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Easy as Pi: Designing a Library Program to Support Computational Thinking in Preteens

By Danielle Wing and Eric Meyers.

Introduction

When a dozen preteens gathered in the computer lab of West Vancouver Memorial Library in May 2014 for a program titled "Easy as Pi," they were not learning how to bake pastry or solve math problems. Over the course of four 90-minute sessions, these young people learned the basics of computational thinking using the Raspberry Pi microcomputer, an inexpensive, credit card-sized circuit board with a tasty name and enormous potential. Since presentations this spring at the BCLA and CLA conferences on our Raspberry Pi program, librarians and educators have been asking us: how did you develop this program? What would we need to start a Raspberry Pi program at our library? In this article, we will discuss the origins of our project, sketch an outline of the program curriculum, provide a few measures of our initial success, and considerations for future programs.

What is the Raspberry Pi?

Born from the realization that children were receiving inadequate computer and technology education in schools, the Raspberry Pi microcomputer was released for sale in the UK in February 2012. Now available in Canada for approximately $45.00, the Pi has captured the imagination of kids and adults, do-it-yourselfers and makers, attracted to its small form factor and user-friendly coding environment. It assembles quickly and easily, and can be expanded using off-the-shelf components found online and at local electronics stores. Scratch and Python, two simple programming environments, the former developed at the Massachusetts Institute of Technology expressly to teach children the basics of computer programming, come pre-installed. Of particular importance to educators, a growing community of coders is sharing programming tips and sample projects online.

The Raspberry Pi serves as an ideal platform to teach young people "computational thinking," the skills and attitudes that software engineers use to design many of the digital tools we use every day. These skills include decomposition -- breaking an object or process into its component parts or steps, and pattern recognition and abstraction -- being able to see how parts or steps in a process recur or co-occur to make meaning. In addition to being easy to program, the Raspberry Pi fits in a transparent case: all the parts of the computer are visible. This helps demystify computing and make the device accessible, both on a physical and an intellectual plane.

The Raspberry Pi and "Informal" Digital Literacies

While the Raspberry Pi was designed to fill a gap in the British education system, it can also serve as an entry point for kids to develop computational thinking in an informal fashion. This is where the public library fits in. Meyers, Erickson and Small (2013) identify libraries, museums and other community spaces as key points for developing digital literacies through informal learning opportunities. This includes not only finding and accessing information using digital tools, but also the capacity to create digital artifacts and share those creations with others. Libraries can enhance digital literacies by providing access to tools, knowledge, and the support of creative peers and adults. Our program was designed to do just that. By running a Raspberry Pi program for middle years children, we hypothesized the public library could encourage and facilitate the development of important skills, and also engage children in a new and exciting way.

Creating new programs for library patrons is essential, but can come with considerable costs, particularly if the program relies on new equipment or specialized knowledge outside the library's existing resources. The "Easy as Pi" program sought to overcome some of the expense and uncertainty associated with piloting a new digital literacy program for youth through a unique partnership with the School of Library, Archival and Information Studies -- The iSchool@UBC. In this partnership, the iSchool purchased and supplied the Raspberry Pi "kits" (the computer, accessories, and

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supplies) for the program, and supported the development of the curriculum through an independent study supervision. The West Vancouver Memorial Library provided advertising and registration, staffing, and a computer lab in which to hold the workshops.

Curriculum Design and Implementation

The initial curriculum was developed before any students had signed-up for the program, so we needed to be prepared for a wide range of participant needs and abilities. The program design incorporated the skills outlined in the Framework for 21st Century Learning developed by the Partnership for 21st Century Skills (P21, 2011). Danielle (first author) compiled a large number of projects and lessons, then structured several activities for each session. She drew from a number of online resources and Raspberry Pi learning communities to select activities that could be combined and accomplished in the limited session duration and within the confines of the lab. We developed activities to be done in pairs to accommodate the limited set of equipment (we could afford six Raspberry Pi "kits") and small lab space. We encouraged participants to collaborate, share, and provide one another with helpful feedback as they worked through the activities together. Thus, our limited resources helped us accomplish the goal of getting kids to engage both with the technology and with each other.

While running our pilot program, we constantly adapted the flow and duration of activities for the learners. Most of the participants had little experience with coding, so we balanced off-computer creative and problem solving activities with on-computer programming, and found creative ways to have children "act out" computational tasks. For example, kids would work together to break a drawing task into a series of easy but precise instructions for an adult "computer" to follow. Then they constructed animations using Scratch, where each movement of the "sprite" or character on screen had to be carefully specified using a set of on-screen building blocks.

Over the course of the four 90-minute sessions, participants were introduced to the computer and its component parts, how to set up and operate the Raspberry Pi, how to code music in Sonic Pi (a simple MIDI program), create animations in Scratch, drawing with code in Python, and were provided with a basic introduction to LED lights and switches. Participants showed a high level of engagement, even though the workshops occurred in the afternoon after a full school day. A ratio of four to one (three adults for 12 participants) was necessary to troubleshoot problems and manage activity flow. Our philosophy of informal learning required that we keep the structure loose and flexible, which the kids and parents responded to with enthusiasm.

Measures of Success

Feedback from the participants, parents and the community at large was overwhelmingly positive. Registration for the May workshop series filled in under an hour, and a second workshop series, with positions determined by lottery, was planned for July to accommodate demand. Youth Services Department Head Shannon Ozirny commented, “The Raspberry Pi program resonated with our community in completely unexpected and unpredictable ways. We had well over 100 kids and parents clamouring to take part, which demonstrated a clear interest and need in our community."

A survey distributed to parents and participating youth after the completion of the workshop also returned positive reactions to the program. In particular, parents all felt that computer programming was an important skill for children to learn, and furthermore that library programs to support digital skills were needed. One parent wrote: "This was a wonderful program, and my son loved attending. We would be happy to attend even if it wasn't free. Wish there were more programs like this available!"

An important outcome of this collaboration between the iSchool and West Vancouver Memorial library has been the testing of joint programming and outreach efforts, seeing digital literacies as something libraries and universities can work toward together. WVML Director of Library Services, Jenny Benedict, remarked, “Our collaboration with the UBC iSchool has been instrumental in developing our understanding of how our public library can support 21st Century learning." The project has also inspired students at the iSchool to begin coding and creating with the Raspberry Pi, and MLIS students recently displayed their efforts at the Vancouver Mini Maker Faire. A future goal is to replicate the "Easy as Pi" program in other library systems with the support of iSchool students, creating a reciprocal teaching-practice relationship.

Considerations for the Future

The Raspberry Pi, and similar low-cost creative technologies, offers enormous promise. Libraries are

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positioned to make a difference in their communities by using these tools to support the development of digital literacies. Such efforts might include workshops for youth, such as ours, community "Pi Jams," where makers and coders assemble to share ideas, or access to "starter kits" as a circulating item. While we consider our pilot to be a success, replication of this program will challenge libraries to consider how best to meet their community's needs. Libraries may wish to pose a number of questions, including: Does teaching children computational thinking fit in with your library's programming goals and objectives? Is there adequate staff, space, and IT support for such a program? Does your curriculum support the needs of diverse patrons?

Our pilot exceeded our expectations, but not without a few challenges along the way. We learned that having spare parts on-hand was essential, and that no matter how many times you tested an activity, be prepared for it to work differently with the kids. A program of this type also demands communication and training beyond those immediately involved; it becomes a whole staff effort.

Conclusions

The focus of this program was to teach children about computational thinking rather than to teach them about using specific coding languages. While developing the ability to think computationally, children are learning about problem solving, reasoning and communication. This leads to improved language skills, and the use of algorithms allows children to use mathematical skills and thinking in a new and exciting environment. Skills outlined in the Framework for 21st Century Learning (P21, 2011) such as Creativity and Innovation, Critical Thinking and Problem Solving, Communication and Collaboration, and Information Media and Technology Skills were all carefully integrated into the "Easy as Pi" program. Beyond developing these essential digital literacy skills, an emphasis was placed on having positive and empowering interactions with technology. When participants left the final session of the program their understanding of computers had changed: they knew that humans were intelligent, but computers only did what they were told to do. Most importantly, they knew that they had the ability and power to participate in the design of their own technology futures.

Resources for Librarians and Educators

Where to Buy Your Pi

You can purchase a Raspberry Pi board or starter kit through these online retailers:

- The Raspberry Pi Foundation (shipping from UK)
- Adafruit Industries (shipping from US)
- CanaKit via Amazon.ca (shipping within Canada)

You can also find Raspberry Pi kits and accessories at select electronics stores. We recommend:

Lee's Electronics
4522 Main St, Vancouver
(604) 875-1993
http://www.leeselectronic.com/

Pi Support Communities (selected)

Raspberry Pi Foundation
http://www.raspberrypi.org/community/

Element 14
http://www.element14.com/community/community/raspberry-pi

Adafruit Learning
https://learn.adafruit.com/category/raspberry-pi

Raspberry Pi on GitHub
https://github.com/raspberrypi

References

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Eric Meyers is an Assistant Professor at the School of Library, Archival and Information Studies -- The iSchool@UBC. Email: eric.meyers@ubc.ca

Danielle Wing is currently an Auxiliary Librarian at the West Vancouver Memorial Library and the North Vancouver District Public Library. She will be starting as Head Librarian at West Point Grey Academy in September 2014.

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