Design with Code Club: An attempt to get kids learning to code while designing solutions to everyday problems (WORK in PROGRESS)

Introduction

Early in the pandemic we gathered a group of educators to create and share at-home educational opportunities for families to design and make STEAM projects while at home. The focus of the project, called CoBuild19, was to create ideas and guides that kids and caregivers could use to do activities that used materials found around where they lived, engaged kids in making and exploration and could be explored together. Activities included a number of design challenges, incorporating various aspects of engineering. As the pandemic continued, we thought of opportunities to extend our offerings. At the beginning, we generally ignored computing and programming tasks because of the need for hardware, but as we looked to expand our set of activities we convinced ourselves that we could do a good amount of activities using the online block coding simulators that exist, particularly Microsoft MakeCode.

We began planning an offering called the Design with Code Club (DwCC). We structured DwCC to be different from other common coding offerings [1-2] in that we wanted the main focus to be on kids designing solutions to problems that might include the use of technology and coding. We were purposeful in this decision for two main reasons. First, we wanted to make our coding club more interesting to girls, where previous research demonstrates their interest in designing solutions to problems with a social impact [3]. Second, we wanted this effort to be different from other common programming instruction, where coding activities use programming as the core of instruction and application in authentic and student-selected contexts generally plays a secondary role [4].

With these instructional goals in mind we spent time planning out how to incorporate and align activities that focused on: a) the design process, b) basic ideas of programming and computational thinking, and c) open-ended design challenges. Because we were doing all of this online, we used the micro:bit interface through Microsoft MakeCode, which includes a functional simulator [5]. From our experiences we realized that simulations are not as enticing as physical computing with a tangible device, so we set up an incentive where youth who participated in at least three sessions of the club would receive a physical micro:bit.

In this presentation we will share our planning and experiences running variations of the Design with Code Club during 2020 through early 2022. We will primarily be using this to describe the program variations but will include relevant program data and feedback, where relevant.

Design with Code Club Content focus

DwCC was set up so that each of the first four weeks had a different larger challenge that was COVID-19 related and sessions unfolded with alternating smaller challenges, discussion around design and coding instruction that would develop their skills and knowledge of micro:bit capabilities. We culminated DwCC with an open-ended project where the participants were given the challenge of coming up with their own problem for which they might incorporate micro:bit as part of the solution. To facilitate this we reduced the instructional component of Weeks 5 and 6 substantially and spent time engaged in thinking about design, brainstorming ideas and trying to troubleshoot issues students had with their plans or programming.

We advertised DwCC through social media platforms (primarily our CoBuild19 Facebook group and other pandemic-related groups) and across listservs we engage with that are for maker educators across the U.S. For DwCC we had nearly 200 families register their kids to participate. We had approximately 105 kids and adults attend Session 1. In total 52 micro:bits were sent to youth: 10 kids completed all 5 activities, 16 kids completed 4 activities, and 29 completed 3 activities.

Table 1. Content coverage for Design with Code Club (V1)

Session	**Topics**	**Attendees (approximate)**	**Challenges completed**
1	Algorithm > Triggers, Lights, Sound, Timing > Handwash timer challenge	**105**	96
2	Machine Classification/AI > Environmental sensors > Sensing “change” challenge	**81**	72
3	Variables and Logic > Logic & Servos > Dispense a treat challenge	**71**	62
4	Empathy & Design > Radio functions > Social Distance Messaging	**65**	27
5	Design Constraints, Problem Identification, 5 Whys > Open Challenge	**48**	24

6	Review of ideas, brainstorming solutions, troubleshooting code	**45**	3

Based on this success, we sought to expand the effort and increase accessibility for groups that are traditionally underrepresented in STEM. In spring 2021, we offered a Girls DwCC. This was a redesigned version of the club where the focus was even more on problem-solving through design. The club was run by all women, including one from the US, an Industrial Engineer from Mexico and a computer programmer from Albania. More than 50 girls from 17 countries participated in the club!

Table 2. Content coverage for Girls Design with Code Club (Spring 2021)

Session	**Topics**	**Content**	**Challenge**	**Attendees (approximate)**	**Challenges completed**
1	Algorithms	Blocks: Inputs, LEDs, Icons	Emoji challenge	70	55
2	Sensors and Variables	Blocks: Variables, light, compass, temperature Creative contest: Seeing double	Sensing the world challenge	70	39
3	Variables and music	Blocks: Variables, Loops, Melody, Tempo, Volume, Tone Unplugged coding: Variables dancing game	Remix challenge	60	41
4	Logic	Blocks: Conditionals, booleans, random Unplugged coding: Guess Who? Conditionals game	Video game challenge	50	27

5	Accessibility	Human Centered Design and Problem Solving Course content review	Accessibility challenge	40	20
6	Radio and multi editor	Send and receive Group activity: Gratitude and learnings	Share your experience	40	13

After the fun and success of working with the all-female version, we worked on another version of GDwCC that was offered in Spanish and focus on Latina girls in the US, Mexico and Central and South America. Registration for this club skyrocketed to 270 individuals registered before we shut down the registration process. Anecdotally, we were told that these types of programs are not common in many of these countries and this is likely why there was such interest.

Table 3. Content coverage for Girls Design with Code Latina Edition Club (January 2022)

Session	**Topics**	**Content**	**Challenge**	**Attendees (approximate)**	**Challenges completed**
1	Algorithms and Latinas in STEM	Blocks: Inputs, LEDs, Icons, String, Pause, Show Introduction: Latinas in STEM	Emoji challenge	90	67
2	Loops and Variables	Blocks: Variable, Loops, Melody, Tempo, Volume, Tone Unplugged coding: Variables dancing game	Remix challenge	80	53

3	Sensors, Variables and Conditionals	Blocks: Variables, acceleration, light, compass, temperature, magnetic force, conditionals Unplugged coding: Guess Who? Conditionals game	Sensors challenge	80	47
4	Logic	Blocks: Conditionals, booleans, random Special guest: Latina in STEM talk	Video game challenge	75	41
5	Accessibility	Sensors and Variables Thinking Routine: Empathy map	Accessibility challenge	60	39
6	Radio, multi editor, review ideas	Blocks: Send, receive Do your :bit challenge Group activity: Gratitude and learnings	Share your experience	60	28

In another recent iteration of DwCC we worked with an educator at a school for deaf students to create a version of the club that works for their students. We are doing some modification of activities and recreating videos that involve sign language interpretation.

Table 4: Content Coverage for Coding Club at Rocky Mountain Deaf School (Fall 2021)

Session	**Topics**	**Content**	**Challenge**	**Attendees (approximate)**	**Challenges completed**
1	Algorithms and Deaf people in STEM	Introduction: Deaf in STEM	Scavenger hunt	12	9

		Blocks: Inputs, LEDs, Icons, String, Pause, Show			
2	Blocks, Loops and Variables	Engineering Design Process Blocks: Sound, Input, LEDs, Loops, Melody, Tempo, Volume, Tone	Icon design, Handwashing design challenge	12	8
3	Classification,Sensors, Variables and Conditionals	Object classification Sensing: light, rotation, acceleration	Classifying emojis Sensing the Environment challenge - Light, Rotation or Acceleration	12	9
4	Sensors, Variables and Conditionals	Blocks: variables, conditionals Sensing, temperature,	Sensing the Environment challenge - Temperature	12	9
5	Logic Sensors, Variables and Conditionals	Unplugged coding: Guess Who? Conditionals game	Challenge - Environmental Sensor - Sensors & Servo function	12	1

		Blocks: Variables, conditionals, servos			

Data

We have multiple forms of data collected for this project – data that we are just starting to analyze. We collected survey data at the time of registration (from caregivers) and in some programs we collected post-participation data. We have video and transcripts from our club sessions and we also have any videos students submitted for their "tasks" between sessions that they posted to Flipgrid. The focus of data for this presentation will be the survey data gathered from participants' caregivers. For V1 and the Girls Design with Code Club we had over 270 parents register from 33 US States. If we look across all versions we had participants from 31 countries besides the US. Although we worked hard to include groups of learners who are traditionally underserved, the parents from V1 who responded to the post survey were not very diverse, with 70% of caregivers between the ages of 35-54 and were very well educated, with 80% having earned a Bachelor's or higher degree.

In two of the rounds we asked for feedback from those who registered about the ways they participated or not. Generally, respondents agreed that both the Zoom sessions (83%) and the website (75%) were moderately or very helpful resources for completing individual challenges.

Qualitatively, we saw many positive indicators that kids across all clubs built confidence, skills and competence in coding and logic skills. There were a lot of "look what I did" or even more exciting, "look what I figured out!" Our educator of deaf students shared that students learned and demonstrated patience, persistence and stamina in their work, including debugging, designing, redesigning and "remixing" their work. Overall, we feel the focus on design really came through in the outputs – students were really excited by the application of what they learned, whether it was guarding a cookie jar, noting the temperature of a refrigerator, or other ideas.

With all programs come things we need to work on. Thankfully, most respondents indicated overwhelmingly positive responses to our program. However, we still feel it is valuable to look at points where people recommended improvements or they are suggested by the data. One

example is if we cross tabulate race with level of participation. While we are dealing with very small samples, the results indicate that a disproportionate number of black/African American families registered but did not complete many or any challenges (72%) compared to their white peers (25%) who responded the same way. If we dig a bit deeper, it seems that the main reason families indicated two primary reasons: scheduling issues (~75%) and lack of interest (18%). While we will not be able to keep everyone engaged – and these results are biased in that we lost many of the initial 105 who participated in Session 1, this can help us improve accessibility in the future.

Summary

We are excited by the early iterations of our club as a way to get kids engaged in design, problem-solving and coding. DwCC was born out of a program to create at-home opportunities for kids and families to engage in STEM during the pandemic; however, we feel strongly that the iterations we have run indicate there is great likelihood this program can work beyond the pandemic. The primary characteristic of our approach is that we created the club with a focus on design and problem solving as the main focus with content learning (i.e., basic programming and hardware of the micro:bit) as ancillary information that can assist in solving problems of interest.

One of the issues we encountered was attendance attrition across weeks. While this is common in a number of related offerings (e.g., online courses, informal STEM programs, etc.) in a program like this it's still worth figuring out what can be done to retain participants. We think that in our first iteration dropoff was primarily based on pandemic online burnout. We have seen less drop with the GDwCCs and we think that is likely due to the efforts put in to developing community among the girls participating. This was done through engaging activities and the 'culture' of caring that was created by the instructors. Although this is likely a component that's overlooked, we realize that creating a safe and welcoming learning environment seems critical, even in short informal activities, in order to retain participants. This may be particularly critical for young girls in computer science and engineering.

Overall we think that the approach we're using will be particularly useful in getting all kids, but particularly those from groups that are traditionally underrepresented in engineering and computer science (as well as other STEM areas), interested and engaged in authentic practices. We are not claiming to be doing anything revolutionary here, but think it's the rearrangement of focus – putting problem-solving and design first and content second – alongside with using

problems that are tied to participants and their lives seems to be a promising combination. We hope to share more about these results and future plans during the presentation.

[1] F. Kalelioğlu "A new way of teaching programming skills to K-12 students: Code. org." *Computers in Human Behavior*, *52*, 200-210, 2015.

[2] O. Erol & N. S. Çırak, "The effect of a programming tool scratch on the problem-solving skills of middle school students." *Education and Information Technologies*, *27*(3), 4065-4086, 2022.

[3] P. H. Miller, J. Slawinski Blessing, & S. Schwartz, "Gender differences in high-school students' views about science." *Intl Jnl of Sci Ed, vol 28, no.* 4, pp. 363-381, 2006.

[4] P. J. Rich, S. F. Browning, M. Perkins, T. Shoop, E. Yoshikawa,, & O. M. Belikov. "Coding in K-8: International trends in teaching elementary/primary computing." *TechTrends*, *63*(3), 311-329, 2019.

[5] G. Fessard, P. Wang, & I. Renna, "Are There Differences in Learning Gains When Programming a Tangible Object or a Simulation?." *Proceedings of the 2019 ACM Conference on Innovation and Technology in Computer Science Education* (pp. 78-84). July 2019.