MakeMe, CodeMe, ConnectUs: Learning digital fluency through tangible Magic Cubes

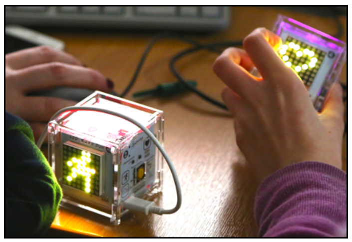

Figure 1: The Magic Cubes toolkit, comprising interactive sensing cubes with Bluetooth Connectivity

Abstract

Recent years have seen an increased empirical interest in designing new approaches to teaching digital fluency to wide audiences. Tangible physical computing interfaces provide much scope for teaching abstract digital fluency concepts in an engaging and playful way. However, questions remain as to how both the form factor and the corresponding task types of such interfaces can be best designed to support learning. In this hands-on workshop, participants will explore how digital fluency topics might be taught through making, discovery learning and coding by interacting with the tangible Magic Cubes toolkit (Figure 1). The workshop will culminate in a discussion of how tangible toolkits for learning can be better designed to encourage collaborative and engaging learning experiences.

Author Keywords

Tangible interfaces for learning; physical computing; Internet of Things

ACM Classification Keywords

H.5.m. Information interfaces and presentation: Miscellaneous

Introduction

Despite increased interest in the design of physical computing toolkits for learning about digital fluency, questions still remain as to how both their form factor and task type contribute to the process of meaningful

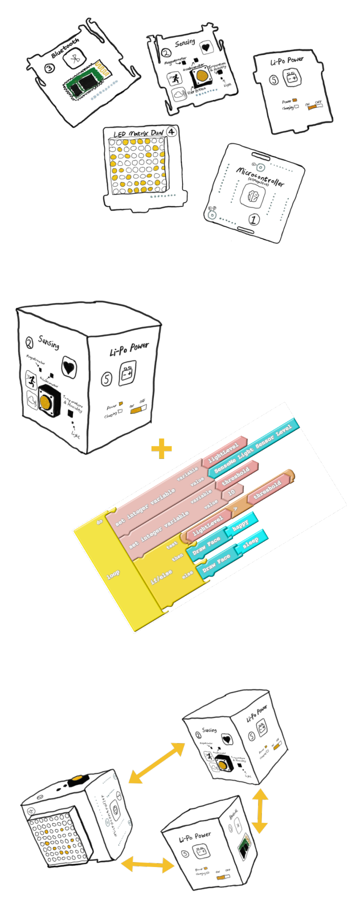

Figure 2: (top) The printed circuit board design of a disassembled Magic Cube; **(middle)** an assembled Magic Cube can be reprogrammed using a drag and drop interface; **(bottom)** multiple Magic Cubes can be wirelessly connected using Bluetooth.

learning. For example, how does the shape and size of the interface influence patterns of engagement and collaboration? What types of learning activities are most suitable for learning computational concepts, as well as critical and creative thinking? Further, how can learning activities be designed to best scaffold learning over time and to provide sustained, engaging experiences? This interactive workshop will explore these questions. Participants will be invited to explore the capabilities of a novel tangible toolkit, the Magic Cubes (Figure 1), through a series of making, discovery and coding activities, as a basis for discussion about these questions.

The Magic Cubes

The Magic Cubes are a part of the UCL CodeMe [2] project, which aims to lower the entry threshold to exploring computing concepts through innovative interfaces and playful learning activities. The Magic Cubes are designed to teach a wide array of digital fluency topics by supporting a variety of learning task types, including making, discovery learning and creative coding.

Each Magic Cube is designed as a flat, printed circuit board sheet comprising five sections, each of which is related to a specific component of a computer: the processor, input, output, connectivity and power (Figure 2, top). The five sections of the printed circuit board are easily assembled into a hand-sized cube that can subsequently be explored through discovery-based activities, as well as coded by the users using a drag and drop programming language for Arduino [1] (Figure 2, middle). Multiple Magic Cubes can also be connected together using the embedded Bluetooth modules in order to create and explore larger sensing systems (Figure 2, bottom). The toolkit is designed to be engaging and playful, and has been shown to encourage collaboration and creativity [3,4].

Workshop Structure

In this workshop, several topics related to digital fluency will be explored through a variety of hands-on activities with the tangible Magic Cubes toolkit. These will relate to: exploring the functionality of hardware, visualizing sensor data, and exploring the privacy implications that come with wireless transmission of personal data. Specifically, during the workshop, participants will have the opportunities to:

- Assemble a Magic Cube from a printed circuit board
- Explore the functionality of personal and environmental sensors through mysterious, discovery-based tasks
- Create simple privacy algorithms to moderate the wireless transmission of personal data between multiple Magic Cubes
- Design and program their own sensor-based data visualizations

The workshop will culminate in a discussion about the design of tangible interfaces for learning. In particular, the discussion will aim to highlight the importance of considering both the task type and the form factor when designing tangible interfaces for learning, as well as explore how theory from the learning sciences can feed into design principles in HCI.

Acknowledgements

The work presented in this workshop has been made possible by an iCASE PhD studentship, in partnership with the BBC and the EPSRC.

References

1. Arduino. 2016. Open-source electronic prototyping platform. Retrieved from https://www.arduino.cc
2. CodeMe. The Magic Cubes Toolkit. Retrieved April 1, 2017 from http://www.codeme.io
3. Johnson, Rose, Venus Shum, Yvonne Rogers, and Nicolai Marquardt. "Make or Shake: An Empirical Study of the Value of Making in Learning about Computing Technology." In *Proceedings of the The 15th International Conference on Interaction Design and Children*, pp. 440-451. ACM, 2016.
4. Lechelt, Zuzanna, Yvonne Rogers, Nicolai Marquardt, and Venus Shum. "ConnectUs: A New Toolkit for Teaching about the Internet of Things." In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, pp. 3711-3714. ACM, 2016.
5. Rogers, Yvonne, Venus Shum, Nic Marquardt, Susan Lechelt, Rose Johnson, Howard Baker, and Matt Davies. "From the BBC micro to micro: bit and beyond: a British innovation." *interactions* 24, no. 2 (2017): 74-77.