order to obtain, create, maintain, and/or advance your employment (CM4)⁵

Unit Outcomes: By the end of this unit, students have a thorough understanding of what the 21st century workplace consists of as well as what will be required of them to be a contributing

member of society. This outcome can be measure in students' reflection of the workplace in their projects (Units 3 & 5).

Unit Timeline: Lessons for this unit will be strategically placed throughout the semester, with 8 instructional periods divided as necessary to complete goals. These periods should be spread throughout the semester as is necessary to schedule any necessary speakers and/or field trips. NOTE: timeline is based on 90 instructional periods.

Unit 5: Capstone Project

Description: This unit follows the same learning goals as Unit 3 but is meant to be implemented on a larger scale. Students should work closely with a mentor from a related professional field to create a solution to a large-scale engineering problem. The major portions of this capstone project should include research on the problem, presentation of the findings and solutions to the problem, community involvement in solving or implementing the solution to the problem, and a tangible product that aides in the project's solution. Ideally this project will be started with a paired course the semester before the *Senior Capstone Course* begins, where the problem to be addressed here can be identified and brainstorming a solution can begin.

Learning Goals:

- 5.1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants (HS-ETS1-1)²
- 5.2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering (HS-ETS1-2)²
- 5.3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as social, cultural, and environmental impacts (HS-ETS1-3)²
- 5.4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem (HS-ETS1-4)²
- 5.5. Develop solutions and achieve goals: refer to students' systematic application of technological knowledge, tools, and skills to address problems and achieve goals presented in societal, design, curriculum, and realistic contexts³
- 5.6. Design project-based products that address global problems (HS.RP.1)⁴

Unit Outcomes: By the end of this unit, students should have generated a solution to a large-scale engineering problem through engineering means. They should present this solution to the local community including a product that will aid the community in some way. This outcome can be measured using project rubrics set forth before the capstone project is completed as well as gauging community feedback on the solution provided.

Unit Timeline: The majority of the second half of this course should be spent on the capstone project, with 38 instructional periods devoted to this unit. Any days needed in the first half of the semester beyond the 1-2 devoted to capstone project work in unit 3 should also be taken from these days.

NOTE: timeline is based on 90 instructional periods.

Footnotes

¹ Achieve, Inc. (2014). The Next Generation Science Standards | Next Generation Science Standards. Retrieved July, 2014, from <http://www.nextgenscience.org/next-generation-science-standards>, Appendix F – Science and Engineering Practices in the NGSS. National science and engineering standards used to outline basic tools required for engineering exploration.

² Achieve, Inc. (2014). The Next Generation Science Standards | Next Generation Science Standards. Retrieved July, 2014, from <http://www.nextgenscience.org/next-generation-science-standards>, HS – ETS1 Engineering Design. National engineering standards applied to design projects used to set outline for any projects completed in this course.

³ National Assessment Governing Board. (2014). *2014 Abridged Technology and Engineering Literacy Framework for the 2014 National Assessment of Educational Progress*. Retrieved July, 2014, from <http://www.nagb.org/>. National standards that link engineering solutions and the ability to communicate ideas used to set guidelines for communication.

⁴ NC Department of Public Instruction. (2011). NC Essential Standards. Retrieved from <http://www.ncpublicschools.org/>, Information and Technology Essential Standards Grades 9-12. North Carolina standards on information and technology used to guide technological and ethical decisions.

⁵ National Career Development Association. (2014). NCDA | Guidelines. Retrieved July, 2014, from <http://www.ncda.org/>, National Career Development Guidelines Framework. National standards on career development aimed at high school aged students used to guide professional preparedness.