University of Colorado Boulder

Abstract

In this Community Anchor Research Project, the Information Science department at University of Colorado Boulder (CU Boulder) will design and study a family learning program to engage young children (ages 4-7) and their parents in design-based activities for the cultivation of computational literacy. The project will focus on high-need families, with limited social support and resources around computing. The CU Boulder team will collaborate with the Boulder Public Library and the Denver Public Library to facilitate this program. Based on the design and study of this program, the CU Boulder team will develop and disseminate a facilitator guide to share the model with more libraries. This project will use the Connected Learning framework and design-based and ethnographic research approaches to explore: *how can we engage children and their parents in design-based activities for the cultivation of computational literacy?*

This project addresses an urgent need expressed by education experts, policy makers, and industry leaders: to engage people in learning to code. As people learn to code, they engage in computational concepts and practices and develop valuable creative thinking and problem solving abilities. For this proposal, we use the term *computational literacy* to describe the ability to create, express, and invent with technology, an important fluency in today's digital society. Libraries can play leadership roles in their communities by facilitating computational literacy opportunities, especially for groups underrepresented in computing. However, libraries need resources, and professional development to support these activities. Additionally, parents can play valuable roles in engaging and sustaining their children's interest in computing, but like librarians, need support to fulfill these important roles.

Project activities will occur across three years and the project outcomes will be: (1) a model of family engagement with young children to support computational literacy; (2) resources for librarians to facilitate this model into their settings; (3) evidence-based case studies of family participation and library facilitation.

To develop the model of family engagement (Outcome 1), we will engage in a design-based and participatory approach in partnership with Boulder Public Library, Denver Public Library, and their community partners to design a workshop series where families create and learn together with computing. We plan to build on the past success of the Family Creative Learning project, but adapt it for younger children, library facilitation, and brokering new opportunities after the program. We will document the iterative development of this family learning program and plan to refine the model with evaluation measures of interests and confidence as well as feedback from participating families.

To support libraries' facilitation (Outcome 2), we will document the various strategies utilized by our library partners to recruit facilitators, engage high-need families, and coordinate this opportunity in their community. We will document these strategies into a facilitator guide, a project website, and host recorded webinars and in-person professional development at conferences to help libraries adapt this model into their setting. We will collect metrics to capture the reach of these resources and support.

Finally, to develop the evidence-based case studies (Outcome 3), we will use ethnographic methods to develop rich descriptions of families' development of computational literacy and libraries' facilitation of this family learning program in their community. We will use the framework developed by Brennan and Resnick (2012) to assess participants' development of computational literacy. We will share this research in the form of reports and publications at library and learning science conferences and journals.

By engaging in this model of engagement, families will develop increased computational literacy, creating and expressing with coding to cultivate computational thinking. Children and parents will get first-hand experience with creative technologies, while developing roles and practices to create and learn together in the context of computing. Additionally, by facilitating these opportunities, our partner libraries will have increased capacity to engage children and families in computational literacy, while strengthening their relationships with families from their communities, particularly from high-need groups. Through our dissemination of this model, we anticipate more libraries expanding their computational literacy opportunities in their communities, especially for young children and families. Our research plan to study family learning and library facilitation will advance knowledge in broadening participation in computing, family learning with technology, and strategies to support libraries as leaders and facilitators of these opportunities.

Narrative

In this Community Anchor Research Project, the Information Science department at University of Colorado Boulder (CU Boulder) will design and study a family learning program to engage young children (ages 4-7) and their parents in design-based activities for the cultivation of computational literacy. The project will focus on high-need families, with limited social support and resources around computing. The CU Boulder team will collaborate with the Boulder Public Library and the Denver Public Library to facilitate this program. Based on the design and study of this program, the CU Boulder team will develop and disseminate a facilitator guide to share the model with more libraries. This project will use the Connected Learning framework and design-based and ethnographic research approaches to explore: *how can we engage children and their parents in design-based activities for the cultivation of computational literacy?*

1. Statement of National Need

In the past decade, leaders in education, research, industry, and policy have recognized the importance for young people to learn how to code. As people learn to code, they engage in computational concepts and practices and develop problem solving strategies and creative thinking (Wing, 2006). For this proposal, we want to use the term *computational literacy* to describe the ability to create, express, and invent with technology, an important fluency in today's digital society. We want people to develop as computational creators in addition to computational thinkers. As Resnick and Siegel (2015) argue, "coding is not a set of technical skills but a new type of literacy and personal expression, valuable for everyone, much like learning to write." We frame computational literacy along three dimensions (Brennan & Resnick 2012): concepts (e.g., sequences and parallelism), practices (e.g., debugging and remixing), and perspectives (e.g., seeing oneself as a creator and collaborator). (See supplementary document ComputationalLiteracy.pdf.) Supporting computational literacy has some overlap with other frameworks such as media literacy, information literacy, and digital literacy, particularly on the emphasis in creating and expressing with new media (Bawden, 2001; Livingstone, 2004). However, with computational literacy, we focus on the role of coding as a means to create, invent, and express with technology.

Despite growing recognition in supporting coding opportunities, there remain troubling gaps in participation especially among young women and ethnic and racial minorities. When we look at spaces that have traditionally supported these activities, such as computer science programs, there is an underrepresentation of women and racial minorities. For example, in 2014, 17% of the computer and information science bachelor's degree recipients were women (NCWIT, 2016), while in 2015, 13% of the computer and information science bachelor's degree recipients were racial minorities (African-American, Hispanic-American, and Native-American) (Zweben & Bizot, 2015). As more technologies mediate our lives, we need to ensure that we invite everyone of all backgrounds to shape our digital world.

To support broader participation in creative activities with computing, many argue that we need to move beyond thinking about access to technology and consider the broader ecology of social support and opportunities that surround a young person (Ito et al., 2013; Barron 2004). Social support can play a major role in engaging and deepening what young people can learn and do with technology, especially young people from underrepresented groups. In particular, parents can be collaborators, resource provides, and co-learners (Barron et al., 2009). The American Academy of Pediatrics recently adjusted their recommendations to encourage parents to act as "media mentors" for their children (Radesky & Christaskis, 2016). To support parents in this role, parents and families need and *want* access to opportunities that allow them understand the kinds of roles they can play and the practices they can take on to support one another (Livingstone, Mascheroni, Dreier, Chaudron, & Lagae, 2015; Takeuchi & Stevens, 2011).

However, access to quality computing resources and opportunities remain a challenge for children and families, especially from low-income households (DiSalvo, Reid, & Roshan, 2014; Rideout & Katz, 2016). While families are increasingly adopting Internet-enabled devices, families remain "under-connected" and struggle with staying connected because of interrupted service, sharing one connection with multiple people

in the family, or hitting the data-limits of their mobile devices (Rideout & Katz, 2016). Additionally, while there might be free and open opportunities online, families have difficulty discovering them (DiSalvo, Reid, & Roshan, 2014). As new technologies and opportunities emerge, some researchers warn that these gaps may accelerate inequality. In a study of household investments in enrichment activities for their kids, Duncan and Murnane (2011) found that investments were increasing in upper income households, while investments in lower income households have remained relatively flat.

Libraries have an important role in addressing this national need to engage communities in computational literacy opportunities and bridging the gaps in participation. Libraries are connected learning spaces that can support the development of interests and bridge opportunities across their communities (MacArthur Foundation, et al., 2014). Additionally, libraries are already playing important roles in providing access to technology and family learning opportunities (Weiss, Caspe, Lopez, & McWilliams, 2016). In a report titled "Libraries Ready to Code" from the American Library Association's Office of Technology Policy, Braun and Visser (2016) echo this national need and emphasize the important role of libraries as a site for this engagement, especially for engaging high-need populations (Martin, 2017). However, they highlight that libraries need more education and funding to provide these opportunities. Efforts are already underway to support libraries such as the Ready to Code initiative (Martin, 2017), but these efforts often focus on older children and teens and miss opportunities to engage their families in meaningful ways beyond showcases and information sessions.

This proposed project builds on similar IMLS-funded projects to strengthen libraries as connected learning spaces and to support family learning, such as the STEMEx initiative. This project, however, focuses on computational literacy and aims to build libraries capacities to facilitate these opportunities within their community. Like STEMEx, we plan to leverage local volunteers with computing experience, but we plan to frame their role as co-learners with families rather than experts.

2. Project Design

The primary research question driving this project: *how can we engage young children and their parents in design-based activities for the cultivation of computational literacy?*

In this proposed project, the Department of Information Science at University of Colorado Boulder (CU Boulder) plans to collaborate with Boulder Public Library (BPL) and Denver Public Library (DPL) to design and study a family learning program that will engage young children and their families in creating and learning together with technology. We will especially focus on high-need families, engaging children (ages 4 to 7 years old) and families from underrepresented groups in computing. This program will develop families' computational literacy, strengthen the roles that parents can take on to support their children in computing, and increase the ways that libraries can facilitate computational literacy opportunities in their community.

Our process will be informed by the Connected Learning framework, which provides a model to design and build environments that support youth from diverse interests and backgrounds and connect these experiences to future opportunity (Ito et al., 2013). Connected Learning builds on socio-cultural (Lave & Wenger, 1991) and ecological theories of learning (Barron, 2004 & Bronfenbrenner, 1979), which emphasize that learning is relational and embedded in shared activities. Parents can play important roles to support their children in creating and learning with technology (Barron et al., 2009). Similarly, libraries are ideal environments to support connected learning, brokering opportunities across school, home, and community.

Additionally, our design and research process is informed by the constructionism framework, which argues that people learn best when they are building things that are personally and socially meaningful to them (Papert, 1980; Kafai, 2006). Constructionism builds on Jean Piaget's theory of constructivism, which argues that people learn by actively building knowledge through experience, rather than learning by transmission of ideas (Piaget, 1976). Constructionist tools like ScratchJr (https://www.scratchjr.org/) and the KIBO Robot, which were designed for young children and allow them to use coding to build a variety of projects such as

animations, games, and stories (Bers, Ponte, Juelich, Viera, & Schenker, 2002; Flannery et al., 2013). As they build projects, they can engage in computational thinking concepts and practices (Brennan & Resnick, 2012). Together the constructionist and connected learning frameworks will guide our design and research process in developing a family learning program that supports high-need families to develop computational literacy.

The driving question guiding this research project is: *how can we engage children and their parents in design-based activities for the cultivation of computational literacy?* We plan to pursue the following sub-questions:

1. What challenges and barriers do parents and their children face in participating in technology-based learning opportunities in their libraries?
2. How can we design programs and structures within libraries that address those challenges and to support children and parents to build on their interests and backgrounds, or "funds of knowledge", to engage in computational literacy?
3. In participating in these programs, how do children and their families develop computational literacy and what aspects of these programs support children and families in their development?

Our project will take a participatory approach by engaging research and practice through the collaboration between CU Boulder, BPL, and DPL.

2.1. Understanding the Challenges of Families to Engage in Technology-based Opportunities

To understand the challenges that families face in engaging with technology-based opportunities, we plan to conduct focus groups, or group interviews, with parents from the libraries' local communities in the first half of Year 1. Working with BPL and DPL to recruit parents, the CU Boulder team will conduct 90-minute focus groups with 3-5 parents, which will be held at the library or local community center. We anticipate engaging at most 20 parents across the focus groups. We will target parents from the low-income communities that the participating libraries serve, working with community partners such as housing developments, to ensure we recruit parents with limited resources and social support around computing. We plan to provide gift cards to participating parents to compensate them for their time and will provide a language interpreter for parents who primarily speak another language.

To examine the connected learning network within their community, we plan to take a multi-level approach to understanding families' challenges and perspectives (Katz & Gonzalez, 2016). Rather than focusing on individual experiences, we will ask parents to look widely at the multiple settings and activities in which parents and their families situate their technology use. We will ask parents about their personal and families' uses of technology, how they learn about new technology-based opportunities in their community, and their strategies to take advantage of new technologies. Focus groups will provide us an opportunity to hear shared perspectives and differing views from parents from the same community. Additionally, focus groups can shift the power from the researcher to the participants, can produce richer, interactive data, and provide opportunities for participants to co-construct meaning (Wilkenson, 1998).

The focus groups will be recorded and transcribed. The CU Boulder team will conduct a thematic analysis, surfacing common features across parents' experiences. Findings will inform the design process for the family program, which will begin in the latter half of Year 1. Findings will be shared with library partners and the advisory board for feedback. We plan to publish these findings and share widely through conferences and gatherings in Year 2. Past focus groups conducted by PI Roque revealed the uncertainty parents felt around the kinds of roles they could play in their children's experiences with technology (Roque, 2013). The focus groups also transformed into support groups, allowing parents to ask questions, share strategies, and validate one another's experiences. These proposed focus groups in this project will expand on these prior findings by taking a multi-level approach to examine families' connected learning network.

2.2 Designing the Family Learning Program

In the latter half of Year 1 and through Year 2, CU Boulder will lead the project team to iteratively design the family learning program. PI Roque has been conducting research engaging families in creative computing since 2012. Together with other community-based organizations such as housing developments, PI Roque designed and studied the Family Creative Learning (FCL) project, which engaged children (between 8 to 12 years old) and their parents from low-income communities in creative technology workshops (Roque, 2016). PI Roque also produced a Facilitator Guide (http://family.media.mit.edu/guide) for educators to adapt this model, which has been downloaded more than 2,500 times and featured by organizations such as MakerEd. FCL has been adapted nationally and internationally through different settings such as schools and community makerspaces and through wider efforts such as an adaptation by PBS Kids with their national public stations (Morris, 2017). Building on the success of FCL, this proposed project will focus on families with younger children (approx. ages 5-7 years old) and examine how libraries can facilitate these opportunities for their communities, especially among high-need groups.

We will use iterative and participatory approaches inspired by design-based and action research approaches, which engage people as collaborators rather than research subjects, experiment with multiple iterations, apply learning theory and contribute back to it, and embed the research and design process in the social, cultural, and historical context of real-life settings (Stringer, 2013; Anderson & Shattuck, 2012; O'Neill, 2016). Staff from our library partners and their community partners will participate in this iterative process with the CU Boulder team. This process will also be informed by observations and feedback from participating families. The project team will carry out four implementations of the family learning program in different library and community partner settings within BPL and DPL to address the different challenges and opportunities that can emerge when a program is implemented in different contexts. PI Roque in collaboration with other colleagues has experience applying design-based and participatory approaches to the design of FCL (Roque, 2016), identifying principles for design (Roque, 2016), and advancing knowledge about family learning in computing (Roque, Lin, Liuzzi, 2016) and refining constructionist theory (Dasgupta & Roque, 2018).

The initial design of the family learning program will be adapted on the past FCL design. A program implementation will consist of a series of 5 two-hour workshops, held in the week-night evenings or weekends when parents will be able to attend. We focus on a workshop series model rather than a one-workshop or drop-in model to enable families to build their competencies over time and to support relationship building between families, facilitators, and libraries. The workshops culminate in a community showcase where families can share their projects and invite friends and family.

The workshops in the series have a four-part structure: Eat, Meet, Make, and Share. Below is an explanation of each part, along with an example of what would be done in Workshop 1:

- During *Eat*, families eat dinner together and facilitators will engage families in activities that build relationships among participants. In Workshop 1, facilitators will hand out "About Me" cards where kids and parents can draw themselves and write down something they like to do. As families fill out their cards, facilitators then hand out larger "About Us" cards for families to combine their cards and write down something they like to do together. During group introductions, families use these cards to help them introduce themselves to the group.
- During *Meet*, parents and kids meet in separate groups, which allow them to get to know their peers and ask questions about their experience. In Workshop 1, facilitators take parents to another room, where facilitators discuss the goals of the program and ask parents if they have questions. With the kids, facilitators ask kids to make a "community code" together to write down what we want to do together to make sure the workshops are creative, fun, and respectful.

- During *Make*, parents and kids engage in design-based activities using ScratchJr (see Figure 1) and other creative technologies that allow them to make a variety of projects that build on their interests. While there have been a surge of apps and technologies for young children, we plan to only incorporate tools that enable children and families to create, tinker, and invent (Ito, 2009). We will design activities that focus on story-making, building on the important role that storytelling plays in supporting relationship-building and celebrating cultural histories of families. In Workshop 1, to get started with ScratchJr and story-making, parents and kids will work separately to make animations of simple scenes from a story of their choice . We found in past implementations of FCL that it was valuable to allow parents to get hands-on experience with ScratchJr without worrying about their kids. As parents and kids make simple animations, they become exposed to the computational concepts of sequence and events as well as the computational practices of experimenting and exploring. As their projects become more complex, they might encounter the computational practice of debugging (See supplementary document ComputationalLiteracy.pdf).

Figure 1 ScratchJr interface. Puzzle-piece shaped blocks with iconic images represent different actions that characters, or sprites, can take on the screen.

- During *Share*, parents and kids share their projects, allowing them to practice talking about their projects in their own words, while other families can ask questions and give feedback. In Workshop 1, parents share their projects first, then we invite kids to share their projects.

We will repeat this structure of Eat, Meet, Make, Share throughout the next three workshops (the last workshop is a community showcase). The structure helps families understand the structure and pace of the program. In Workshop 2, families continue becoming familiar with ScratchJr and focus on developing more complex projects. In Workshop 3 and 4, families brainstorm stories and design their own family project using one of those stories. Parents and kids share their project ideas with other families to feedback and work to refine their project. In Workshop 5, families can invite friends and family to share their projects in a community showcase. We also plan to invite local community organizations and educators from local schools to participate.

In Year 1 and Year 2, we plan to support four program implementations, two in Year 1 and two in Year 2 across BPL and DPL. Each program implementation will support about 25 people for each program. All together, we anticipate engaging about 100 people, which could include 25 to 50 families depending on the sizes of family units. We have already implemented pilot workshops with local librarians in the greater Boulder and Denver area.

After the workshops, libraries will play an important role to ensure the continued engagement of participating youth and families by brokering new opportunities to events, programs, individuals, and institutions. This brokering practice is essential in fulfilling the promise of connected learning to bridge interests across activities and to connect to academic, civic, and economic opportunity (Ching, Santo, Hoadley, & Peppler, 2016; Penuel & Bevan, 2014). For example, BPL supports a regular Youth Maker Hangout, an afterschool club for youth to meet other young makers, learn about new technologies, and share their projects. BPL also hosts an annual expo for creators and makers in the community to share their projects. DPL will connect families to events regularly held in the ideaLab, a makerspace open to youth and

adults. One event hosted by DPL called DevCamp support youth to invent using different programming languages and maker kits.

2.2.1 Participant Recruitment and Support

Recruiting Families: To engage high-need families, the project team will work with library branches and their community partners to target underrepresented groups in computing, who have limited access to social support and resources with technology (Katz & Rideout, 2016). For example, BPL will connect with Boulder Housing Partners, which provide affordable housing options for the Boulder community, while DPL will select branches that primarily serve Latino- and African-American households. BPL and DPL, with support from the CU Boulder team, will leverage existing recruitment strategies and relationships with youth and their families to attract families to participate in the workshops. We plan to employ numerous strategies within each community by hosting information sessions and demonstrations in the evenings, participating in community fairs, and visiting other community sites, such as housing developments and school classrooms.

We understand that families who participate might have different needs and challenges that need to be addressed to support their participation. Families can come in diverse structures and can include single parent households, multi-generational families, and other non-traditional configurations. We use "parents" loosely to mean any adult caretaker and can include grandparents, extended relatives, family friends, and older siblings. To help parents who speak languages other than English, we plan to recruit facilitators who can interpret for family members. The CU Boulder team will make sure any written resources such as registration forms, surveys, or activity handouts are translated in families' primary language. To accommodate parents' times, workshops will be hosted in the evenings or weekends when parents can attend after work. Additionally, dinner will also be provided from a local restaurant to attract families and alleviate a load from already busy parents.

Recruiting and Facilitating Facilitators: CU Boulder, BPL, and DPL will recruit facilitators to help families during the workshops. The CU Boulder team can recruit undergraduate students from Information Science, Computer Science, ATLAS, and School of Education. PI Roque teaches a required introduction to computer programming course offered to the entire College of Media, Communication, and Information, where she can recruit additional students. BPL and DPL will recruit facilitators from the numerous school, professional, and community organizations. For example, DPL regularly recruits local engineers to help with coding and making activities. BPL has a partnership with a local youth services organization that support high school students to engage in community activities.

CU Boulder will host 3 facilitation workshops for volunteers before each program implementation to discuss facilitation practices and help volunteers learn to see themselves as guides and co-learners with families rather than instructors. During these facilitation workshops, facilitators will engage in the same activities as families so that they become familiar with the creative technologies and empathize with some of the challenges and breakthroughs families will experience in the activities. Additionally, we will discuss strategies to support family members who may be novices and/or may be intimidated by the technologies. For example, some important practices in past FCL workshops for facilitators have been knowing when to ask questions rather than giving answers or building trust and relationships to help families feel comfortable in the space (Roque, 2016). Facilitation learning and training continue during the program implementation as facilitators will debrief after workshops to discuss observations and their experiences.

2.2.2 Formative Evaluation of Iterative Design

The development of the family learning program will undergo an extensive iterative process. The project will have four program implementations in Year 1 and 2 of the project (2 implementations at BPL and 2 implementations at DPL). Throughout the process, we will rigorously document the design thinking and reflections of the project team and collaborators as well as the implementation of the model. We will employ

the following strategies to track project progress, get critical feedback from key stakeholders, and incorporate suggestions into successive implementations.

- CU Boulder will gather pre- and post-surveys from participating families to assess their interest, confidence, and attitudes as well as get open-ended feedback from families about their experience.
- Feedback and comments from facilitators and library partners will be recorded during debrief and planning meetings.
- The Advisory Board will provide critical feedback on the program design and respond to results from survey data and feedback from facilitators. Advisory Board member Professor William Penuel has expertise in design-based research approaches and program evaluation of connected learning environments like libraries.
- CU Boulder will collect metrics of family participation during the workshops and follow-up with families and libraries to collect family participation in related opportunities beyond the program.
- CU Boulder will conduct in-depth, qualitative research (described in the next section) to assess how families develop computational literacy and what supports their development, particularly examining the role of library facilitation.

2.3. Studying Families' Learning and What Supports Their Learning

During Year 2, we will conduct research activities to examine two aspects of the program (1) how families develop computational literacy and (2) what aspects of their experience in the family learning program support that development. We will use qualitative and ethnographic approaches to understand families' and facilitators' experiences, drawing on case study and ethnographic methods. These methods enable us to develop in-depth descriptions of family members' and facilitators' experiences, while also focusing on the emergent social interactions and cultural patterns among families and facilitators within this learning environment. These approaches allow us to discover important factors and relevant categories for analysis in participants' learning experiences. Additionally, these approaches allow us to focus on the process of learning: how children and their parents negotiate working together on projects, how facilitators step in to help and step out to give learners space to figure things out, and how participants develop relationships with other families in the room – and how these processes contribute to families' development of computational literacy. CU Boulder has already received approval for its research protocol from the CU Boulder IRB, the ethics and research review board.

We will use the computational thinking framework developed by Brennan and Resnick (2012) to assess families' development of computational literacy from our collected data. We frame computational literacy along three dimensions (Brennan & Resnick 2012): concepts (e.g., sequences and parallelism), practices (e.g., debugging and remixing), and perspectives (e.g., seeing oneself as a creator and collaborator). We will also adapt their assessment strategies (http://scratched.gse.harvard.edu/ct/). These strategies include asking participants to talk about their projects during interviews, embedding design challenges in the workshop experience, and examining their project artifacts. For example, we will look for consistent uses of certain programming blocks in their ScratchJr programs, which can suggest understanding of different computational concepts (see Figure 2 and supplementary document ComputaitonalLiteracy.pdf for more examples of how we will identify computational concepts and practices).

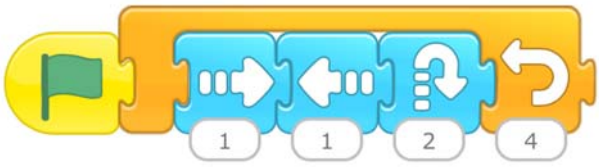

Figure 2 Example of programming blocks that use the computational concept of "loops," or running the same sequence multiple times.

We plan to collect multiple forms of data to prevent bias. During the workshop, we will collect observations in the form of field notes, short interviews with children and parents, and photos and video recordings of family interactions. We will implement pre- and post-surveys to provide immediate feedback and assess families' changing attitudes, confidence, and interests. After the workshops, we plan to conduct 30-60

minute interviews with individual family members and facilitators to examine their experience from their perspective. We will conduct a thematic analysis of the qualitative data to develop themes across families' experiences, such as the kinds of roles and practices parents take on to support their children, the different ways families work together, common misconceptions, and what helps them overcome challenges. Through this analysis, we will develop case studies of family participation to highlight different trajectories of participation among families.

To examine what supported families' participation, we will take a close look at facilitation. We will use a grounded, thematic analysis to examine facilitators' and libraries' experiences, focusing on individual experiences and emergent themes in the social interactions. Librarians need different forms of support from resources, such as facilitator guides and access to peers (Martin, 2017). Many of the facilitators we recruit will have varying experiences with coding, pedagogy, interacting with communities with diverse needs, and addressing equity and inclusion in computing. We plan to examine how facilitators learn, what roles emerge for individual facilitators, and what supports them in this development. Additionally, we plan to study the role of the library as an institution in coordinating with their community partners, families, and the CU Boulder team to facilitate this opportunity. We will develop case studies of BPL's and DPL's participation and the approaches that each library takes to facilitate this opportunity. These case studies will help to demonstrate the possibilities and strategies for other libraries.

2.4 Communication and Dissemination

In Year 3, we will conduct an extensive effort to communicate and disseminate the project results and outputs. We are committed to sharing the project broadly through nationally and internationally recognized venues to reach libraries, researchers, and decision makers to expand family learning opportunities in the context of computing, especially among underrepresented groups.

- Using documentation and research from Year 1 and Year 2 program implementations, the CU Boulder team will design a Facilitator Guide, which will include: a description of the model, documentation from the different implementations to demonstrate the model, family recruitment strategies, facilitation strategies, activity handouts, tips on community partnerships, and short case studies of family experiences. The design of the guide will build on the past design of the Family Creative Learning Facilitator Guide (http://family.media.mit.edu/guide) and lessons learned from other educators' adapting the guide. We plan to get feedback from our project partners and Advisory Board convening in Year 3.
- We will build a project website as a central point of access to key project outputs such as the Facilitator Guide and the research publications and reports.
- We will share the Facilitator Guide with online curated collections for educators such as MakerEd, ScratchEd, and Connected Learning Alliance, who have broad participation from library practitioners. The Facilitator Guide will be under a Creative Commons license which will allow libraries to adapt, remix, and re-share their implementations of the program.
- We will support libraries interested in adapting the model by hosting professional development workshops at gatherings such as ALA and DML. Additionally, we plan to host online webinars using an open and free learning platform called Unhangout (http://unhangout.media.mit.edu), which supports large-scale gatherings online and participant-driven interactions.
- The findings from analysis of parent focus groups in Year 1 and studies of family learning in Year 2 will be shared widely in learning science conferences such as ICLS and AERA and ALA journals such as Library Journal. The team will also summarize and share research results in blog posts to make the research results publicly accessible, digestible, and broadly available.
- Our Advisory Board members represent key stakeholders in educational research, technology design, CS/STEM learning, and libraries and museum settings. We will leverage their extensive network of researchers, practitioners, and policy makers to disseminate the project outputs.

2.5 Key Personnel and Partners

CU Boulder research and design team: **Ricarose Roque**, PI, is an assistant professor in the Department of Information Science at the University of Colorado Boulder and faculty associate at the Berkman Klein Center for Internet and Society. She has led the Family Creative Learning project for 5 years. She has also helped with the design and implementation of programming languages for kids for more than 10 years and include StarLogo TNG, OpenBlocks (which was used to implement the first version of App Inventor for Android), and Scratch. Roque will lead the research and design process with a **Graduate Research Assistant** (GRA). A GRA will support the research and design activities of the project and will have experience conducting qualitative and survey research as well as experience working in community-based programs. PI Roque will mentor the GRA to develop additional the design and research strategies to support the project implementation.

Library partners: **Kathy Lane**, Programs and Outreach Coordinator at Boulder Public Library, and **Nate Stone**, ideaLAB Program Administrator at Denver Public Library, will collaborate with the CU Boulder team. Both Lane and Stone have extensive experience facilitating coding and making opportunities for youth and families in their library systems. Lane and Stone will help coordinate family and facilitator recruitment at their library sites, coordinate with the CU Boulder team to implement the family learning program, and connect families to ongoing opportunities to existing coding and making opportunities in the library community. Boulder Public Library has 6 branches and Denver Public Library as 26 branches.

2.6 Advisory Board

We have assembled an Advisory Board that will provide external review of the design, development, and impact of this project. The Advisory Board members represent diverse expertise in research and practice across many areas that include: family learning and new technologies, informal STEM learning environments, and broadening participation in CS/STEM. We will assemble the Board in the early part of Year 1 to provide feedback and guidance on our project plan. In the Year 3, we will convene the Advisory Board again to review findings from the past two years of the project as well as determine next steps and future opportunities. Throughout the three-year project timeline, PI Roque and the GRA will connect informally with Board members for critical feedback on key project milestone during shared research conferences such as DML, in-person gatherings, and virtual meetings.

- **Lisa Brahms**, Director of Learning and Research of Children's Museum of Pittsburgh, leads MAKESHOP at the Children's Museum of Pittsburgh, a national model for the design and development of making experiences for young children and their families.
- **William Penuel**, Professor at the School of Education at CU Boulder, is currently engaged in an IMLS-supported project to develop evaluation tools to measure Connected Learning program outcomes within libraries. He has expertise in participatory and design-based research methods and has extensively studied the role of joint-media engagement between children and their parents.
- **Natalie Rusk**, Director of Learning Research for the MIT Scratch Team and co-creator of Scratch, leads the NSF-supported project Coding For All. Natalie is a co-founder of the Computer Clubhouse, an international network of informal learning spaces that support youth from low-income communities to engage in creating with technology.
- **Crystle Martin**, post-doctoral associate at the University of California Irvine and researcher with the Connected Learning Alliance, focuses on equity in youth learning in interest-driven, informal environments. Her current research explores the pathways of youth from non-dominant communities into and out of Scratch, and how those paths can be cultivated through programs in libraries.

2.7 Schedule Overview

The project schedule is described in the Schedule of Completion document.

2.8 Financial Resources

The total cost for this project is $385,327. Salaries and wages will be $187,867, which will support 1 summer month of PI Roque's time for three years and a graduate research assistant for three years to participate in the design, implementation, research, and dissemination of the project. Conference travel support for PI Roque and the graduate student in Year 2 and 3 will be $10,143. Participant support will cost $14,000 to support 20 facilitators who will help to adapt, run, and facilitate the family workshops in Year 1 and 2. Direct costs which will support materials ($1000) and food for the workshops ($8000), support four advisory board members to visit during Year 1 and Year 3 ($8000), and tuition remission for a graduate student across three years ($39,428) will all together cost $54,428. There will be no cost sharing or contracts and sub-awards. The indirect cost will be $115,025. From the preliminary proposal, we increased participant support at the suggestion of IMLS reviewers and added research incentive for 20 parents to participate in focus groups in year 1 ($500).

3. Impact

This project will support a national need to provide computational thinking opportunities by engaging younger children and their families (Braun & Visser, 2017). This approach addresses IMLS priorities in early learning and STEM and connects with the Learning Performance Goal of providing inclusive and accessible learning opportunities. The project will target populations that are economically disadvantaged and focus on engaging young children (ages 4-7 years old) and their families. The project will have the following impact on underrepresented groups in computing, how libraries can facilitate computational literacy opportunities, and researchers and decision makers interested in early-childhood, family learning, and computing:

1. **A model of family engagement with computational literacy**. The proposed project will produce a model of family engagement that will allow young children and their families to develop computational literacy by creating and learning together with computing. Focus groups with parents from low-income communities that our partner libraries serve will surface challenges and opportunities to engage families in computational literacy. This model will be iteratively developed through a design-based and participatory process to ensure that it is inclusive and accessible to families from underrepresented groups in computing.

2. **Support resources for librarians to facilitate this model into their settings**. We will produce a Facilitator Guide for libraries to adapt this model into their settings. The guide will present a template model, share strategies, and present stories from the different implementations to help libraries understand what would make sense for their communities. The CU Boulder team will disseminate this guide through an online website and share the guide with related platforms such as MakerEd and ScratchEd. The CU Boulder team will also share the model, the guide, and the website through professional development workshops at gatherings such as ALA and through online webinars.

3. **Evidence-based case studies of family participation and library facilitation**. The qualitative and ethnographic study of families' learning experiences and libraries' facilitation will advance knowledge in (1) family learning and computing; (2) the roles that libraries can play in facilitating computational literacy; (3) strategies for engaging underrepresented groups in computing. The team will share the research resulting from the project through relevant conferences such as ALA, ICLS, and DML and library publications.

We plan to sustain the project beyond the funding period in a number of ways. For participating families, our library partners will continue to build on these strengthened relationships with families and connect families to existing opportunities within their networks. For the project outputs, the publicly accessible project website, which will be hosted on CU Boulder servers, will continue to host the Facilitator Guide, blog posts, and research reports and publications. As new adaptations of the family learning program emerge, the CU Boulder team will reference those implementations from the project website. The CU Boulder team will continue to play a support role for any libraries interested in adapting this model into their community. Our team is committed to developing a family learning program and to generate resources and research that can support libraries to lead and facilitate meaningful computational literacy opportunities for all.

University of Colorado Boulder

Year 1 (Oct 2017 – Sept 2018)

Responsible Partner	Activity	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
CU	Conduct focus groups with families												
CU	Analyze focus group data to develop themes												
CU	Gather advisory board for feedback												
CU	Train volunteers and participating library staff												
CU, LP	Implement and facilitate 2 pilot programs												
CU	Revise and review workshop design												
CU	Develop data collection protocol for workshops												
LP	Recruit parents for focus groups												
LP	Recruit families for workshops												
LP	Connect families to ongoing opportunities at the library												

Legend for Responsible Partner

CU – CU Boulder
LP – Library Partners in Boulder Public Library and Denver Public Library

Year 2 (Oct 2018 – Sept 2019)

Responsible Partner	Activity	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
CU, LP	Implement and facilitate 2 program implementations	■	■					■	■				
CU	Train volunteers and participating library staff	■					■						
CU	Data collection during and after workshops (interviews)	■	■	■				■	■	■			
CU	Revise and review workshop design				■	■					■	■	
CU	Analyze collected workshop data				■	■	■				■	■	■
LP	Recruit families for pilot workshops					■	■						
LP	Connect families to ongoing opportunities at the library				■	■	■				■	■	■
CU	Share preliminary findings at conferences such as ALA, DML, AERA	■						■		■			

Legend for Responsible Partner

CU – CU Boulder
LP – Library Partners in Boulder Public Library and Denver Public Library

Year 3 (Oct 2019 – Sept 2020)

Responsible Partner	Activity	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
CU	Analyze collected workshop data												
CU	Write research papers based on analyzed data												
CU	Share research at relevant conferences												
CU	Design Facilitator guide and project's online website												
CU	Share and disseminate Facilitator guide and project website												
CU	Host online webinars for librarians												
CU	Convene advisory board to get feedback on research results and facilitator guide												
CU	Share findings and products and host PD at conferences such as ALA, DML, ICLS												

Legend for Responsible Partner

CU – CU Boulder
LP – Library Partners in Boulder Public Library and Denver Public Library

DIGITAL STEWARDSHIP SUPPLEMENTARY INFORMATION FORM

Introduction
The Institute of Museum and Library Services (IMLS) is committed to expanding public access to federally funded research, data, software, and other digital products. The assets you create with IMLS funding require careful stewardship to protect and enhance their value, and they should be freely and readily available for use and re-use by libraries, archives, museums, and the public. However, applying these principles to the development and management of digital products is not always straightforward. Because technology is dynamic and because we do not want to inhibit innovation, we do not want to prescribe set standards and best practices that could become quickly outdated. Instead, we ask that you answer a series of questions that address specific aspects of creating and managing digital assets. Your answers will be used by IMLS staff and by expert peer reviewers to evaluate your application, and they will be important in determining whether your project will be funded.

Instructions
If you propose to create any type of digital product as part of your project, complete this form. We define digital products very broadly. If you are developing anything through the use of information technology (e.g., digital collections, web resources, metadata, software, or data), you should complete this form.

Please indicate which of the following digital products you will create or collect during your project
(Check all that apply):

	Every proposal creating a digital product should complete …	Part I
	If your project will create or collect …	**Then you should complete …**
☑	Digital content	Part II
☐	Software (systems, tools, apps, etc.)	Part III
☑	Dataset	Part IV

PART I.

A. Intellectual Property Rights and Permissions

We expect applicants to make federally funded work products widely available and usable through strategies such as publishing in open-access journals, depositing works in institutional or discipline-based repositories, and using non-restrictive licenses such as a Creative Commons license.

A.1 What will be the intellectual property status of the content, software, or datasets you intend to create? Who will hold the copyright? Will you assign a Creative Commons license (http://us.creativecommons.org) to the content? If so, which license will it be? If it is software, what open source license will you use (e.g., BSD, GNU, MIT)? Explain and justify your licensing selections.

All resources created for educators such as the Facilitation Guide will be under Creative Commons Attribution-ShareAlike 4.0 International License.

A.2 What ownership rights will your organization assert over the new digital content, software, or datasets and what conditions will you impose on access and use? Explain any terms of access and conditions of use, why they are justifiable, and how you will notify potential users about relevant terms or conditions.

The Facilitator Guide will be published and freely accessible on an online website. The CC license will allow wide adoption and allow others to remix and adapt the content.

Qualitative and quantitative data collected (e.g. interviews, observations, and surveys) from families' and librarians' participation will be follow the data collection, management, and research consent policies by research and ethics review board at the University of Colorado Boulder (CU Boulder).

A.3 Will you create any content or products which may involve privacy concerns, require obtaining permissions or rights, or raise any cultural sensitivities? If so, please describe the issues and how you plan to address them.

We do not anticipate that the Facilitation Guide and online website created will involve privacy concerns, require obtainment of permissions or rights, or raise cultural sensitivities.

By following CU Boulder's policies of data collection and data management, we do not anticipate the quantitiative and qualitative data collection to involve privacy concerns or raise any cultural sensitivies. We will follow CU Boulder's policies on research consent to obtain permission from participants.

Part II: Projects Creating or Collecting Digital Content

A. Creating New Digital Content

A.1 Describe the digital content you will create and/or collect, the quantities of each type, and format you will use.

The Facilitator Guide will be in the form of a downloadable PDF. We plan to host these resources on an online website, which will be hosted on CU Boulder servers.

A.2 List the equipment, software, and supplies that you will use to create the content or the name of the service provider who will perform the work.

To create the Facilitator Guide, we will use visual and text editing software provided by CU Boulder. To create the website, we will use a text editor to create the HTML and CSS files and host the website on CU Boulder servers.

A.3 List all the digital file formats (e.g., XML, TIFF, MPEG) you plan to create, along with the relevant information on the appropriate quality standards (e.g., resolution, sampling rate, or pixel dimensions).

The Facilitator Guide will be a PDF.

B. Digital Workflow and Asset Maintenance/Preservation

B.1 Describe your quality control plan (i.e., how you will monitor and evaluate your workflow and products).

The PI and the graduate student will get feedback from community partners and advisory board members as they develop the Facilitator Guide and the online website. The PI and graduate student will review and test all materials before they become publicly available and respond to any issues found by users of content.

B.2 Describe your plan for preserving and maintaining digital assets during and after the award period of performance (e.g., storage systems, shared repositories, technical documentation, migration planning, commitment of organizational funding for these purposes). Please note: You may charge the Federal award before closeout for the costs of publication or sharing of research results if the costs are not incurred during the period of performance of the Federal award. (See 2 CFR 200.461).

CU Boulder is committed to perserving, maintaining, and continuing public access to the Facilitator Guide during and after the award period. CU Boulder has a dedicated IT services team through the Office of Information Technology. The Facilitator Guide once created will be published on a public website hosted on CU servers and be available during and after the award period.

C. Metadata

C.1 Describe how you will produce metadata (e.g., technical, descriptive, administrative, or preservation). Specify which standards you will use for the metadata structure (e.g., MARC, Dublin Core, Encoded Archival Description, PBCore, or PREMIS) and metadata content (e.g., thesauri).

A menu on the online website will support navigation of the site content and the Facilitator Guide. We will consult with advisory board members and community partners to develop categories and subject tags.

C.2 Explain your strategy for preserving and maintaining metadata created and/or collected during and after the award period of performance.

Metadata used on the website will be periodically reviewed by the PI, co-PIs and their students, including at least annually after the grant period of performance, and will update terms and the metadata schema as needed to ensure the site continues to be useful and navigable.

C.3 Explain what metadata sharing and/or other strategies you will use to facilitate widespread discovery and use of digital content created during your project (e.g., an API (Application Programming Interface), contributions to the Digital Public Library of America (DPLA) or other digital platform, or other support to allow batch queries and retrieval of metadata).

The PI and team will follow search optimization strategies to support the Facilitator Guide's and project website's discoverability. We will also work with the CU Boulder social media team to Facilitator Guide share the content widely.

D. Access and Use

D.1 Describe how you will make the digital content available to the public. Include details such as the delivery strategy (e.g., openly available online, available to specified audiences) and underlying hardware/software platforms and infrastructure (e.g., specific digital repository software or leased services, accessibility via standard web browsers, requirements for special software tools in order to use the content).

We will publish the Facilitator Guide on an online website hosted on CU Boulder servers and will be accessible through standard web browsers. Anyone can download the Facilitator Guide for free and use the Facilitator Guide under Creative Commons license (see A.1).

D.2 Provide the name and URL(s) (Uniform Resource Locator) for any examples of previous digital collections or content your organization has created.

Example website of previous content created: http://family.media.mit.edu

Part III. Projects Creating Software (systems, tools, apps, etc.)

A. General Information

A.1 Describe the software you intend to create, including a summary of the major functions it will perform and the intended primary audience(s) this software will serve.

N/A

A.2 List other existing software that wholly or partially perform the same functions, and explain how the tool or system you will create is different.

N/A

B. Technical Information

B.1 List the programming languages, platforms, software, or other applications you will use to create your software (systems, tools, apps, etc.) and explain why you chose them.

N/A

B.2 Describe how the intended software will extend or interoperate with other existing software.

N/A

B.3 Describe any underlying additional software or system dependencies necessary to run the new software you will create.

N/A

B.4 Describe the processes you will use for development documentation and for maintaining and updating technical documentation for users of the software.

N/A

B.5 Provide the name and URL(s) for examples of any previous software tools or systems your organization has created.

N/A

C. Access and Use

C.1 We expect applicants seeking federal funds for software to develop and release these products under an open-source license to maximize access and promote reuse. What ownership rights will your organization assert over the software created, and what conditions will you impose on the access and use of this product? Identify and explain the license under which you will release source code for the software you develop (e.g., BSD, GNU, or MIT software licenses). Explain any prohibitive terms or conditions of use or access, explain why these terms or conditions are justifiable, and explain how you will notify potential users of the software or system.

N/A

C.2 Describe how you will make the software and source code available to the public and/or its intended users.

N/A

C.3 Identify where you will be publicly depositing source code for the software developed:

N/A

Name of publicly accessible source code repository:
URL:

Part IV. Projects Creating a Dataset

1. Summarize the intended purpose of this data, the type of data to be collected or generated, the method for collection or generation, the approximate dates or frequency when the data will be generated or collected, and the intended use of the data collected.

Field note observations will be collected during every workshop to understand participants' experiences. Interviews during and after the program will assess families' and facilitators' experiences from their perspective. Photos and videos during the program will help capture the physical interactions and projects. Pre- and post-surveys administered before and after the

2. Does the proposed data collection or research activity require approval by any internal review panel or institutional review board (IRB)? If so, has the proposed research activity been approved? If not, what is your plan for securing approval?

The proposal data collection and research activity require approval by CU Boulder's IRB. A research protocol developed by the PI has already received approval from the CU Boulder IRB.

3. Will you collect any personally identifiable information (PII), confidential information (e.g., trade secrets), or proprietary information? If so, detail the specific steps you will take to protect such information while you prepare the data files for public release (e.g., data anonymization, data suppression PII, or synthetic data).

Fieldnotes and interviews will contain sensitive information about participants. The audio recording of interview data, video recordings of workshop sessions, written fieldnotes, and interview transcripts will be stored on a password-protected laptop. The survey database and subsequent analysis documentation will also be saved on a password protected laptop, and

4. If you will collect additional documentation such as consent agreements along with the data, describe plans for preserving the documentation and ensuring that its relationship to the collected data is maintained.

N/A

5. What will you use to collect or generate the data? Provide details about any technical requirements or dependencies that would be necessary for understanding, retrieving, displaying, or processing the dataset(s).

We will use digital cameras to record photos and videos during the workshops and audio recording equipment to record the interviews. We will use paper-based surveys to collect the pre- and post-survey data. We will write fieldnotes using word processors like Microsoft word. All data will be stored in password protected laptops.

6. What documentation (e.g., data documentation, codebooks, etc.) will you capture or create along with the dataset(s)? Where will the documentation be stored, and in what format(s)? How will you permanently associate and manage the documentation with the dataset(s) it describes?

We will create a codebook to document themes that emerge from the qualitative dataset. We will create this codebook using the MAXADA qualitative data analysis tool.

7. What is the plan for archiving, managing, and disseminating data after the completion of the award-funded project?

We plan to follow the guidelines for archiving, managing, and sharing data from the CU Boulder IRB office. http://www.colorado.edu/crdds/what-we-do/research-data-management

8. Identify where you will be publicly depositing dataset(s): N/A

Name of repository:
URL:

N/A

9. When and how frequently will you review this data management plan? How will the implementation be monitored?

We will follow the CU Boulder IRB policies in reviewing this data management plan, which require annual review and renewal. CU Boulder IRB policies require review and approval when any changes need to be made in our data management processes.