

## **Promoting Computational Thinking Skills for Blind and Visually Impaired Teens through Accessible Library Makerspaces**

**Project Overview:** This project addresses the IMLS National Leadership Grants for Libraries grant program *Goal 1: Build the workforce and institutional capacity for managing the national information infrastructure and serving the information and education needs of the public* and all three of its objectives, including developing replicable library programs, models, and tools to support learning (objective 1.1), collaborating with learning organizations (objective 1.2), and creating and facilitating opportunities for continuous learning for individuals with disabilities (objective 1.3).

The School of Information Sciences at the University of Illinois at Urbana-Champaign (UIUC) and the Champaign-Urbana (C-U) Community Fab Lab are requesting \$554,810 for a 2-year National Leadership Applied Research grant project, in partnerships with American Printing House for the Blind (APH), National Federation of the Blind of Illinois (NFBFI), and Reaching Across Illinois Library System Makerspace Networking Group (RAILS MNG). This project addresses the largely underserved need of young blind and visually impaired (bvi)<sup>1</sup> learners in computational thinking and maker learning in libraries. The intended impact is to create more inclusive and accessible library makerspaces for bvi learners.

**Project Justification:** Nowadays a number of libraries offer a makerspace and/or opportunities for maker learning—a hands-on learning approach where learners create, design, tinker, experiment, and share projects with a range of technologies. While the initial maker movement in the U.S. has been criticized owing to its notoriously inequitable participation, makerspaces in libraries—a free space open to the general public with a mission of supporting lifelong learning and democratization of access to information—hold its promise to equity in makerspaces. Accessible making across various dis/abilities, however, remains far under-practiced. In particular, making activities and tools are highly vision dependent. Bvi people experience extra challenges and have become even more marginalized from the maker movement. This applied research aims to fill this gap by (a) solidifying partnerships between national and local organizations for bvi people, library services for people with disabilities, and the maker community; (b) developing and testing a prototype for accessible library makerspaces—its spaces, tools, and activities for bvi teens; (c) implementing the tested tools and curricula in Illinois library makerspaces; and (d) advancing both theoretical and practical knowledge on accessible maker approaches in promoting computational thinking for bvi learners.

**Project Work Plan:** We propose 2-year design research to address the following research questions: (1) What design considerations contribute to accessible library makerspaces for bvi learners? (2) In what ways can tangible maker tools and activities be implemented and redesigned with and for bvi learners to promote their computational thinking skills in libraries? The theoretical frameworks include constructionism—tangible, accessible, and observable knowledge construction—and ability-based design and a social model of disability, which explains that disability is framed and perpetuated by sociocultural, sociotechnical, and political powers. Experimenting with exploratory services and tools is a daunting task for librarians who deal with day-to-day operations and accountability, which is often a barrier to offering innovative services for marginalized groups. Therefore, the C-U Community Fab Lab will provide a space to design and test a prototype model for accessible makerspaces, to be disseminated and adapted in library makerspaces later. Year 1 is devoted to developing and testing prototypes in the Fab Lab, followed by implementations in library makerspaces in Year 2.

**(1) Year 1 Phase 1 (Aug 2022 – Jan 2023). Study setting design and preparations.** Based on the Universal Design principles, the team will systematically evaluate current accessibility status of the Fab Lab and address potential barriers against bvi people. The Universal Design evaluation and prototype development processes will thoroughly be documented to provide a guide to designing accessible library makerspaces. Working with the UIUC Disability Resources & Educational Services, our team will simultaneously train the staff on core accessibility concepts through monthly

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<sup>1</sup> This project uses the identity-first language when addressing visual impairments, following the philosophy of the National Federation of the Blind.

seminars. IRB will be obtained in Phase 1. **(2) Year 1 Phase 2 (Feb – Jul 2023): Designing and testing accessible maker activities.** In partnership with the APH, the world's largest nonprofit R&D organization for the blind, this project will explore and ameliorate accessibility barriers of tangible maker tools for bvi learners. While we plan to design and host the workshops at the C-U Fab Lab, considering the uncertainty around the COVID-19, the workshops may be conducted in other places or virtually. Approximately 10 learners between 7th and 12<sup>th</sup> grades will be recruited for this initial prototype with the aid of the NFBI. The workshops will cover the three areas that have potential to increase their computational thinking skills through tangible maker activities, including coding (software engineering education with Code Jumper), electronics (hardware and electrical engineering education using Snap Circuits), and integrated prototyping (computer engineering education using Snapino). Data collection and analysis methods to answer the proposed research questions include: pre-tests (surveys and interviews with the participants on prior making/coding experience; interests/self-efficacy in STEM+C subjects/careers); interaction video analysis and think-aloud protocol during the sessions; and post-tests (interests/self-efficacy in STEM+C subjects/careers; design feedback on activities and maker tools) **(3) Year 2 Phase 1 (Aug 2023 – Jan 2024): Implementation in library makerspaces.** The prototype tools and activities will be disseminated and implemented in 3-5 Illinois library makerspaces, recruited and selected based on their need and capacity through the RAILS Makerspaces Networking Groups—a group of librarians working in library makerspaces in Illinois. Up to 50 bvi learners will be engaged. The Fab Lab staff who were involved in Year 1 will train the librarians and offer needed support. **(4) Year 2 Phase 2 (Feb -- July 2024). Debrief and disseminations.** Debrief sessions will be held with all partners to discuss challenges and opportunities of the current maker tools and activities for bvi learners and to identify future directions. The project results will be synthesized in a replicable framework and report, and will be distributed through various channels, including but not limited to, conference presentations and workshops, journal papers, and webinars. Partners and advisory board members will support wider dissemination.

**Diversity Plan.** By engaging one of the most marginalized population in the maker movement in libraries and in society, the project strongly upholds the IMLS' emphasis on diversity, equity, and inclusion. This applied research project will be a significant step toward creating a more inclusive library makerspace for all abilities.

**Project Results:** This project will result in (1) a guide to designing an accessible library makerspace, (2) tested accessible maker tools and curricula that promote computational thinking for teens, and (3) research findings on the effectiveness and accessibility of current maker tools and activities for bvi learners. In addition, we hope to generate a clearly identified future agenda to advance the area of accessible making with solidified partnerships.

**Project Personnel:** The PI, Dr. JooYoung Seo, is an Assistant Professor at the UIUC iSchool and a certified accessibility professional (CPACC), whose research focuses on accessible computing for all abilities. The Co-PI, Dr. Kyungwon Koh, is an Associate Professor at the UIUC iSchool and the Director of Research at the C-U Community Fab Lab, whose expertise includes youth maker learning in libraries. Our partners and collaborative roles include: (1) APH for accessible curricula design and training services with specialized maker tools for bvi learners; (2) NFBI for recruiting bvi participants in Illinois; and (3) RAILS MNG for implementing accessible maker activities in Illinois libraries. Our advisory board members are: (1) Dr. Colleen M. Lewis, an Associate Professor at the UIUC CS department, whose research involves broadening participation in computer science education; (2) Dr. Marijel (Maggie) Melo, an Assistant Professor in the Information and Library Science at the University of North Carolina at Chapel Hill, whose specialization involves equitable and inclusive makerspaces; and (3) Dr. Natalie L. Shaheen, an Assistant Professor of Special Education at the Illinois State University, who has extensive research and practical experience in inclusive STEM education for K-12 bvi students.

**Budgets:** The estimated 2-year project budget is \$554,810, including 1 month summer support for the PI and Co-PI each year (\$48,390); 50% PhD stipend for 2 students each year (\$120,934); personnel benefits (\$35,314); travel (\$17,100); other costs, including transcription services, remuneration for advisory board members, maker professionals and other collaborators, and tuition remission (\$111,398); materials and supplies, including accessible maker tools and assistive technologies (\$45,278); and indirect costs (\$176,396).