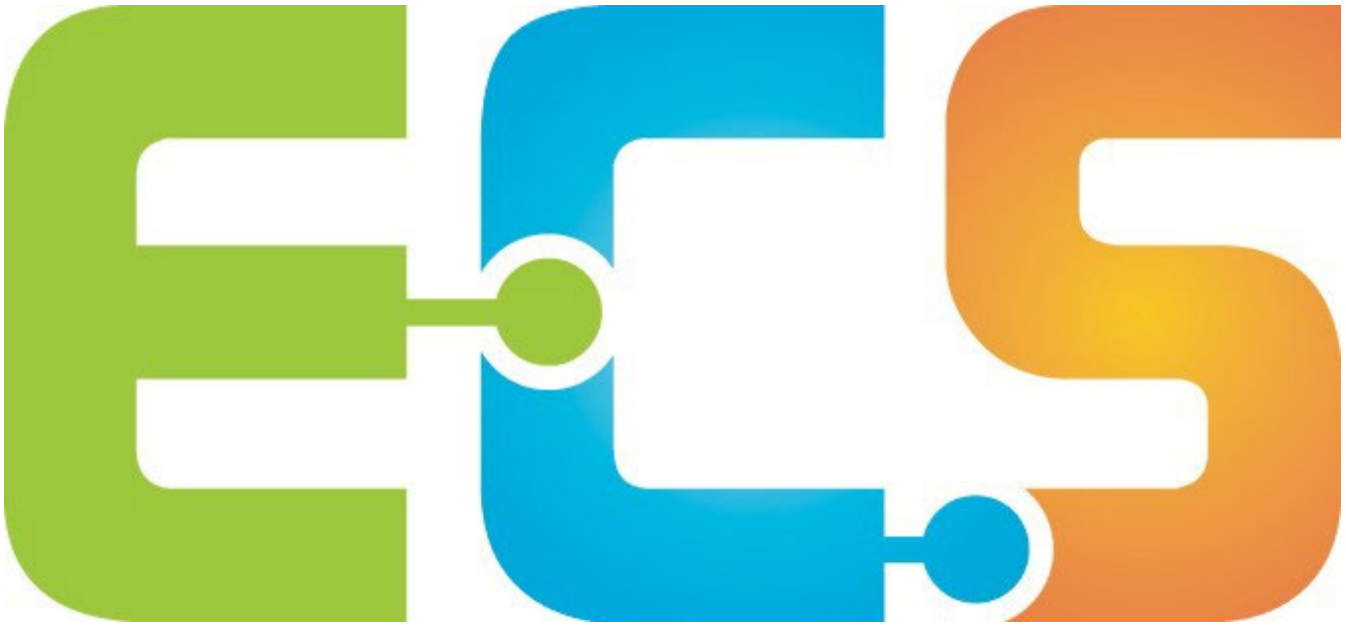
Version 7.0



EXPLORING COMPUTER SCIENCE

Course Overview

Goals

Exploring Computer Science (ECS) is designed to introduce students to the breadth of the field of computer science through an exploration of engaging and accessible topics. Rather than focusing the entire course on learning particular software tools or programming languages, the course is designed to focus on the conceptual ideas of computing and help students understand why certain tools or languages might be utilized to solve particular problems. The goal of *Exploring Computer Science* is to develop in students the computational practices of algorithm development, problem solving and programming within the context of problems that are relevant to the lives of today's students. Students will also be introduced to topics such as interface design, limits of computers, and societal and ethical issues.

Standards

The *Exploring Computer Science* curriculum was developed around a framework of both computer science content and computational practice. This combination of both content and practices provides students with a sense of what computer scientists do.

Hardware

An ideal laboratory environment for this course would include a classroom with tables, chairs, and computers that are conducive to group-work. While it is also ideal to have one computer for each student in the class, the collaborative nature of this class allows for a 2-1 student-computer ratio if fewer computers are available. These computers can be either Macintosh or PC depending on availability. A networked system makes installation of software easier for the teacher.

Software

Each computer in the classroom should have a web browser installed that allows students to perform searches and make use of a variety of websites and Internet tools. The latest version of Scratch 2.0 is available at http://www.scratch.mit.edu.

Unifying Themes and Practices

The individual lessons in this course were developed to reinforce the unifying themes and support the use of the computational practices that we expect students to employ.

The three themes are:

- The creative nature of computing
- Technology as a tool for solving problems
- The relevance of computer science and its impact on society

There are many technological tools that enable people to explore concepts and create exciting and personally relevant artifacts that impact society. In this course, programming is used as one of the tools, but not the only tool. Students are asked to be creative in designing and implementing solutions as they translate ideas into tangible forms. As students actively create, they will also discuss the broader implications of computing technologies.

Throughout the course students will gain experience in employing the following computational practices:

- Analyze the effects of developments in computing (impact/connections)
- Design and implement creative solutions and artifacts
- Apply abstractions and models
- Analyze their computational work and the work of others
- Communicate computational thought processes, procedures, and results to others
- Collaborate with peers on computing activities

As students design and implement solutions using abstractions and models, they will analyze the processes they and their peers use to arrive at solutions, study the effects of their creations and learn how computing concepts connect explicitly and implicitly to other disciplines. Students will learn about the collaborative nature of computer science by working in teams and communicate the results of their work in writing and orally supported by graphs, visualizations and computational analysis.

Topic Descriptions and Objectives

Unit 1: Human Computer Interaction (4 weeks)

Topics to be addressed:

- Computers and the internet
- Models of Intelligent Behavior
- Societal impacts of computing

Topic Description:

In this unit students are introduced to the concepts of computer and computing while investigating the major components of computers and the suitability of these components for particular applications. Students will experiment with internet search techniques, explore a variety of websites and web applications and discuss issues of privacy and security. Fundamental notions of Human Computer Interaction (HCI) and ergonomics are introduced. Students will learn that "intelligent" machine behavior is not "magic" but is based on algorithms applied to useful representations of information, including large data sets. Students will learn the characteristics that make certain tasks easy or difficult for computers, and how these differ from those that humans characteristically find easy or difficult. Students will gain an appreciation for the many ways in which computing-enabled innovations have had an impact on society, as well as for the many different fields in which they are used. Connections among social, economical and cultural contexts will be discussed.

Objectives:

The student will be able to:

- Analyze the characteristics of hardware components to determine the applications for which they can be used.
- Use appropriate tools and methods to execute Internet searches which yield requested data.
- Evaluate the results of web searches and the reliability of information found on the Internet.
- Explain the differences between tasks that can and cannot be accomplished with a computer.
- Analyze the effects of computing on society within economic, social, and cultural contexts.
- Communicate legal and ethical concerns raised by computing innovation.
- Explain the implications of communication as data exchange.

Unit 2: Problem Solving (4 weeks)

Topics to be addressed:

- Algorithms and abstraction
- Connections between Mathematics and Computer Science
- Societal impacts of computing

Topic Description:

This unit provides students with opportunities to become "computational thinkers" by applying a variety of problem-solving techniques as they create solutions to problems that are situated in a variety of contexts. The range of contexts motivates the need for students to think abstractly and apply known algorithms where appropriate, but also create new algorithms. Analysis of various solutions and algorithms will highlight problems that are not easily solved by computer and for which there are no known solutions. This unit also focuses on the connections between mathematics and computer science. Students will be introduced to selected topics in discrete mathematics including Boolean logic, functions, graphs and the binary number system. Students are also introduced to searching and sorting algorithms and graphs.

Objectives:

The student will be able to:

- Name and explain the steps they use in solving a problem.
- Solve a problem by applying appropriate problem-solving techniques.
- Express a solution using standard design tools.
- Determine if a given algorithm successfully solves a stated problem.
- Create algorithms that meet specified objectives.
- Explain the connections between binary numbers and computers.
- Summarize the behavior of an algorithm.
- Compare the tradeoffs between different algorithms for solving the same problem.
- Explain the characteristics of problems that cannot be solved by an algorithm.

Unit 3: Web Design (5 weeks)

Topics to be addressed:

- Web page design and development
- Computers and the internet
- Algorithms and abstraction
- Societal impacts of computing

Topic Description:

This section prepares students to take the role of a developer by expanding their knowledge of algorithms, abstraction, and web page design and applying it to the creation of web pages and documentation for users and equipment. Students will explore issues of social responsibility in web use. They will learn to plan and code their web pages using a variety of techniques and check their sites for usability. Students learn to create user-friendly websites. Students will apply fundamental notions of Human Computer Interaction (HCI) and ergonomics.

Objectives:

The student will be able to:

- Create web pages to address specified objectives.
- Create web pages with a practical, personal, and/or societal purpose.
- Select appropriate techniques when creating web pages.
- Use abstraction to separate style from content in web page design and development.
- Describe the use of a website with appropriate documentation.

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Unit 4: Introduction to Programming (6 weeks)

Topics to be addressed:

- Programming
- Algorithms and abstractions
- Connections between mathematics and computer science
- Societal impacts of computing

Topic Description:

Students are introduced to some basic issues associated with program design and development. Students design algorithms and create programming solutions to a variety of computational problems using an iterative development process in Scratch. Programming problems include mathematical and logical concepts and a variety of programming constructs.

Objectives:

The student will be able to:

- Use appropriate algorithms to solve a problem.
- Design, code, test, and execute a program that corresponds to a set of specifications.
- Select appropriate programming structures.
- Locate and correct errors in a program.
- Explain how a particular program functions.
- Justify the correctness of a program.
- Create programs with practical, personal, and/or societal intent.

Unit 5: Computing and Data Analysis (6 weeks)

Topics to be addressed:

- Data and information
- Algorithms and abstraction
- Connections between mathematics and computer science
- Programming
- Societal impacts of computing

Topic Description:

In this unit students explore how computing has facilitated new methods of managing and interpreting data. Students will use computers to translate, process and visualize data in order to find patterns and test hypotheses. Students will work with a variety of large data sets that illustrate how widespread access to data and information facilitates identification of problems. Students will collect and generate their own data related to local community issues and discuss appropriate methods for data collection and aggregation of data necessary to support making a case or facilitating a discovery.

Objectives:

The student will be able to:

- Describe the features of appropriate data sets for specific problems.
- Apply a variety of analysis techniques to large data sets.
- Use computers to find patterns in data and test hypotheses about data.
- Compare different analysis techniques and discuss the tradeoffs among them.
- Justify conclusions drawn from data analysis.

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Unit 6: Robotics (7 weeks)

Topics to be addressed:

- Robotics
- Algorithms and abstraction
- Connections between mathematics and computer science
- Programming
- Societal impacts of computing

Topic Description:

This unit introduces robotics as an advanced application of computer science that can be used to solve problems in a variety of settings from business to healthcare and how robotics enables innovation by automating processes that may be dangerous or otherwise problematic for humans. Students explore how to integrate hardware and software in order to solve problems. Students will see the effect of software and hardware design on the resulting product. Students will apply previously learned topics to the study of robotics.

Objectives:

The student will be able to:

- Identify the criteria that describe a robot and determine if something is a robot.
- Match the actions of the robot to the corresponding parts of the program.
- Build, code, and test a robot that solves a stated problem.
- Explain ways in which different hardware designs affect the function of a machine.
- Describe the tradeoffs among multiple ways to program a robot to achieve a goal.

The societal impacts of computing should be woven throughout the course.

Topic Description:

Throughout the course, emphasis is placed on how computing enables innovation in a variety of fields and the impacts that those innovations have on society. Computing is situated within economic, social and cultural contexts and, therefore, influences and is influenced by each of these. The proliferation of computers and networks raises a number of ethical issues. Technology has had both positive and negative impacts on human culture. Students will be able to identify ethical behavior and articulate both sides of ethical topics. Students study the responsibilities of software users and software developers with respect to intellectual property rights, software failures, and the piracy of software and other digital media. They are introduced to the concept of open-source software development and explore its implications. Students identify and describe careers in computing and careers that employ computing.

Objectives:

The student will be able to:

- Describe ways in which computing enables innovation.
- Discuss the ways in which innovations enabled by computing affect communication and problem solving.
- Analyze how computing influences and is influenced by the cultures for which they are designed and the cultures in which they are used.
- Analyze how social and economic values influence the design and development of computing innovations.
- Discuss issues of equity, access, and power in the context of computing resources.
- Communicate the legal an ethical concerns raised by computational innovations.
- Discuss privacy and security concerns related to computational innovations.
- Explain positive and negative effects of technological innovations on human culture.