MAKING THE CONNECTION

COMPUTATIONAL THINKING AND EARLY LEARNING FOR YOUNG CHILDREN AND THEIR FAMILIES

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"In the nonstop tsunami of global information, librarians provide us with floaties and teach us to swim."—*Linton Weeks ("The Old-Fangled Search Engine,"* The Washington Post, *January 13, 2001)*

Libraries have long been an important source of traditional early literacy learning and support for young children and their grownups. However, as technology continues to grow and change, traditional literacy skills alone may not be sufficient to solve twenty-first-century challenges. Children and adults are now in need of a larger set of skills to help them successfully navigate, consume, and create information across a variety of digital and analog formats—from the paper book, smartphone, and virtual assistant to the yet to be imagined. While traditional literacy skills are still crucial, they need to be supplemented with an emerging set unique to the digital landscape, often referred to as twenty-first-century competencies.

Twenty-first-century competencies have come to the forefront as a way of helping people develop essential media literacy skills, including the "ability to access, analyze, evaluate, create, and act using all forms of communication,"[1] and successfully navigate this digital landscape. These competencies are crucial for everyone, but in a constantly evolving, information-rich, technology-driven society, it is particularly critical to introduce these competencies to children and youth starting at a young age so they may be fully media literate and thrive as twenty-first-century world citizens. While the Institute of Museum and Library Services (IMLS) has identified an extensive list of twenty-first-century competencies for all ages,[2] Grover has put forth a simplified list of four twenty-first-century competencies for children and youth that schools are focusing on—creativity, critical thinking, collaboration, and communication—and argues that computational thinking should be the fifth competency emphasized for children and youth.[3]

Public libraries may already be supporting some aspects of these competencies for older children and youth in their library programming. However, it is important to consider how libraries are supporting these twenty-first-century competencies for young children, ages 0–9, and their families, especially the competency of computational thinking. Computational thinking, most simply, can be considered a replicable process that assists with completing a task or developing possible solutions to a problem. While computational thinking may seem too advanced for young children, it can, in fact, be introduced and encouraged in developmentally appropriate ways. Similar to early literacy and early math, emerging computational thinking concepts can be incorporated and encouraged, using play-based methods, in library programs and services, helping families build a foundation that will enable children to fully engage with more advanced computational thinking concepts as they grow and develop. Additionally, by being intentional with how they model, incorporate, and make computational thinking concepts accessible for *all* young children and families, library staff can reassert their dedication to equity and empowerment by making mastery of twenty-first-century competencies and media literacy skills achievable for everyone.

This article aims to empower library staff to embrace and integrate computational thinking concepts and skills into their programs and services for young children and their families by presenting the following information:

- an overview of computational thinking concepts and skills;
- detail on computational thinking's role in early childhood development and relationships with other early learning domains; and
- examples of how to integrate computational thinking into library programs and services for young children and families.

WHAT IS COMPUTATIONAL THINKING?

Computational thinking was first described in Seymour Papert's seminal research on children's computer culture in 1980 and Jeannette Wing's later work in 2008, and since then multiple definitions of computational thinking have arisen, but researchers have yet to agree on one universal definition.[4] In general, computational thinking can be thought of as an expressive or creative process that helps children and adults create solutions to a problem or complete a task in a manner that could be replicated by others. Problems can be as routine as "How do you tie a shoe?" or as complex as "How might humans survive on Mars?"[5]

Many early definitions of computational thinking shared conceptual elements with other academic fields like math, science, and engineering,[6] and emphasized computational thinking as akin to "thinking like a computer scientist" by developing solutions that could be effectively carried out by either a computer or a person.[7] However, more recent definitions shift computational thinking towards something beyond computer science, positioning it as a type of higher-order thinking or mindset that involves skills that are applicable across multiple fields. While the term's origins lie within computer science, computational thinking is now thought of as applicable to a variety of problem-solving situations[8] that do not require digital technologies, but can be expanded when partnered with them.[9] However, the use of digital technologies, coding for example, does not necessarily correspond to the use of computational thinking.[10]

Overall, the general concept of computational thinking is reflective of recent educational paradigm shifts that place a focus on higher-order critical thinking skills and other twenty-first-century competencies.[11] While the twenty-first-century competencies are all related, creativity shares strong ties with computational thinking. Though creativity was not identified in early descriptions of computational thinking, it has emerged as an important aspect of computational thinking's problem-solving mindset.[12] In fact, WGBH, the creators of *Aha! Island*, a television show and curriculum designed to introduce computational thinking to preschoolers and their families, defines computational thinking as "a creative way of thinking that enables children to identify and systematically solve problems."[13] Creativity serves as a fundamental catalyst in using computational thinking, and working with computational thinking skills can support creative thinking.[14]

Computational thinking concepts have grown out of identified computer science skills but can and should be universally applied to situations that include tech and those that do not. These concepts are applicable on the playground as well as in the classroom, in conjunction with high and low tech materials.

SUPPORTING COMPUTATIONAL THINKING

Computational thinking consists of a number of different concepts, which are classified as either skills (specific abilities that relate to computational thinking) or dispositions (broader character traits that support effective computational thinking). These concepts are broadly defined and can be applied to all ages and abilities as youth grow. The scaffolding nature of the skills allows young children to begin exploring them, even during the first few years of their lives.

COMPUTATIONAL THINKING SKILLS

Currently, there is not one universally agreed upon, definitive set of skills that support the computational thinking mindset, especially for young children. However, various organizations and scholars have identified a number of different skills that fall under computational thinking. For the purposes of this article, we have narrowed down the skills to the six most common (see table 1).

The development of each skill is interdependent on the other skills. Logic and evaluation develop as children explore the world, build knowledge, and experiment. Critical thinking skills, another twenty-first-century competency, emerge as children's logic and evaluation skills become more nuanced

Table 1. Definitions of common computational thinking skills[15]

COMPUTATIONAL THINKING SKILL	DEFINITION
Logic	Predicting and analyzing
Evaluation	Making judgments
Decomposition	Breaking down into parts
Algorithm design	Creating rules and sequential steps
Pattern recognition	Spotting and using similarities
Abstraction	Removing unnecessary detail

and complex. Decomposition and algorithm design both require problem solvers to understand the different components or steps that are needed in problem solving or to accomplish a task. When dividing a problem or solution into smaller, easily accomplished parts, a problem solver is decomposing. When those smaller components must be completed in a specific order, a problem solver is using algorithm design. Abstraction and pattern recognition both support the other skills and computational thinking more broadly. Abstraction is the act of reducing complexity by stripping away the extraneous details to get to the essential pieces of a task. Pattern recognition is identifying commonalities in material, actions, or steps that can help to classify the "problem" and identify possible solutions.

COMPUTATIONAL THINKING DISPOSITIONS

Also significant in the conversation of how to successfully support young children's emerging computational thinking skills is a set of important dispositions, sometimes referred to as "soft skills." These dispositions apply to the use of both traditional and "new" media[16] as well as to social interactions and experiences with no media at all. They allow children to be agile in their media literacy skills and use media of all kinds effectively, helping to build twenty-first-century competencies that enable them to live and learn in a connected world.

While there is no formal list of dispositions required to be fluent in the relatively new area of computational thinking, certain dispositions seem to be considered necessary for successful computational thinking. ISTE and CSTA are some of the only organizations to identify a specific list of dispositions that contribute to computational thinking.[17] "These dispositions or attitudes include:

- Confidence in dealing with complexity
- Persistence in working with difficult problems
- Tolerance for ambiguity
- The ability to deal with open ended problems
- The ability to communicate and work with others to achieve a common goal or solution"[18]

Two other researchers, Brennan and Resnick, add two additional dispositions to the list: *expressing* themselves through creative means and *questioning* concepts and ideas that are "taken for granted."[19]

These computational thinking dispositions may be familiar to those versed in whole child development, as they are relevant to what children need to succeed when living and learning in a connected world.[20] Providing developmentally appropriate, low-tech and high-tech opportunities for young children and their caregivers to "tinker, create, debug, persevere and collaborate" can support the growth and development of emerging dispositions and skills that are fundamental to computational thinking and various academic fields.[21] Furthermore, supporting the growth and development of these dispositions and skills can help children and youth to be collaborative, confident, creative, flexible, communicative, persistent, curious, and interested in experimenting, all crucial traits for living and learning in a media-diverse, highly connected world.

COMPUTATIONAL THINKING AND YOUNG CHILDREN

As computational thinking has become more widely accepted, it has fast become thought of as critical for academic success, even in early primary grades. Wing, one of the more recent drivers behind the computational thinking movement, has been quoted as saying that ideally "this learning should best be done in the early years of childhood" in order to provide for a solid foundation of skills[22] that are developed over time, because young children are naturally curious and are learning rapidly about the world around them.[23]

Computational thinking can actually be seen, and supported, from infancy onward. For example, very young children (birth to three years) have been found to use statistical patterns and modeling to learn language, social responses, and causation.[24] Strengthening a child's computational thinking mindset can help them, later in life, with handling more complex problems that cannot be solved by a more traditional trial and error method.[25] In addition, they will be better positioned to function and succeed in a world of ubiquitous and constantly evolving digital technology and new media.[26] Finally, given that computational thinking shares skills with early literacy, math, and scientific thinking, placing an emphasis on supporting computational thinking can also help support early learning skills across multiple developmental domains.

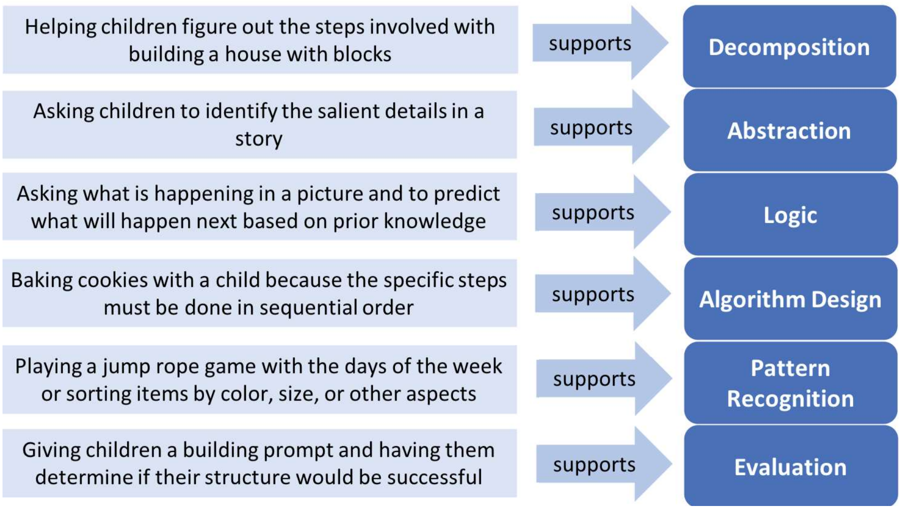
In fact, computational thinking and its core skills are closely related to a few domains of child development that have been identified as essential for school and lifelong learning by the National Education Goals Panel:[27] *approaches to learning*, *cognition*, and *language and literacy*.[28] *Approaches to learning* shares a strong connection with computational thinking. According to The Head Start Early Learning Outcomes Framework, the *approaches to learning* area covers the skills and abilities children need to accomplish goals, build knowledge, and be able "to successfully navigate learning experiences that are challenging, frustrating, or simply take time to accomplish."[29] On a basic level, setting and accomplishing goals and navigating challenging learning experiences, such as learning to read, consist of complex problems that children have to work through. Creativity, curiosity, and initiative also fall under the *approaches to learning* domain and share qualities with computational thinking. In addition to *approaches to learning*, computational thinking also shares strong ties with *cognition* and *language and literacy*. *Cognition* is split into two domains—mathematics development and scientific reasoning—which both share a variety of skills with computational thinking, including logic, evaluation, decomposition, patterns, and algorithms. Similarly, *literacy and language* share similar skills with computational thinking, such as pattern recognition, sequencing (which falls under algorithm design), logic, and evaluation.

Given the relationships between computational thinking and these important areas of child development, there is a pressing need to add a layer of intentionality in supporting computational thinking in young children. This is particularly key for at-risk and disadvantaged children who typically start school behind their more advantaged peers and may not have access to a variety of learning experiences, including those with digital technology; experienced mentors and facilitators; and other resources that might help to increase their computational thinking skills. Because computational thinking can be present in almost all activities for young children[30] (see figure 1), families and educators may already be using or encouraging computational thinking for their young children without being aware of it, possibly because they lack an understanding of the concept. Once parents, caregivers, and educators understand how everyday activities can support computational thinking skills, they can be more intentional with these activities, helping to strengthen the development of computational thinking skills.

COMPUTATIONAL THINKING AND LIBRARIES

While some schools have made progress in incorporating computational thinking concepts into their curriculum, it is likely that current K–12 and preschool educational practices do not fully support the development of the computational thinking mindset for young children,[31] even though it has been demonstrated that younger children use and would benefit from computational thinking teaching support.[32] Parents and caregivers could also play a crucial role in supporting computational thinking for children, but they may lack an understanding of its underlying

Figure 1. Examples of computational thinking in common activities for young children and families.



concepts and how to support it for their child. Including computational thinking vocabulary and activities in the settings where young children and families spend their time can introduce and reinforce these fundamental skills and dispositions in developmentally appropriate ways for *all* children as they grow, setting the stage for deeper understanding and complex use later on.

Out-of-school learning environments—such as libraries and museums—hold the potential to serve as a community-wide support system for young children and their grownups who are learning and practicing computational thinking concepts. Libraries, in particular, are well-situated to support computational thinking and have begun to make significant progress in supporting computational thinking for teens through library programs.[33] As many libraries are already offering a variety of free literacy and STEAM (science, technology, engineering, art, and math) programs for young children, they are uniquely positioned to support computational thinking for young children in a developmentally appropriate way as well. Furthermore, programs for young children offer opportunities to learn through play, which is an ideal method for introducing emerging computational thinking skills and dispositions in both individual and collaborative ways,[34] because it often includes rules and schemas as well as the development, sequencing, and enforcement of a child's own instructions—all concepts usually associated with computational thinking.

It is crucial that libraries take on this role of supporting computational thinking for young children and their families as libraries are not only strong in supporting early learning[35] but also in engaging families with young children.[36] Historically, these family engagement practices included supporting learning for parents and caregivers through techniques such as incorporating early learning tips and suggestions into programs and services.[37] However, given the increased attention on the library's important role in family engagement, these practices have begun to include opportunities that engage the whole family and encourage them to learn together.[38]

Family learning experiences—which sit at the heart of family engagement efforts—are ideal for supporting computational thinking. Family learning occurs when families interact around experiences, media, objects, and information to learn together. The grownups help to mediate the learning experience as active participants with their child, essentially creating a "state of togetherness in learning."[39] In addition, an important aspect of family learning is giving the grownups opportunities to learn more about the concepts and experiences they will be engaging in with their children to empower them in their role with learning support and scaffolding. Providing opportunities for family learning that support computational thinking and broader media literacy skills is crucial: It promotes grownups' active engagement in the child's learning and family bonding. When libraries provide opportunities for families and children to play and interact with computational thinking concepts, they are ultimately encouraging and bolstering families' intentional nurturing of their children's computational thinking mindset.

In addition, through free programs and services, libraries have the capability to reach and serve *all* children and families, especially those in underserved communities.[40] Families in underserved communities may lack the resources needed to be able to expose their children to opportunities and digital technologies that could support computational thinking.[41] By incorporating computational thinking activities and vocabulary into a variety of programs for children and families, libraries are providing inclusive opportunities for *all* families to engage with computational thinking concepts and increasing equity for the diverse communities they serve.[42]

SUPPORTING COMPUTATIONAL THINKING FOR YOUNG CHILDREN IN THE LIBRARY

Libraries have become early literacy leaders in their communities for families with young children through the ways that they have embraced and integrated early literacy and learning practices into their programs and other efforts. However, information is no longer contained in just one or two media formats. Supporting families as they work to navigate, communicate, learn, and play in a rapidly evolving digital landscape necessitates that libraries embrace and integrate computational thinking in a similar manner. For libraries to become leaders in encouraging computational thinking for families with young children, it is important to focus on *how* library staff can support computational thinking for young children, including both the skills and dispositions, alongside the other learning outcomes they already integrate into library experiences. Individual computational thinking skills and dispositions, as discussed, are not new and unique per se, but collectively they enhance current library objectives and practices and provide critical digital literacy skills necessary for living and learning in a connected world. Remixing traditional activities in innovative ways and introducing new kinds of learning tools can provide opportunities to support computational thinking for young children and their families, although just one program will not logistically or theoretically be filled with activities or tips that support all of the early literacy skills, computational thinking skills, early math, etc. As with any library program, individual skills are highlighted through engaging experiences for children and families, and when combined with other library programs, at-home activities, and outreach opportunities with other community organizations, over time, they provide access to new ideas that support a range of needed skills.

The following examples help demonstrate what supporting computational thinking can look like with young children and their families in library programs.[43] While these examples may look familiar, by adding a layer of intentionality around incorporating computational thinking, library programming can successfully support the development of computational thinking skills and other twenty-first-century competencies for young children and families. Hopefully these examples, which use both low- and high-tech tools, can serve as inspiration for how to integrate more opportunities to help young children grow their emerging computational thinking skills and dispositions.

0–3 YEAR OLDS PROGRAM: FACILITATED PLAY DATE

Play can take on many forms from facilitated play sessions with specific themes or objects to open free play with unrestricted access to material. Emerging computational thinking skills can be introduced through these activities. **Sorting**, or grouping like materials, is a precursor to **pattern recognition** that can easily be incorporated into facilitated play sessions by curating a selection of toys and manipulatives that can be organized or grouped based on discrete parameters, like color, shape, size, function, etc. In addition, facilitated play sessions are an opportunity to create a community for families with young children, support grownup-child interactions, and demonstrate how to incorporate early and emerging learning skills into informal and everyday activities.

When toddlers' play includes make believe and role playing, they explore the world around them while fostering computational thinking dispositions like creativity and curiosity.

Little Builders and Early Literacy Play Date are two play-based toddler programs that can support computational thinking. Little Builders is a library staff–facilitated program guided by caregivers. Families have access to a variety of building materials, along with a prompt to direct the building process, if needed. Some of the prompts are open-ended (e.g., "How would you travel to the moon?") to offer young children and their families developmentally appropriate opportunities for supporting **creativity**, time for **experimentation**, and opportunities for young children to gain **confidence** successfully solving problems. Others focus on the actions, such as "Build a tower with three different colored or shaped blocks." These types of everyday activities provide opportunities to practice computational thinking skills like **algorithms** and **decomposition** in developmentally appropriate play experiences initially with an eye toward applying these skills in a variety of situations as children grow.

Early Literacy Play Date is a library practitioner–facilitated program. Household objects, like empty cereal boxes, paper rolls, and cans, are transformed into maracas, building blocks, and toys, helping to support the computational thinking dispositions of **creativity** and **curiosity**. Grownups and young children talk, sing, and dance while playing. These programs also provide families access to informed library staff who can model grownup guided learning moments that support emerging computational thinkers. For example, library staff and caregivers can support emerging computational thinking skills by asking questions that help young children talk about the steps or order involved in their play and practice **cooperation**, an emerging disposition, by playing alongside or with another child.

4–6 Year Olds Program: Storytime

Storytimes offer a unique opportunity to support young children's learning while at the same time empowering grownups in their roles as a child's first teachers. While many preschool storytimes are geared toward children ages three to five, libraries often expect younger and older siblings to come along, making storytime a family affair. Libraries can easily infuse computational thinking into storytime. One example of a computational thinking–infused storytime was a celebration of the fiftieth anniversary of Eric Carle's iconic book, *The Very Hungry Caterpillar*, that included low-tech, play-based activities that supported computational thinking skills along with early literacy and early math.

This storytime began by reviewing the image-based, visual scheduler, which helps children, especially those with sensory integration challenges, navigate the order of the storytime program, make predictions, and see the computational thinking concept of **sequencing**, part of **algorithm design**, in action. Next, families played the ABC Body Game with preselected letter cards that, when ordered in a specific way, spell a word related to the theme of the program. The letter cards (Twist and Spell Cards) were placed in a bag and children took turns selecting individual letters. The group, as a whole, identified the name of the letter on the card and then individually made the shape of the letter with their bodies to the best of their abilities, matching the child pictured on the card. When children struggled to make the shape, the librarian prompted the group to practice **decomposition**. The group first looked to the top or bottom of the image, then identified what each body part was doing—the hands are extended up toward the sky in the letter "i," for example—and adjusted their own bodies, one part at a time. Once all of the cards were drawn, named, mimicked, and placed in the particular order, the mystery word was read and defined. When the word appeared in the stories shared later in the program, the librarian paused and drew attention to the letters in the matching order. Activities like this support a child's ability to **logically** organize and find **patterns** while also working **collaboratively** to solve a problem.

Following the opening game, the librarian shared *The Very Impatient Caterpillar* by Ross Burach and *The Very Hungry Caterpillar* by Eric Carle. These two books, with very different styles, explore the life cycle of a caterpillar and allow space for children to recognize **patterns** and make comparisons between the two. Between stories, families danced with scarves to a movement song that included four previously introduced ordered actions, or parts, featured in the song's verses: jump, shake, spin, and flap. Identifying the individual actions performed during the song and their order modeled the use of **decomposition** and **algorithm design** skills in play-based activities.

Sequencing and algorithm design are a fundamental part of Carle's book. As the story was read, a visual map of the story's events was created on the felt board, including the metamorphosis process and representations of the foods the caterpillar consumed. Felt pieces were added in the same order as the book to introduce families to **abstraction** and **algorithm design** skills. After reading, families made edible caterpillars on skewers using a selection of foods featured in Carle's book. Referring to the felt map or Carle's book, they added foods in a similar order, which provided another opportunity to support **sequencing**, **pattern recognition**, and **algorithmic thinking** in the program. Grownups were encouraged to ask questions that drew their children's attention to the order of the food. Sharing a book-inspired meal together sparked conversation, encouraged children and adults alike to make new community connections, and incorporated the **communication** disposition into low-pressure learning experiences. Several young children demonstrated other dispositions during the activity, such as **curiosity** and **experimenting**, when they tried foods that were new to them.

7–9 Year Olds Program: LEGO Club

Afterschool LEGO Clubs are almost as common at public libraries as storytime programs. These programs use low-tech tools, LEGOs, to offer building experiences that develop traditional literacy as well as computational thinking skills and dispositions. During one LEGO program, for children ages 7–11, the librarian encouraged young builders to apply their **creativity**, **tolerance for ambiguity**, and individual perspective to a monthly challenge, which consists of a "problem" that requires children to use computational thinking skills and dispositions to solve. Children are also guided to use a design strategy that includes four key elements: think, design, build, evaluate and modify.

For this program young makers built a replica of their town out of LEGOs. At first glance, the project seemed daunting, but computational thinking made it possible and fun. First, the whole group **collaboratively** decided what buildings and features were important to them and should be included in the replica, thus working on the computational thinking skills of **abstraction** and **decomposition**. Then the footprint for the replica, a map of sorts, was drawn on brown paper and locations for each creation were identified using spatial vocabulary like east and west, below and above. Due to time constraints, interest, and resources, not every building would be included in the replica, much like how a map designed for a specific use includes only necessary features. The

> **Sequencing is an important early literacy skill that helps children predict what happens next in a story, anticipate the next sound in a word, or word in a sentence. It is also essential to the computational thinking skill of algorithm design.**

builders used **abstraction** to decide what features they would include in the map and what others (extraneous information) they would not.

Once the map was created, makers then divided up into teams or worked individually to design and build the selected buildings and features for the rest of the ninety-minute program. Both experiences involved **collaboration**—children built together at the same time or individually contributed a part that supported or benefited the whole group project. Throughout the program, the young makers talked and consulted with each other and the librarian, growing their project-related vocabulary and social-emotional skills as well as practicing the computational thinking disposition of **communication**.

As individual buildings were completed, they were placed on the brown paper map. Some children built highly detailed, individual models while others worked on multiple, more basic, buildings. There was no assigned endpoint, so participants felt free to design, build, and modify at their own pace accommodating not only individual interests, but also various developmental stages. Not every building was completed, but the young makers **confidently** gave their grownups a tour of the replica before clean-up.

Accentuating vocabulary associated with computational thinking draws attention to the emerging skills and dispositions children and their families are practicing and will help them address and talk about new, unforeseen challenges and situations beyond the library program.

MULTI-AGE FAMILY PROGRAM: DIGITAL STORYTELLING

Digital storytelling programs provide families with multi-aged kids the opportunity to explore early literacy, strengthen bonds between grownups and children, celebrate shared family experiences, develop both the important computational thinking skills and dispositions outlined previously, and build new relationships between grownups in a community (one of the 5Rs of Family Engagement identified in PLA's *Ideabook*). The library's low-stress learning environment is an ideal place for this to happen.

During a Saturday workshop, families created personalized digital stories. Using library iPads and the ScratchJr app as storytelling tools, families remembered special events, celebrated family members, and retold traditional tales. After an icebreaker game and introductions, grownups and their children worked together in pairs or family groups to brainstorm a story of their own and talked about an event, person, or tale they wanted to feature. Identifying and then writing or drawing the places, order of important moments, actions, conversations, and characters on paper in a type of storyboard helped the storytellers explore the computational thinking skills of **decomposition**, **abstraction**, and **algorithm design** that they need to create a digital version of their story in ScratchJr, a free digital tool designed for young children that is a simpler version of the popular Scratch programming language.

After the brainstorming segment, families learned how to manipulate the ScratchJr app. Coding a story with ScratchJr (or the more robust version, Scratch) empowers children and their families to **tackle an ambiguous, open-ended "problem"** and be the authors, illustrators, directors, playwrights, programmers, set designers, and actors. Grownups and their children learned how to navigate the app, design characters, and connect blocks of code into **algorithms** that direct the story's events and the characters' actions and conversation. The programming teams **collaborated** and **communicated** to create and modify their story. The flexibility of the tool allows families to create stories in a style that reflects their storytelling traditions and incorporates their home language, with content that reflects their life experience (**self-expression**). They **tinkered** with the app's features, modified their story until it reflected their intentions, and then shared their digi-

Creating even simple digital stories using ScratchJr. encourages self-expression and helps underrepresented families see positive representations of themselves in stories, sometimes for the first time, and communicate their unique ideas and values. Diverse and divergent ideas are important for solving big problems.[44]

tal story (if they wished) with others at the workshop and with family members at home.

Limited access to digital devices and learning platforms like ScratchJr can be a hindrance to learning. Therefore, an iPad loaded with the ScratchJr app and tip cards to help users get started are freely available in the library so families can keep exploring the app and creating stories after the program, even if they do not have an iPad at home. Increasingly, library staff are providing supported, mediated access to resources, like expensive robots or devices, that may be otherwise out of reach for families.[45] Offering an array of digital storytelling experiences outside and inside the library provides families with multiple entry points to learning computational thinking skills and practicing the related dispositions.

CONCLUSION

As demonstrated in these examples, computational thinking can be incorporated into a variety of programs that libraries are already offering and adapted to meet the diverse needs of families in the communities they serve. Using the examples and information presented here, library staff can more confidently explore how to support computational thinking for young children and families in their community. There is no right way to encourage and build these computational thinking skills and dispositions for young children as they can be incorporated through countless techniques and activities. It may be challenging and unfamiliar at the beginning, but if taken one skill, disposition, and activity at a time while also *articulating to grownups the importance of what is being done*, library staff should find that it will get easier to incorporate computational thinking into their efforts to support learning for the families in their community.

By incorporating computational thinking skills and dispositions into their work with young children and their families, library staff are also supporting the key twenty-first-century competencies of creativity, critical thinking, collaboration, and communication for the young children in their community.[46] They are also engaging caregivers of young children with these competencies, helping them to be intentional with encouraging learning outside of the library. Most importantly, library staff are ensuring equitable access to a variety of learning opportunities and experiences for *all* children and families in their community, demonstrating the crucial role the library is positioned to play in supporting *all* children and families in a media-rich, highly connected world. PL

READ MORE

- Libraries Ready to Code, www.ala.org/tools/readyto code/home
- Computational Thinking for All, www.iste.org/explore/Solutions/Computational-thinking-for-all
- Computer Science in Early Childhood Education, https://k12cs.org/pre-k
- PBS KIDS Family & Community Learning, https://westernreserve.pbslearningmedia.org/collection/pbs-kids-family-community-learning

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