Programming for STEM

Overview

This course expands the practice of software development in a variety of settings, so that students acquire a broad set of programming skills and a deeper understanding of software engineering principles. Students learn to plan, design and implement relatively large programming projects that require background research and team work. Topics include simulations, games and interactive on-line applications. Robust program design and sound software engineering practices are emphasized throughout the course.

Objectives

- Explain the basic structure and organization of a medium-size program.
- Design, implement and debug programs of several hundred to a few thousand lines of code.
- Make reasonable design choices for algorithms and data representation.
- Use a variety of data and control structures to make programs clear and efficient.
- Organize code hierarchically.
- Demonstrate familiarity with the functions in the standard library of one or more languages.
- Properly use documentation and on-line resources to resolve programming questions.
- Work efficiently in a team to build programs collaboratively.
- Demonstrate an understanding of integrity and ethics pertaining to computing professions

Assessment

This course is project-based. Students will need to keep a Journal detailing all the steps of the design and implementation of the projects, as well as reflections on their progress. Weekly progress assessments will be based on the Journal Entries and Work Ethic. Four 9-week projects will also be assessed on outcome, presentation and quality of the development process.

Course Essentials

Equipment	**Cost/Unit**
Classroom set of computers	$0 if you already have some, $500-600 per computer if you need to purchase
Software	All the software used in this course is open source and widely available free of charge, but installation of software in local computers is required.
Prerequisites	Intro to Computational Thinking (LSU Partnership) AND one of the following: Data Manipulation and Analysis or Interactive Computing

Outline:

Unit 1: Review of Programming Basics	Programming languages. Development tools. Program design. Program components (variables, functions, conditions, loops). Project: Multi-scene, multi-character, procedurally-generated animation.
Unit 2: Advanced programming features	Map, reduce, and higher order functions. Abstract data types. Algebraic types. Recursive data structures. Project: Extensions to the Towers of Hanoi algorithm
Unit 3: Grid-based games	Search algorithms, pathfinding, graph traversals. Collision detection. Suggested projects: Snake, Pacman, Tetris, or similar. Alternatively: virtual robot map navigation.
Unit 4: Group-project	Creating requirement proposals. Estimating required work. Planning strategies. Team roles. Testing and debugging strategies. Student chosen project (Evidence that project can be completed in the given time must be provided.)

PROGRAMMING FOR STEM/ENGINEERING

1. Materials

   Internet access, 1-to-1 computer use daily, and access to the LSU servers.

Hardware/Reusable Material	Recommended Unit	Cost/Unit
Arduino Starter Kits (Sunfounder Basic Starter Kit with Arduino Uno Board) https://www.sunfounder.com (Cannot be shared between sections)	1 per student	$50
Consumable Material		
Annual consumable materials to replenish Arduino supplies.	1/Classroom	$150
Software		
Arduino IDE	1 per student	Free on PC; $1/month for Chromebook

2. Required software, networking access, and access to LSU servers
   - Students will need to sign up with online development and testing environments, including but not limited to codesandbox.io, jsfiddle.net, scratch.mit.edu and others.
   - Students will need access to YouTube instructional videos relevant to the course, as well as other educational video repositories.
   - Teachers will need to be able to access the LSU servers using several Internet protocols including but not limited to HTTPS and SSH.
   - Students and teachers will access the curriculum and teaching materials through the LSU servers.
   - Teachers will need to share sample student work with their designated LSU Pathway Point-of-Contact.
   - Principals will need to communicate with the district's information technology department to ensure that there are no technological restrictions that block access to the LSU servers in the lsu.edu, college-readiness.lsu.edu or stempathways.lsu.edu domains on any port. In addition to the sites mentioned above, students will need web access to:

w3schools.com	codepen.io	tonejs.github.io
editor.p5js.org	create.arduino.cc	lunapic.com
elm-lang.org	youtube.com	github.com
freesound.org	p5js.org	stackoverflow.com

3. Required teacher collaborations

   Teachers will communicate with LSU instructors via emails, Google Drive, and/or apps hosted on the LSU servers.

4. Required administration of course content, pre/post test, and research instruments

   All required materials and instruments will be either posted in the LSU servers, Google Drive, or their location announced via email.

5. Course Work

   Teachers must present the course material in sequence or as approved by collaboration with the LSU Pathway Point-of-Contact. Teachers are expected to deliver a minimum of 80% of the course material.

6. Other
   As this is a project-based learning class, we strongly suggest that each section of the course be limited to a *maximum* of 20 students. The course is dependent on the teacher providing feedback and reviewing student code. The course requires that teachers have adequate time to interact with each student.