Universal Design: An Intercultural Perspective

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Maker / Do-It-Yourself (DIY) Movement
Global community of (mostly) amateur hackers, tinkerers, technology/arts/crafts enthusiasts
Focus on self-directed personally meaningful projects
Value sharing of knowledge and resources
Celebrate hard-work, know-how and learning from failure

Maker Movement and Education

Creating customized small batch artifacts that often use low-cost and open-source hardware and software

Has recently received considerable attention as:
Supporting STEAM education
Supporting careers in technology innovation sector

Image: The image shows a group of people sitting at a table and soldering electronics.

Maker Tools and Technologies

Prototyping Electronics (e.g., Raspberry Pi, Arduino)
3D printing and scanning
Online resources and tutorials

Image: This image shows a geometrically intricate object being 3D printed.

Physical Computing Platforms

(Relatively) affordable and powerful electronic and computational components
Many are open-source with online learning resources
Can interface with a variety of sensors and actuators

Image: This image shows a Raspberry Pi Microcomputer that is a board with electronic components attached to it.

How can we leverage maker technologies for use by people with disabilities?

Image: This image shows drawing of many hands each holding a different tool.

Example DIY Accessibility Projects

E-NABLE: 3D design and fabrication of upper limb prosthetics
Tactile Picture Book Project: 3D printing tactile graphics for users with visual impairments
Makers Making Change: DIY puff switch

E-NABLE (enablingthefuture.org)
Tactile Picture Book Project (tactilepicturebooks.org)
Makers making chance (http://www.makersmakingchange.com/lipsync)

Image: The image shows 3 projects. The picture on the left shows a 3D printed prosthetic hand on a table. The picture in the middle shows a child touching a 3D printed book and there are several other 3D printed books on a table. The pages showed raised outlines of a mouse and a mouse. The picture on the right show a puff switch that is partially 3D printed.

Maker Movement and Accessibility

As enabling technologies for the creation of specialized small-batch Assistive Technologies (AT)
As teaching tools for introducing students to accessibility and and Universal Design (UD)
A combination of both

TalkBox: An Open-source low-cost DIY communication board for non-verbal users

Image: The image shows TalkBox which is a physical device made of a foamcore chassis and an electronic component (Raspberry Pi connected to sensors) with wires coming out and connecting to custom-made conductive buttons. The device is also connected to a battery and a small speaker.

TalkBox can be used by non-verbal users to communicate with others.

Image: This image shows a 12-year-old girl with cerebral palsy sitting in a wheelchair and touching buttons on a TalkBox with her hands.

TalkBox was invented by Ray Feraday, a Special Education Teacher, for several of his students and was co-designed and co-developed by a team of students and researchers at York University.

Image: The picture shows Mr. Ray Feraday, making cutsomized buttons that are connected to a computer via a prototyping board (called Makey Makey).

Commercial Communication Boards

Expensive
Complex
Hard to redesign

The image shows a DynaVox communicaton board which is a rectangular object with buttons with letters of the alphabet and pictures on them.

TalkBox in Use

Video: The video shows two children using TalkBoxes. In the first part a boy on the autism spectrum walks to a classroom and uses TalkBox by pressing a button that plays back the phrase "Attendance, Please". Next, he goes to the office and hands the attendance to the principle. In the second part, a small girl in a wheelchair uses TalkBox to complete a sentence completing exercise.

What if users could customize and build their own assistive technology?

What if users' caregivers, teachers or therapists help to build ATs?

TalkBox as a DIY prototyping kit for users to build their own devices

The image shows different electronic and 3D printed components that can be used to build a TalkBox, they include a Raspberry Pi, Battery, Touch sensor, wires, speaker, velcro and conductive tape.

TalkBox as a Teaching Tool

Hands-on self-directed project
Multidisciplinary perspective
Real world impact
Applying Universal Design

Image: This image shows students assembling TalkBox kits in preparation of the TalkBox making workshop.

DIY Session

Six teams comprising of non-verbal children and adults and their parents or caregivers worked with students from Computer Science and Kinesiology to build their own TalkBoxes.

During the workshop, a team of multidisciplinary student volunteers (from Computer Science and Kinesiology) helped participants and their parents/caregivers put together TalkBoxes. Small changes and customizations were implemented on the spot and if the participants required something more substantial/technical notes were taken for later.

Image: This image shows two pictures. The picture on the left shows two groups of two adults each working together to assemble TalkBoxes on a table. The picture on the right shows a young boy putting together a TalkBox with her mother and a helper.

Outcomes

Users could build 6 TalkBoxes themselves
Students became aware of diverse user needs
Many unexpected variations of TalkBoxes emerged
Task of making the technology created communication and collaboration
Students expressed interest in working on other technologies that help people

More Information: Hamidi et al., ICCHP'14, JAT'15; Haworth et al., ICCHP '16

How can we translate TalkBox's design for use in other contexts?

How can DIY assistive technology engage multiple stakeholders?

How can education contribute to sustainability?

Low-cost Assistive Technology in Developing Contexts

There is a tradition of building low-cost customized assistive technology for users in developing contexts.

Example: Jaipur Foot (1.55 million free devices)

Image: The image shows two pictures. The picture on the right shows a series of leg prostethics against a wall with the logo Jaipur Foot on top. The picture on the right shows the cover of a box called Disabled Village Children and shows a picture of a small boy with a wodden home-made walker beside an older girl holding a small child.

Kenya: A New Setting for TalkBox

Kenya is emerging as a leader in tech innovation in East Africa.
Innovative Kenyan technologies include, M-Pesa – mobile phone-based financial service and kiokit – educational tablet computer platform

Kenyan innovation hubs include Lakehub, Kisumu (http://lakehub.co.ke/) and iHub, Nairobi (https://ihub.co.ke/)

Kenya is increasingly recognizing the rights of people with disabilities:
Signing and ratification of The U.N. Convention on the Rights of Persons with Disabilities (CRPD) (2007, 2008)
Recognition of disability rights by the National Kenyan Constitution (2010)

Image: The image shows two pictures. The picture on the top picture shows four Kenyan children sitting at a table and holding yellow tablets and wearing headphones. Behind them there is a logo that says kio kit. The image on the bottom shows a conference room with many people sitting and watching a presentation. On the wall it is written iHub.

Fabrication-Lab-in-a-Kit (FLiK)

Pilot study in Kisumu in Western Kenya

Teaching local college students about universal design and open-source technology

Engaging local stakeholders and community, including children, parents, teachers, government
representatives, NGOs.

Working with both urban and rural schools and with children with a variety of physical and cognitive
disabilities

Image: This picture shows different components of TalkBoxes laid out. They include 5 raspberry pi computers in enclosures and power plugs, batteries and USB keys.

Our Team

Transnational interdisciplinary research team from 3 countries with expertise in Computer Science, Psychology, Social Work, Critical
Disability Studies and Anthropology

Previous combined research experience in different contexts including East Africa, Asia and Latin America

Image: This picture shows four hands each holding a piece of a puzzle.

FLiK Project Components
We formed teams of multidisciplinary university students in Kenya to act as workshop facilitators when running workshops about DIY assistive technology in rural schools. We ran the workshops, outside of the university in a community setting where the university students met with school teachers and formed teams. Once the training was conducted they co-conducted workshops at the rural schools.

Stakeholder meetings (x2) with 22 governmental and non-governmental participants

Student workshop facilitator training (x2) with 6 local university students from Computer Science and Special Needs Education programs at Maseno university, 2 teachers per school (2 schools), 2 research assistants, 2 multidisciplinary teams formed

Participatory design workshops (x4) at 2 schools (1 urban and 1 rural), 24 children and 20 parents

Image: This picture shows 13 people sitting around a table and listening to a presenter. It is part of the workshop facilitator training conducted in Kenya.

Participatory Design Workshops with Children and Parents

Mixed-methods approach: Surveys, Pre- and post- questionnaires and observations
Children with a range of disabilities participated and students were able to build new variations of TalkBox based on their user input and observations

Image: This image shows three pictures. The picture on the left shows a TalkBox that is cased in a wooden chassis. The picture in the middle shows a Kenyan child in wheelchair reaching to touch a TalkBox. The picture in the right show a group of Kenyan children using a TalkBox.

Lessons Learned

Universal Design Supporting Community Building

Technology design can facilitate conversation between different stakeholders.
Stakeholders can benefit from each other's domain knowledge.
Different priorities and opportunities for connection and growth can be identified.
Local capacity, knowledge and experience can be developed.

Universal Design Supporting Learning

Hands-on design and evaluation tasks provided first-hand learning opportunities for students from different disciplines.
Students experienced working in real-world contexts and directly with community members.
Students exercised creative problem-solving and teamwork.
With minimal supervision, students were able to solve most technical and logistical problems.

Universal Design Across Social and Cultural Contexts

The design process should be sensitive to the ecology of materials and resources available in the context in which it is deployed.

> We found that the prevalence of the Maker Movement in the West is partially dependent on the network of online and offline video and text resources, as well as, convenient e-commerce platforms that work in tandem with them.

The social and cultural settings can impact design outcomes; designers should strive to incorporate possibility for flexible adoption to support emergent use.

> In Kenya, TalkBoxes are used by groups of children and as a tool to include children in class activities; this is in contrast to the primarily individual usage we have seen in the North American contexts.
>
> We found many concepts have different meanings in the Kenyan context (e.g., “community”, “family” and “resources”); in an ongoing process, we are translating, adapting and reevaluating our teaching, design and research tools.

A Question of Sustainability

Will the project survive over time? …. only the future can tell! But so far the signs are positive:

Engaging local stakeholders and connecting learning institutions and communities are promising strategies.

Using open-source software and hardware and local materials as much as possible have supported user appropriation in the new context.

Image: This image shows TalkBox in a wooden chassis and with wires coming out of the container.

Thanks! Questions or comments?

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For questions or comments please send an email to Foad Hamidi (foadhamidi@umbc.edu)