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Make and learn: A CS Principles course based on the Arduino platform

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Make and Learn: A CS Principles Course Based on the Arduino Platform

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ABSTRACT
We present preliminary experiences in designing a Computer Science Principles undergraduate course for all majors that is based on physical computing with the Arduino microprocessor platform. The course goal is to introduce students to fundamental computing concepts in the context of developing concrete products. This physical computing approach is different from other existing CS Principles courses. Students use the Arduino platform to design tangible interactive systems that are personally and socially relevant to them, while learning computing concepts and reflecting on their experiences. In a previous publication [1], we reported on assessment results of using the Arduino platform in an Introduction to Digital Design course. We have introduced this platform in an introductory computing course at the University of Hartford in the past year as well as in a Systems Fundamentals Discovery Course at the University of New Hampshire to satisfy the general education requirements in the Environment, Technology, and Society category. Our goal is to align the current curriculum with the CS Principles framework to design a course that engages a broader audience through a creative making and contextualized learning experience.

Keywords
Computer Science Principles curriculum framework; physical computing; broadening participation in computing

1. MOTIVATION
Physical computing has become increasingly popular in university classrooms as well as extracurricular computer science education [2]. Studies have shown that the choice of context or problem domain of assignments and examples used in class can have a dramatic impact on student motivation and in turn on the quality of their learning. Furthermore, research has shown that participatory or project-based learning methods can level the playing field for different types of students, especially for female and underrepresented minority students. A shift to a learning environment that values hands-on work, interactivity, and collaboration can result in a broader range of students who feel more engaged and, by extension, can lead to greater success.

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2. COURSE DESCRIPTION/OBJECTIVES
Our proposed introductory computing course is designed to meet the CS Principles curriculum framework and is based on our experiences introducing the Arduino platform in introductory courses. The main goal of CS Principles Courses is to introduce students to computational thinking and foster their creativity in developing computational artifacts. A physical computing curriculum provides the unique opportunity for a broader audience, including those often underrepresented in technologies, to design and implement innovative solutions that are tangible, creative and personally relevant. A variety of contexts and themes have been used in the physical computing curriculum. The Arduino platform provides a flexible and easy-to-learn environment for beginning learners. The proposed course provides an opportunity for students to become engaged with and understand the development of modern computing systems which have become part of our daily lives. In addition, the course provides an opportunity for students to have a hands on experience designing computing-based systems. Students will use microcomputer and microcontroller devices to design systems that they encounter routinely. Upon completion of the course, students should be able to (1) demonstrate knowledge of how the interaction of hardware components and low level software/firmware affects the operation of a modern computing system, (2) discover how an Engineering Design process functions and interacts with many other disciplines to yield new, useful and innovative products, (3) design a simple system that performs a meaningful and useful function using low cost, readily available computing modules and related software, (4) communicate and collaborate with peers of many backgrounds in the creation of computing based systems, and (5) connect computing systems with economic, social, and environmental contexts and with issues of diversity, inclusion, equity, and power.

3. EXPERIENCES
Preliminary results show that students had good experiences in the course. We found that the physical computing approach using the Arduino platform to be effective in teaching students computing concepts as well as engaging students in a creative making and learning process.

4. REFERENCES
[1] Mellodge, P. and Russell, I. Using the Arduino Platform to Enhance Student Learning Experiences In *Proceedings of the 2013 conference on Innovation & technology in computer science education* (ITiCSE'13).

[2] Przybylla, M. Physical Computing in Computer Science Education In *Proceedings of the 10th Annual Conference on International Computing Education Research* (ICER'14).