

## **Capturing Computational Thinking Literacy Development in Public Libraries Project Summary**

This project responds to the IMLS National Leadership Grants for Libraries (funding category: Research in Service to Practice), focusing specifically on helping library staff evaluate and improve computational thinking (CT) programming for youth (ages 11-18). This three-year project, running from July 1, 2019 to June 30, 2022, brings together interdisciplinary faculty from the College of Information Studies and College of Education at the University of Maryland, public library staff that serve youth, experts in public library assessment and CT assessment in schools serving as advisory board members, and partners within the American Library Association (ALA) that are leading CT in libraries initiatives on [Libraries Ready to Code](#) — the Young Adult Library Services Association (YALSA), and the Public Policy and Advocacy Unit (PPAU) at the ALA Washington Public Policy and Government Relations Office. The main goals of this project are to identify the learning outcomes that can be achieved through CT programs for youth offered through libraries and to develop a bank of assessment tools that can be used by public library staff to document and measure CT literacy development in youth as a result of participating in CT programs through their libraries.

The project is designed to respond to three interrelated needs: (1) broaden participation in CT through effective and engaging library programming, (2) understand the current landscape of CT programming in libraries, and (3) develop materials to assess the CT learning that is happening in libraries across the country. Toward this end, the project is pursuing research questions looking both at the CT learning that can and does happen in libraries as well as identifying ways to support library staff to evaluate, improve, and champion the CT programming in their libraries.

During the first year of the project, we will focus on understanding the current landscape of CT in libraries. To accomplish this, we will conduct interviews with public library staff from across the country, with care being taken to ensure that we recruit participants and libraries that reflect the breadth and diversity of the national library landscape. We will also review academic literature to catalog the current state of CT programming and CT assessment strategies and instruments. The outcome of the first year will be a typology of the current state of CT programs offered through libraries, along with a catalog of learning outcomes, and CT program materials and data collection tools currently in-use.

In the second year, we will focus on the creation and evaluation of CT assessment tools designed specifically for library contexts. As part of this effort, we will invite in-service library staff to co-design these tools so as to ensure the voices, ideas, and experiences of those we are designing for are represented throughout the assessment creation process. These participatory design sessions will be conducted in collaboration with YALSA and its Train the Trainer project. The emerging set of CT assessment tools will be piloted with partner library staff at select libraries. We will also conduct pre- and post- interviews with the library staff who are testing out our materials as a means to improve the accessibility and ease-of-use of the assessments.

Taking seriously the service-to-practice goal of this grant program, the final year of our project will focus on understanding if and how the assessment tools impact practice and identifying the supports and training that need to accompany them so as to ensure effective adoption and use by library staff across the country. The result of this project will include a typology of the current state of CT programming in libraries, a bank of assessment tools for capturing CT literacy development in libraries, and resources to support library staff in using these materials, all of which will be made publicly available. In doing so, this project seeks to make a meaningful contribution towards helping libraries and library staff meet the call to prepare youth for the computational futures that await them.

## Capturing Computational Thinking Literacy Development in Public Libraries

The project detailed below responds to the IMLS National Leadership Grants for Libraries (funding category: Research in Service to Practice) and covers a three-year period from July 1, 2019 to June 30, 2022. The direct audiences for this grant are public library staff that are currently offering or will offer computational thinking (CT) programs for youth ages 11-18 through their libraries and the youth that participate in these programs. This project brings together interdisciplinary faculty from the College of Information Studies and College of Education at the University of Maryland (UMD), public library staff that serve youth, experts in public library assessment and CT assessment in schools serving as advisory board members (AB), and partners that are leading CT in library initiatives nationwide. The main goals of this project are to identify the learning outcomes that can be achieved through CT programs for youth offered through libraries and to develop a bank of assessment tools that can be used by public library staff to document and measure CT literacy development in youth as a result of participating in CT programs through their libraries. We are partnering with two organizations within the American Library Association (ALA) that are leading national initiatives on [Libraries Ready to Code](#) (RtC)—the Young Adult Library Services Association (YALSA) and the Public Policy and Advocacy Unit (PPAU) at the ALA Washington Public Policy and Government Relations Office. The RtC project (funded by Google) is a national initiative to create curated resources that support libraries in offering CT programs, pilot strategies to help existing library staff design and implement CT programs through several grant programs and work with library educators to redesign their courses to incorporate CT skills in pre-service librarian education. We are partnering with YALSA to leverage their current [Train the Trainer](#) (T3) IMLS-funded project work, where state library agencies (SLAs) and public library staff (from 50 states 5 territories) are receiving mentoring in implementing CT programs at their libraries from “coaches” who are primarily library staff that were selected as [lead libraries](#) in the RtC project. The participants and coaches of the T3 project will co-design, prototype, and administer the CT assessment tools that we will develop as part of this project. We are partnering with PPAU to leverage their leadership in the RtC initiative to disseminate the research findings and the bank of assessment tools developed through this project via their RtC website, past and present RtC partners and grant recipients, and established communication channels to all public library staff that serve youth. The proposed project fills a significant need in the CT in the library landscape by offering a suite of ready-to-use CT assessments for evaluating and refining the various efforts to integrate CT into library programming. Further, this project addresses an existing gap in the research on understanding why and how youth library programming contributes to CT literacy development and will advance research in CT literacy development through libraries, which is almost non-existent.

### Statement of National Need

The White House Computer Science (CS) for All initiative was launched in 2016 to “empower all American students from kindergarten to high school to learn computer science and be equipped with computational thinking skills they need to be creators of the digital economy, not just consumers, and to be active citizens in our technology-driven world” (Smith, 2016). The concept of CT and its importance to all young people was widely popularized by Jeannette Wing in her influential 2006 article. That article states that “Computational thinking is a fundamental skill for everyone, not just the computer scientists” (Wing, 2006, p. 3) going on to say that CT should be added along with reading, writing, and arithmetic as an essential skill for all students. She defined CT as “...solving problems, designing systems, and understanding human behavior, by drawing on concepts fundamental to computer science” (Wing, 2006, p. 13). While there is little consensus as to a single definition of CT, it is generally agreed upon that CT practices include problem decomposition, developing and using abstractions, debugging, defining algorithms, and concepts grounded in the practice of programming such as iteration, parallelization, and conditional logic (Grover & Pea, 2013). Our operationalization of CT for this project, which we will refer to as CT literacy in this proposal, adheres closely to the structure and content presented by Grover & Pea and includes both practices and concepts from the discipline of computer science. In the next sub-sections, we delineate the current national challenges associated with bringing CT to all and present a discussion of the potential for libraries to serve as an essential component in achieving this goal. This project is designed to build off the significant investment libraries and funders are making in CT programming

and to address the challenges that library staff are facing in demonstrating and communicating the impact of their CT programs.

### Need 1: Broadening participation in CT through out-of-school CT programs

In the decade since Wing's initial call to action, significant effort has been made to try and integrate CT into formal school contexts. This has included the development of new curricula across the K-12 spectrum (e.g. the Scalable Game Design program (Reppening et al., 2010)), renewed initiatives to train new CS teachers (e.g. Cuny 2011; 2015), and state-level frameworks and standards that incorporate CT like the K-12 Computer Science Framework and the Next Generation Science Standards which includes CT as a core scientific practice. While progress is being made to bring CT into K-12 classrooms, there are still significant challenges associated with this approach. These challenges include scheduling time for new content into an already packed school day, preparing overburdened educators to teach new concepts or old concepts in new ways, and providing the necessary resources (computers, robotics kits, etc.) in schools and districts where such resources are already scarce (Google Inc., & Gallup Inc., 2016; Weintrop et al., 2016). The dependence on additional resources and experienced and qualified teachers makes the goal of bringing CT for all particularly difficult for schools that serve high numbers of at-risk youth from economically disadvantaged households. This has the potential to further exacerbate the persistent issue of underrepresentation among racial minorities and English-language learners in CT-related contexts. This is where out-of-school learning contexts have the potential to make a significant impact. While schools need to play a role in CT education, educators and CT advocates are starting to look outside of classrooms for opportunities to introduce youth to these essential 21st century skills, this includes museums (Horn et al., 2014), after-school programs (Kafai et al., 2009), toys and game-based learning contexts (Weintrop et al., 2016), and, importantly, libraries (Braun & Visser, 2017; Hong & Visser, 2016; Subramaniam et al., 2018). Libraries in particular are uniquely positioned to help with this issue due to their ubiquity and the fact that parents and children recognize libraries as "community institutions" (Braun & Visser, 2017, p. 9) that provide a myriad of learning opportunities, an important, but often-overlooked dimension of broadening participation (DiSalvo Reid & Roshan, 2014).

### Need 2: Understanding the Landscape of Computational Thinking in Libraries

Wing articulated a vision "that computational thinking will be an integral part of childhood education." (2008, p. 3721), and specifically called out informal learning spaces such as libraries as places where children learn. Libraries are uniquely positioned to provide physical, intellectual, and social access for all types of youth to develop digital literacies (Meyers et al., 2013; Thompson et al., 2014), including CT (Hong & Visser, 2016; Lee et al., 2017; Martin, 2017; Wing & Meyers, 2014). Braun & Visser (2017) conducted a nationwide scan of libraries offering CT or CS programs for youth and found that libraries are abundantly offering such programs. Librarians and researchers have been experimenting with CT programming with youth in libraries and have provided insights into multiple opportunities that libraries offer in the development of CT skills (ALA, 2018; Lee & Recker, 2018; Martin, 2017), including contributing to specific CT literacy practices and illuminating the application of CS in other disciplines (fondly known as CS+X), whereby core CT concepts can be applied in fields such as fashion design and architecture (Braun and Visser, 2017). However, very little empirical evidence has been produced that can point to the actual CT literacy practices and outcomes that libraries are well positioned to develop in young adults. The enthusiasm to offer CT programs through libraries to young people continues to grow, as evident in the [call for proposals](#) for the Lead Libraries (mentioned above) that received 393 applications (30 funded – \$20,000 to \$25,000 each) and [Hour-of-Code mini-grants](#) that received over 285 applications (250 funded - \$500 each). Evidently, interest and investment in CT programs is soaring. Through an evaluation report prepared by Caitlin Martin (who serves as an AB member of this project)<sup>1</sup>, it was clear that the majority of applications for the Lead Libraries RtC program were coming from libraries that are serving lower socioeconomic youth (86% of the applications) and youth of color (82% of the applications). Over two-

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<sup>1</sup> This report is not publicly available - a version of the report for the public is currently under preparation by PPAU and a summary was presented by Martin at ALA Midwinter Meeting in January 2019. An executive summary of this report is attached as a supporting document. This report is referenced multiple times in the *Statement of Need*. It is the single most important report that captures the lack of attention to CT assessment while interest in CT is soaring in public libraries.

thirds of programs focused on supporting girls in their proposed programs (67%). The application program portfolio ranged from programs focused on making, coding, gaming, solving community problems, unplugged activities, and many more. While this is encouraging, the research on what are the types of CT programs offered via libraries to youth and its associated strengths and opportunities is non-existent. This proposed research will fill in this gap in the research and provide resources to identify and measure the unique learning outcomes that result from the implementation of CT programs for youth in libraries.

### **Need 3: Assessing CT literacy development in libraries**

Whereas it is exciting that libraries' interest in CT literacy development is soaring and resources to support such programs are currently available, it is discouraging to see that almost 90% of the applicants to join the Lead Libraries for the RtC project stated that attendance and retention will serve as their primary means of measuring outcomes of their CT program as indicated in Martin's evaluation report. Only 10% of the grant recipients considered themselves expert in the area of youth CT learning assessments, and this percentage did not increase by the end of the grant program. Only 39% of grant recipients reported that they had demonstrated impact through outcomes in their programs. Of the 70 material resources developed and shared by grant recipients, only 9% of these materials included some form of assessment of CT. The grant recipients overwhelmingly reported they were unable to demonstrate the impact of their programs because they did not know what CT literacy development looked like or how to measure it.

The challenge of assessing CT is not simply unique to libraries as it is a persistent issue being actively researched in formal educational contexts. Panels examining this exact topic have been held at recent education conferences (Basu et al., 2019; Tissenbaum et al., 2018). A number of notable frameworks and assessments have been developed for CT that will help inform the proposed line of work. One common way to assess CT is through the use of programming activities, as can be seen in instruments such as the assessments in the Foundations for Advancing Computational Thinking curriculum which asks program comprehension questions in a multiple choice format (Grover et al., 2014), the Fairy Assessment which focuses on debugging incorrect programs (Werner et al., 2012), and the REACT system which uses an automated tool to evaluate student understanding in real-time as they author programs (Koh et al., 2014). A second increasingly common approach for assessing CT is the use of mathematics and scientific contexts for students to demonstrate CT mastery (e.g. Basu et al., 2018; Weintrop et al., 2014). There is also a growing number of tools and rubrics being developed to evaluate student work for CT, these often take the form of portfolio assessments and have been created for learner-authored programs (e.g. Brennan & Resnick, 2012) and e-textile projects (Kafai et al., 2014).

While CT researchers have made some advances in building the assessment tools for classroom learning contexts, similar research efforts focusing on CT practices in informal learning contexts such as libraries are lagging. The assessment frameworks and instruments mentioned above will serve as theoretical and practical inspiration for the proposed work but are not directly transferable to libraries given the dynamic and diverse constraints of library CT programs. CT programs in libraries come in different types (focused on making, gaming, etc.), utilize different formats and timing for programs (summer camps, weekend programs, weekly programs, special one-time programs, etc.), are facilitated by library staff with varying levels of CT and technical skills (can range from none to having a significant technical expertise), and vary in terms of size of support staff and level of participation by youth (attending a portion of the program to complete attendance in the entire program). All these factors provide unique opportunities and challenges to develop strategies for libraries to demonstrate and communicate their vital impact in measurable learning metrics to sustain CT programming, recruit mentors and community support, and attract external funding. This research intends to produce a bank of assessment tools for library staff, organized so as to make it easy for library staff to choose a specific assessment approach based on the format and context of the CT learning experience and the desired outcomes they seek to measure. This research will also advance our understanding of how to identify and measure CT learning beyond the classroom. It also has the potential to be adopted in other out-of-school learning environments such as in community centers, museums, after-school enrichment clubs. Finally, this work expands and compliments the theoretical CT assessment work that has been done in formal contexts.

### Alignment with IMLS project category

This project is in complete alignment with the [IMLS Strategic Plan](#), primarily goal 1, “Promote Lifelong Learning”, with a special focus in fulfilling objectives 1 and 2 within this goal (IMLS, 2018, p. 4-5). The project category *Lifelong Learning* adequately captures the underlying motivation and goals of the project. Identifying the CT learning outcomes that come out of library programs, being able to assess how libraries contribute to CT development and being able to improve library programming based on what is learned from these assessments will allow youth (particularly those underserved by classroom-based CT approaches) to develop these essential CT literacy practices and skills. Vogel (2017) developed one of the most comprehensive descriptions of benefits and projected impacts of acquiring CT for youth, which he extracted by convening a group of youth stakeholders that came up with the following: economic and workforce development; equity and social justice; competencies and literacies; citizenship and civic life; scientific, technological and social innovation; school improvement and reform; and fun, fulfillment and personal agency – all of which are goals of lifelong learning.

### **Project Design**

The project lead will be Dr. Mega Subramaniam (an expert in creating learning environments in libraries that foster the development of emerging digital literacies and served as an RtC Fellow) and Dr. David Weintrop (an expert on designing and evaluating CT learning environments and assessments). Both PIs will function as project managers, coordinating all activities with project partners, AB members, and participants. The time commitments and responsibilities of Drs. Subramaniam and Weintrop are described in the *Budget Justification*.

We have commitments from both partners (PPAU and YALSA), whose roles and responsibilities are described in their letters. An AB consisting of representatives from project partners (Marijke Visser, Senior Policy Advocate who leads the RtC portfolio of activities for PPAU and Linda Braun, the Continuing Education Consultant for YALSA), the external evaluator for RtC (Caitlin Martin from CKMartin Consulting), leading CT assessment experts (Victor Lee from Utah State University and Aman Yadav from Michigan State University), and an expert on overall public library assessment (John Bertot from the University of Maryland) will assist project PIs. We will conduct virtual meetings with AB members two times per year to obtain their continuous feedback on project activities including the development of data collection instruments and development of resources and will engage their specific expertise in the project activities as indicated below.

**Budget:** Funds are requested for: (1) salary and fringe benefits support for the PIs during the summer; (2) support for one full-time graduate student (including tuition, stipend, benefits, and fees); (3) travel support for PIs and graduate student, (4) stipends for project partners and AB members; and (5) participant incentives and research supplies. The total amount requested for the project is \$414,740. See *Budget*-related forms and justification for details.

The goals of this grant project are three-fold: (1) identify the CT literacy that can be developed in youth through programs that are offered through public libraries, (2) create assessment tools that can be used by library staff to accurately capture the CT literacy development through these programs, and (3) utilize these assessment tools to further improve and refine existing CT programs offered through public libraries or create new ones. This project focuses on the age group 11-18 for three reasons: (a) This is the primary age group for library-based CT programming. The recent call for RtC grant proposals mentioned earlier had the most applications (70%) that targeted programs at the age group 11-13 (the middle grades). Those awarded the grants in this age group also often ended up extending their programs to include 14 and 15 years olds (information obtained from post-grant survey, reported by Martin); (b) The Train the Trainer (T3) group (led by YALSA) that we intend to partner with is focused on the age group of 11-18; and (c) Focusing on a narrower age range will allow the project to create more precise and accurate CT assessment instruments. This stems from the fact that CT activities and the underlying skills and practices shift based on the age of the learner (i.e. CT learning outcomes for a 5-year old will vary significantly from a 15-year old). Given the paucity of rigorous CT assessments for library contexts amidst its growing need, beginning with a smaller age range will make the problem more tractable. Expanding the assessments to include younger learners is one potential avenue of future work.



Based on the presented needs and goals, the existing literature on CT assessment, and challenges and gaps identified in the *Statement of National Need* above, this research will be guided by the following three sets of research questions (RQ) looking at CT outcomes, CT assessment, and impact on practice:

**CT Outcomes RQ:** What CT learning opportunities currently exist for youth (ages 11-18) in public libraries and what skills and practices (CT literacy) do they promote? [Fulfilling Need 1 and 2, and Goal 1]

**Outcomes subRQa:** What are the specific learning outcomes related to CT literacy that are present in library programming?

**Outcomes subRQb:** Who participates in CT learning opportunities offered at libraries? Why do they choose to participate?

**CT Assessments RQ:** How can the CT literacy that develops through library programming be assessed? [Fulfilling Need 2 and 3, and Goal 2]

**Assessment subRQa:** What CT assessment tools and strategies currently exist for library contexts (if any)? What CT concepts and practices do these assessments measure? What CT concepts and practices are not currently covered by existing tools?

**Assessment subRQb:** How can CT assessments be designed so as to be flexible enough to work across differing contexts and programs, and populations that participate in library CT programming?

**Assessment subRQ2c:** What information and classifiers need to accompany a CT assessment to help library staff effectively choose and administer CT assessments?

**Impact on Practice RQ:** How can a suite of CT assessments be used to demonstrate the impact that libraries have on the development of CT literacy? [Fulfilling Need 3, and Goal 3]

**Impact on Practice subRQa:** In what ways can CT assessment materials be used to inform the development and improvement of CT youth programs at their libraries?

**Impact on Practice subRQb:** How can library staff use the results of applying CT assessment to advocate for more resources for CT programs at their libraries?

Below, we break down the project by year to highlight the methods we will use to address these questions. A summary of data collection and outcomes are presented later in **Table 1**.

### **Research Plan, Year 1 (July 2019 - June 2020)**

**Goals:** The focus of the first year is to identify CT literacy that youth (ages 11-18) can develop through CT programs offered in public libraries, specifically addressing the CT Outcomes RQs above. The first year of the project will be devoted to understanding the current state of CT programming and assessment in libraries and conducting a systematic review of the landscape of CT assessment research and materials (broadly defined).

**Methods:** We will conduct virtual interviews with 50-60 public library staff serving ages 11-18 nationwide and educators/staff from other informal learning environments and organizations who have offered CT programs and gather the materials they have used. Recruitment efforts will be supported by our project partners (PPAU and YALSA) through their existing networks of RtC grant applicants, RtC grant recipients, YALSA members, and through their past and current collaborators (i.e. Association for Rural and Small Libraries, Development without Limits, Chief Officers of State Library Agencies, Black Girls Code, National Center for Women in Technology (NCWIT), Google, Hispanic Heritage Foundation, etc.). Interview questions will provide insight into their understanding of what CT literacy is, what are the backgrounds of youth that they have worked with, what experience they have with CT and assessment (in general), their goals related to offering CT programming, how they measure CT/CS learning outcomes, what data they collect to assess their programs, what challenges they face in terms of assessing their programs, what their future goals for CT are, and what scaffolds and supports they would like for improving their CT programming. We will obtain feedback on the interview questions from our AB members and will pilot the interview protocol before conducting the actual interviews. We will also conduct one virtual focus group with the T3's first cohort of library staff and SLAs (12 staff), one virtual focus group with the T3's coaches (5 librarians from the RtC Lead Libraries), and another in-person focus group at the 2019 YALSA Symposium. Given our desire to understand the current state of CT in

libraries and a recognition of the diversity of contexts and audiences libraries serve, focus groups and interviews will help us understand where libraries currently are and, therefore, tailor the assessments to fit with the current state-of-practice and support library professionals where they currently are. These focus groups will be tackling similar questions, facilitated by our project partners. Concurrent with these first-year activities, we will conduct a systematic review and synthesis of the currently dispersed research, worked examples, and shared practices associated with CT in libraries, paying special attention to the variation in the types of CT programs and their formats, assessment and evaluation of programs, and how assessment results are shared and utilized (if any). We will also assemble a collection of currently in-use CT materials and assessments through our interviews and focus groups that will complement the literature and further fill in the gaps to paint a fuller picture of the current landscape of CT in libraries. Institutional Review Board (IRB) application to work with human subjects for Year 1 data collection is currently under review.

**Data analysis:** All data generated will be transcribed and analyzed using established qualitative methods. This includes importing interview/focus group transcripts into the qualitative analysis software Dedoose, generating a codebook based on the RQs and existing knowledge, and using an iterative, line-by-line coding procedure to refine themes as they emerge (Lincoln & Guba, 1985; Strauss & Corbin, 1998). Typologies of CT programs offered through libraries will be developed, along with a catalog of learning outcomes and data collection tools and strategies that are currently used for evaluating CT programs. We will also analyze the data to identify how this typology relates to similar efforts looking at CT across different contexts (e.g. Math and Science (Weintrop et al., 2016) and archival sciences (Underwood et al., 2018)). In doing so, this work contributes to the growing literature on the nature of CT across different contexts.

**Expected outcomes:** The outcome of the first year will be a typology of the current state of CT programs offered through libraries, along with a catalog of learning outcomes, and CT program materials, resources and data collection tools and strategies currently in-use for evaluating CT programs. We will share the results of Year 1 via the [RtC website](#), YALSA and PPAU communication channels (including their collaborators' channels), and research articles (e.g. in the Journal of the Association for Information Science and Technology and CS Education Journal) and a presentation at the ALA Annual Meeting in 2020.

### **Research Plan, Year 2 (July 2020 - June 2021)**

**Goals:** The second year will focus on the CT Assessments RQs. We will be primarily dedicated to developing the bank of assessment tools to capture CT literacy development, with extensive input from library staff and teens.

**Methods:** We will start with the data gathered in Phase 1 to generate an initial set of assessment tools. These tools will address the most salient challenges in capturing outcomes articulated in the interviews and focus groups and the resulting typology of CT programs and evaluation of CT programming materials that were created in Phase 1. We will conduct 3 online and one face-to-face participatory design sessions with the T3 participants (which at that time will be SLAs and library staff from 50 states and 5 territories) using the participatory design (PD) method, whereby we will engage these groups to obtain external feedback on the format and content of the tools developed and continue to develop prototypes of these tools in partnership with our research team (Druin, 1999, 2005). PD is an especially useful method for working with practitioners (in this case, library staff) as it provides insights that might otherwise be missed by researchers; as Titlestad et al. (2009) note, "A key PD principle is to bridge and blur the user-designer distinction from both directions, through mutual learning processes" (p. 31). The online sessions will be conducted via WebEx (with a maximum of 7-8 people in a session), and the face-to-face PD session will take place at the 2020 YALSA Symposium, where about 110 library staff and SLAs were already planning to gather for T3 for a project exchange. The first two PD sessions (which will take place online) will be focused on tailoring the tools to best fit the specific learning outcomes that were identified through Phase 1. At the in-person PD session (which we will facilitate with our project partners), we anticipate gathering feedback on how our tools can be adapted by individual libraries based on the types of CT programs that they offer and outcomes that they are interested in, by giving

them the tools that we have developed and engaging them in a design thinking process where they tweak our tools to meet their needs. We will then seek our AB members' expertise by presenting them the feedback that we have received from these design sessions and engaging them in advising us on the revisions that are further needed for the assessment tools. As a result of designing tailored tools with the T3 participants and gauging the types of CT programs that they are trying to assess, our research team will contact a subset of these participants (5-8 libraries) to utilize these assessment tools as a means to evaluate their own programming. These 5-8 libraries will be carefully selected to ensure the entire typology of CT literacy programming is represented in the selected pool of libraries. The selected libraries must have CT programs that cover all the age ranges that we have been focusing on - ages 11-18 (including CT programming for subgroups within that range, e.g. 11-13), and serve diverse constituencies of youth. We will conduct pre- and post-program interviews with the library staff that will be implementing these programs and deploying these assessment tools. We will obtain feedback on the interview questions from our AB members. During the pre-program interview, we will ask them about the goals and learning outcomes of their program, the planning, recruitment, implementation of their CT program, and how they will be adapting and deploying the assessment tools. After the program implementation, we will be doing post-interviews with them to learn how the implementation and assessment of the program took place and any challenges that were associated with the administration of the CT assessment tools. These libraries will share the resulting data from the assessment tools with the research team. We will analyze the resulting datasets with them and mentor them to communicate the impact of CT programs to their stakeholders.

**Data analysis:** Data—including transcripts from the design sessions as well as any material artifacts will be analyzed as it is collected, with results implemented into future sessions. This iterative process of testing, getting feedback, and revising materials is one of the strengths of PD work, especially as the end-users are involved in all steps of the design process, resulting in a final set of CT literacy assessment tools. Data from the pre- and post-program interviews (from 5-8 subset libraries) will be analyzed similar to the process described in Phase 1. The resulting datasets from the administration of CT assessment tools will be analyzed using appropriate qualitative and quantitative methods (depending on the tools and data gathered).

**Expected outcomes:** A bank of assessment tools to measure CT literacy will be developed, mapped to all the learning outcomes found in Year 1, including information and classifiers that will help library staff effectively choose and administer CT assessments. A data analysis guide will also be developed to provide guidance to library staff on conducting analysis of the data that they have collected. Using a multiple case-study approach, the data collection in Year 2 will be used to create case studies (which will include the outcomes measured, tools used, analysis, and impact). The variations of use of these assessment tools will be illuminated through the production of 5 to 8 different case studies in a case study publication, which will be distributed to library staff nationwide. One research article will be published in a journal focusing on research-practice partnerships or design-based approaches such as *the Journal of the Learning Sciences*, and a presentation at the ALA Annual Meeting in 2021.

### **Research Plan, Year 3 (July 2021 - June 2022)**

**Goal:** In the final year of the project, our focus shifts from instrument development to understanding how the assessments can impact practice, focusing on the Impact on Practice RQs. Specifically, we will deploy and validate our assessment tools to further improve and refine existing CT programs offered through public libraries and to create new ones.

**Methods:** We will have an open nationwide call for any public libraries to use our tools (selecting about 15 public libraries offering CT programs for youth at rural, suburban, and urban areas). We will select a wide range of types of CT programs that were not previously represented in the Year 2 case-studies, to ensure we further validate the ability to use our assessment tools to assess CT literacy development in a variety of formats and types of CT programs. We will again do pre- and post-program interviews with these 15 libraries, similar to year 2 activities. This cohort of 15 libraries will administer the assessment tool, conduct analyses of the data collected, communicate the impact of their program, and use it to refine/inform the next iteration of their program, with mentorship from the project team. They will document all their activities in a work process



template that will be provided to all the 15 libraries, so that we will be able to track decisions that they have made and why (i.e. why use tool A and not tool B). The research team will provide guidance to these libraries and also determine what additional supports library staff need to conduct such work. During the final stage of the project (last five months), we will work closely with our partner organizations, AB members, and the SLAs from T3 to share the bank of assessment tools (including an expanded data analysis guide and information/classifiers for choosing suitable assessments), case study publications, and recorded webinars around the country. We will also engage with the larger community of library educators and researchers through presentations at library meetings and national library conferences and national conferences for CS/CT educators. We will work with partner organizations and the cohort of 15 libraries to co-host 2-3 national webinars for library staff to introduce them to the bank of assessment tools that have been developed, and how it can be used at the initial stage of the design and development of CT programs for youth.

**Data analysis:** The data collection in Year 3 will be used to create in-depth case studies. Using a multiple case-study approach, the rich dataset on each of the 15 participating libraries (the program details, the data collected from youth and analysis, pre- and post-interviews with library staff, how they have used the outcomes of assessments to communicate impact) will be analyzed. Additionally, data generated during this phase that will assist us in evaluating success include visits to the project website, enrollment in and feedback on webinars, and feedback on presentations to various academic and practitioner communities.

**Expected outcomes:** The case studies and webinars will be widely shared through our project website, YALSA and PPAU channels, partners and AB members’ networks, social media, and researchers and librarians at national/regional library conferences (i.e. ALA Midwinter Meeting in 2022, YALSA Symposium 2021, and ALA Annual Meeting in 2022) as well as conferences that focus on CS education, broadening participation in STEM, and youth and digital media (i.e. Connected Learning Summit, ACM SIG CS Education Conference).

As each year’s data analysis and outcomes inform the development of data collection instruments for the upcoming years of this project, IRB application for Year 2 and 3 will be pursued three months before the actual beginning of the research activity for those years.

Table 1. A summary of outcomes, data sources, and targets by year.

| Year                 | Goals & Needs Addressed  | Data sources  | Measurable Outcomes   |
|----------------------|--|---|---|
| 1<br>(07/19 - 06/20) | Identify CT literacy that youth (ages 11-18) can develop through CT programs offered in public libraries<br><br>Needs: 1 & 2 | Interviews with 50-60 library staff and staff from other informal learning environments<br>3 focus groups (20 library staff)<br>Systematic review of literature on CT assessment & currently in-use library CT materials                        | <ul style="list-style-type: none"> <li>• Relevant research analyzed</li> <li>• CT literacy in libraries defined</li> <li>• Typology created</li> <li>• CT learning outcomes catalog</li> <li>• CT program materials and data collection tools currently in-use</li> <li>• Two academic publications</li> </ul>                |
| 2<br>(07/20-06/21)   | Create assessment tools to capture CT literacy among youth in libraries<br><br>Needs: 2 & 3                                  | Participatory design sessions with SLAs and library staff (approximately 110 library staff will be involved)<br><br>Pre-post program interview with 5-8 libraries (approximately 12-16 staff), datasets from administration of assessment tools | <ul style="list-style-type: none"> <li>• Bank of assessment tools created, including accompanying information and classifiers</li> <li>• Data analysis guide</li> <li>• Library staff report increase of understanding of CT impact</li> <li>• 5-8 case studies ready to share</li> <li>• One academic publication</li> </ul> |

|                            |  |  |   |
|----------------------------|--|--|---|
| <p>3<br/>(07/21-06/22)</p> | <p>Support library staff to utilize the bank of resources to inform the development and improvement of CT youth programs at their library.</p> <p>Disseminate finalized tools and case-study publications widely</p> <p>Needs: 3</p> | <p>Completed work process template including CT program details, data collected, and outcomes of assessment for each participating library and pre-post program interview with 15 libraries (approximately 15 staff)</p> <p>Website statistics<br/>Webinar enrollment<br/>Presentation of findings</p> | <ul style="list-style-type: none"> <li>• Library staff report increase of understanding of CT impact and ability to use data collected to communicate impact</li> <li>• 15 case studies ready to be shared</li> <li>• 200+ resource/tools/case study downloads.</li> <li>• 100+ unique participants across three webinars.</li> <li>• 3+ presentations for libraries &amp; CS education.</li> </ul> |
|----------------------------|--|--|---|

**Diversity Plan**

A key strength of the proposed project is its national scale and commitment to obtain the voices of library staff serving diverse constituencies, particularly youth living in low-income, immigrant, and rural communities. It is expected that by engaging such staff in our study, we will be able to capture the learning outcomes from CT programs that are offered in under-resourced and under-staffed libraries across the nation. In doing so, we will reach a diverse population of youth, including those that have historically been underrepresented in computing. Our commitment to diversity is evident in all aspects of the project design. In Year 1, through our partners and AB networks (see the list of diverse partner networks in *Project Design* section above), we will recruit public library staff and staff from other informal learning environments working with youth in urban and rural communities across the country to take part in focus groups and interviews. PI Subramaniam has demonstrated success in doing such recruiting for the recently-completed [ConnectedLib](#) project (IMLS funded). In Year 2, we will work with the T3 participants who will come from 50 states and 5 territories, where each of the respective SLAs are currently recruiting front-line staff that are working with a wide range of youth from historically underrepresented populations, and particularly those who serve in small and rural libraries. The libraries selected for the first and second set of case studies (in Year 2 and 3) will also serve diverse constituencies, serving urban, suburban, and rural populations, and vary in terms of size, resource, and staffing. In our dissemination efforts, we will target library staff working in traditionally underserved communities, with the ultimate goal of these libraries “seeing themselves” in the case studies that will be produced, and having virtual webinars that will reach library staff that often cannot afford to attend conferences. Throughout the grant, we will seek advice and feedback from the AB as well as from participants to ensure that the project meets [equity, diversity, and inclusion goals](#). Collectively, these individuals will represent libraries from across the country of various types, capacities, sizes, geographical areas, and services to underrepresented populations. The AB members for this project were carefully selected because of their past experiences in working with diverse libraries and/or communities.

**National Impact**

Contribute results that are adaptable - benefitting multiple institutions and diverse constituencies

This project will support a national and immediate need to capture and quantify CT literacy development among youth who participate in CT programming through public libraries. Project outcomes include: (1) A typology of CT programs offered through libraries, along with a catalog of learning outcomes that can be achieved through CT programs for youth in libraries; (2) a bank of assessment tools for capturing CT literacy development through library programs, mapped to all the learning outcomes, including information and classifiers that will help library staff effectively choose and administer CT assessments; (3) A data analysis guide will provide

guidance to library staff on conducting analysis of the data that they have collected; and (4) Case study publications comprised of various flavors of CT programs (differing in terms of format, types, age groups, assessment used, staff, resources, etc) and how they communicated the impact of CT programs on youth. Employing a design-based approach and PD methods, the PIs will conduct research activities that will result in the project outcomes above *with* library staff. As such, this research project is grounded in practice, involving library staff to provide input in every phase of the proposed project that includes answering the research questions to identify the CT literacy learning outcomes through interviews and focus groups with approximately 90 library staff, and using these answers to develop the resulting bank of assessment tools through online and in-person PD sessions with approximately 135 library staff. Additionally, 20 libraries (5 in year 2 and 15 in year 3 who serve diverse constituencies) will be using the developed bank of tools to collect data, utilize our data analysis guides to assess their CT programs, and provide feedback on these resources as they use it. This allows for greater adaptability of our resources to libraries from across the country that differ in types, capacities, sizes, geographical areas, and populations that they serve.

#### Contribute results that will transform practice

As mentioned in the statement of national need, interest and offering in CT literacy programs is soaring in libraries as libraries are experimenting with offering CT literacy programs that will hopefully broaden participation of underrepresented youth. While this experimentation is exciting, to position libraries as mature sites for CT literacy development, libraries need to produce empirical evidence that communicates the impact that they have in youth's CT literacy development. The deliverables from this project can be used by library staff nationwide to design, develop, implement, and assess youth CT programs, and can be used to communicate the impact of their programs to policymakers, funders, and other stakeholders – ultimately transforming libraries into prime out-of-school spaces for CT literacy development.

PI Subramaniam was the lead PI for the [Phase II of the RtC program](#), where she worked with a group of youth-services instructors to incorporate CT into their existing courses in their MLIS programs. She will share these deliverables of these projects developed through this research grant with these instructors so that they can incorporate these resources into their courses. The deliverables will also be shared with the entire youth-services library educator community through the appropriate listservs. Subramaniam will also be incorporating these resources into her INST651 course (*Promoting Rich Learning with Technology*) focused on designing, developing, and assessing technology-based programs in public and school libraries. INST651 was developed as part of the core offerings for the [Youth eXperience \(YX\) specialization](#) in the MLIS program and [YX Certificate](#) program—developed through generous funding from IMLS. This will ensure that pre-service librarians are exposed to these available assessment tools even before they enter the workforce.

#### Sustaining the results beyond the grant period

The resulting resources will be licensed under a Creative Commons Attribution-NonCommercial-ShareAlike license (CC BY-NC-SA). This license will encourage wide and flexible adoption of our tools and resources by allowing others to remix, tweak, and build upon them non-commercially and use them in their existing professional development contexts, provided they credit project personnel and license their new creations under the same terms. Following the three years of this project, PIs will continue to add to the bank of assessment tools through crowd-sourced tools and analysis that will be produced by students taking INST651 as mentioned above and library staff nationwide who can upload and share their tools and usage stories via our project website. The deliverables for this project will also be available through the RtC website, which is maintained by ALA staff, and will continue to be maintained and promoted through the ongoing support that is provided by Google, Inc.

**Year 1: July 2019 – June 2020**

|   | July | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
|---|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Developing interview/focus group protocols & pilot testing protocols                | ■    | ■   |     |     |     |     |     |     |     |     |     |     |
| Recruitment of interview & focus group participants                                 |      | ■   |     |     |     |     |     |     |     |     |     |     |
| Virtual meetings with advisory board  | ■    |     |     |     |     |     | ■   |     |     |     |     |     |
| Virtual focus groups with T3 participants & coaches                                 |      |     | ■   |     |     |     |     |     |     |     |     |     |
| Focus group at YALSA Symposium  |      |     |     |     | ■   |     |     |     |     |     |     |     |
| Virtual interviews  |      |     | ■   | ■   | ■   | ■   | ■   | ■   |     |     |     |     |
| Systematic review/synthesis of relevant research and practices in CT in libraries   | ■    | ■   |     |     |     |     |     |     |     |     |     |     |
| Assemble collection of currently in-use CT materials and assessments                |      |     | ■   | ■   | ■   | ■   | ■   |     |     |     |     |     |
| Focus groups/interviews data analysis   |      |     |     | ■   | ■   | ■   | ■   | ■   | ■   | ■   |     |     |
| Writing & submitting first two research papers                                      |      |     |     |     |     |     |     |     | ■   | ■   | ■   | ■   |
| Presentation at ALA Annual  |      |     |     |     |     |     |     |     |     |     |     | ■   |
| IRB application for Year 2 & 3 activities and development of associated instruments |      |     |     |     |     |     |     |     |     |     | ■   | ■   |

**Year 2: July 2020 – June 2021**

|   | July | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
|---|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Virtual meetings with advisory board  | ■    |     |     |     |     |     | ■   |     |     |     |     |     |
| Development of initial assessment tools   | ■    | ■   | ■   |     |     |     |     |     |     |     |     |     |
| Virtual participatory design sessions   |      |     | ■   | ■   |     |     |     |     |     |     |     |     |
| In-person participatory design session at the YALSA symposium                       |      |     |     |     | ■   |     |     |     |     |     |     |     |
| Development of data analysis guide  |      |     |     |     |     | ■   | ■   |     |     |     |     |     |
| Development & refinement of assessment tools & accompanying information/classifiers |      |     | ■   | ■   | ■   | ■   | ■   | ■   | ■   | ■   |     |     |
| Selection and recruitment of 5-8 T3 libraries for case-study development            |      |     |     |     |     |     | ■   |     |     |     |     |     |
| Pre-program interviews with case study libraries                                    |      |     |     |     |     |     |     | ■   |     |     |     |     |
| Case study libraries utilize tools  |      |     |     |     |     |     |     | ■   | ■   |     |     |     |
| Post-program interviews and analysis mentoring                                      |      |     |     |     |     |     |     | ■   | ■   |     |     |     |
| Case-study production and publication   |      |     |     |     |     |     |     | ■   | ■   | ■   | ■   | ■   |
| Presentation at ALA Annual  |      |     |     |     |     |     |     |     |     |     |     | ■   |



**Year 3: July 2021 – June 2022**

|   | July | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
|---|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Virtual meetings with advisory board  | ■    |     |     |     |     |     | ■   |     |     |     |     |     |
| Recruitment and selection of 15 libraries   | ■    | ■   |     |     |     |     |     |     |     |     |     |     |
| Pre-program interviews with case study libraries                                  |      |     | ■   | ■   |     |     |     |     |     |     |     |     |
| Case study libraries utilize tools, conduct analysis, share impact with PIs       |      |     |     | ■   | ■   | ■   |     |     |     |     |     |     |
| Post-program interview  |      |     |     |     | ■   | ■   |     |     |     |     |     |     |
| Case-study production and publication   |      |     |     |     |     | ■   | ■   | ■   |     |     |     |     |
| Co-hosting webinars   |      |     |     |     |     |     |     |     | ■   |     | ■   |     |
| Dissemination of developed resources and case studies through partner, T3, and AB |      |     |     |     |     |     |     | ■   | ■   | ■   | ■   | ■   |
| Research presentations at academic conferences                                    |      |     |     |     |     |     |     | ■   |     | ■   | ■   |     |
| Presentations at library conferences, including ALA Annual                        |      |     |     |     |     |     | ■   | ■   | ■   | ■   | ■   | ■   |
| Articles submitted to practitioner and research venues                            |      |     |     |     |     |     |     |     | ■   | ■   | ■   | ■   |



## DIGITAL PRODUCT FORM

### Introduction

The Institute of Museum and Library Services (IMLS) is committed to expanding public access to federally funded digital products (e.g., digital content, resources, assets, software, and datasets). The products 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. Because technology is dynamic and because we do not want to inhibit innovation, we do not want to prescribe set standards and practices that could become quickly outdated. Instead, we ask that you answer questions that address specific aspects of creating and managing digital products. Like all components of your IMLS application, 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

All applications must include a Digital Product Form.

- Please check here if you have reviewed Parts I, II, III, and IV below and you have determined that your proposal does NOT involve the creation of digital products (i.e., digital content, resources, assets, software, or datasets). You must still submit this Digital Product Form with your proposal even if you check this box, because this Digital Product Form is a Required Document.

If you ARE creating digital products, you must provide answers to the questions in Part I. In addition, you must also complete at least one of the subsequent sections. If you intend to create or collect digital content, resources, or assets, complete Part II. If you intend to develop software, complete Part III. If you intend to create a dataset, complete Part IV.

### Part I: Intellectual Property Rights and Permissions

**A.1** What will be the intellectual property status of the digital products (content, resources, assets, software, or datasets) you intend to create? Who will hold the copyright(s)? How will you explain property rights and permissions to potential users (for example, by assigning a non-restrictive license such as BSD, GNU, MIT, or Creative Commons to the product)? Explain and justify your licensing selections.

**A.2** What ownership rights will your organization assert over the new digital products and what conditions will you impose on access and use? Explain and justify any terms of access and conditions of use and detail how you will notify potential users about relevant terms or conditions.

**A. 3** If you will create any products that may involve privacy concerns, require obtaining permissions or rights, or raise any cultural sensitivities, describe the issues and how you plan to address them.

## **Part II: Projects Creating or Collecting Digital Content, Resources, or Assets**

### **A. Creating or Collecting New Digital Content, Resources, or Assets**

**A.1** Describe the digital content, resources, or assets you will create or collect, the quantities of each type, and the format(s) you will use.

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

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

## **B. Workflow and Asset Maintenance/Preservation**

**B.1** Describe your quality control plan. How will you monitor and evaluate your workflow and products?

**B.2** Describe your plan for preserving and maintaining digital assets during and after the award period of performance. Your plan may address storage systems, shared repositories, technical documentation, migration planning, and 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 C.F.R. § 200.461).

## **C. Metadata**

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

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

**C.3** Explain what metadata sharing and/or other strategies you will use to facilitate widespread discovery and use of the digital content, resources, or assets created during your project (e.g., an API [Application Programming Interface], contributions to a digital platform, or other ways you might enable batch queries and retrieval of metadata).

#### **D. Access and Use**

**D.1** Describe how you will make the digital content, resources, or assets 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).

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

### **Part III. Projects Developing Software**

#### **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) it will serve.



**A.2** List other existing software that wholly or partially performs the same functions, and explain how the software you intend to create is different, and justify why those differences are significant and necessary.

## **B. Technical Information**

**B.1** List the programming languages, platforms, software, or other applications you will use to create your software and explain why you chose them.

**B.2** Describe how the software you intend to create will extend or interoperate with relevant existing software.

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

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

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

### **C. Access and Use**

**C.1** We expect applicants seeking federal funds for software to develop and release these products under open-source licenses to maximize access and promote reuse. What ownership rights will your organization assert over the software you intend to create, and what conditions will you impose on its access and use? 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 and justify any prohibitive terms or conditions of use or access and detail how you will notify potential users about relevant terms and conditions.

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

**C.3** Identify where you will deposit the source code for the software you intend to develop:

Name of publicly accessible source code repository:

URL:

## **Part IV: Projects Creating Datasets**

**A.1** Identify the type of data you plan to collect or generate, and the purpose or intended use to which you expect it to be put. Describe the method(s) you will use and the approximate dates or intervals at which you will collect or generate it.

**A.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?

**A.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).

**A.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.

**A.5** What methods 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).

**A.6** What documentation (e.g., data documentation, codebooks) 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?

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

**A.8** Identify where you will deposit the dataset(s):

Name of repository:

URL:

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