Co-adapting a design thinking activity to engage students with learning disabilities: Insights and lessons learned

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ABSTRACT

Teaching students with learning disabilities about design thinking can prepare them to be active co-designers of learning tools and resources that will ultimately benefit them and their peers. In this paper, we outline an introductory design thinking activity conducted with students with learning disabilities and share two specific and contrasting student interactions that occurred during the activity. The two interactions highlight how being able to engage in open, respectful, and constructive idea sharing can lead to a more sophisticated and evolved design prototype. Student collaboration observed also provides insight into improved ways to scaffold learners in introductions to design thinking. We share lessons learned and ideas for how to modify this activity to better support a positive introduction to design thinking experience.

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KEYWORDS

Participatory design; co-design; design thinking; learning disabilities; dyslexia

Table 1: Summary of the co-adapted "5 Chairs Challenge" activity conducted with students

Number of Students	11
Number of Facilitators	4
Materials	Student worksheet, design thinking handout, craft supplies
Activity goals	Introduce students to and have them practice the complete design thinking process
Day 1 (About 15 min)	1. Introduction to the activity and design thinking 2. Student groups assigned, read story cards and identify two user needs
Day 2 (About 90 min)	1. Two-minute individual rapid ideation 2. Group design discussion (5-15 min) 3. Prototyping (40 min) while facilitators walk around talking to groups and making suggestions 4. Groups give and receive feedback to another group and iterate on their prototype (10 min) 5. Final presentations

INTRODUCTION AND BACKGROUND

Students with disabilities often get left behind in STEM, as typical classroom science content can present significant access barriers to students with disabilities or special learning needs [3, 5]. Interactive and multimodal math and science simulations are flexible learning tools that have the potential to close the achievement gap between students with and without disabilities while benefiting both. A practical way to design an effective and adaptive learning tool that students with disabilities can use alongside students without is to involve them in a participatory design thinking process. We are interested in understanding how students with no prior formal experience with design thinking engage in the process and how to design activities to best facilitate this engagement before involving them in participatory design.

Participatory Design Thinking with Special Student Populations

Participatory design, or 'co-design,' actively engages users as partners in a collaborative design process alongside designers and researchers [4]. We have partnered with a specialized school in Colorado that serves students with reading and language disabilities to involve them in a co-design process to improve the accessibility of online science and math simulations ('sims'). To prepare and scaffold students for sim co-design, we will first engage them in a series of *design thinking* activities without sims. Design thinking is a creative problem-solving process used across a variety of disciplines to identify a problem, understand the context, and design solutions [1, 2]. The design thinking activities will be co-designed by a researcher and teachers and will give students practice applying design thinking to relevant design problems. The co-designed activities will themselves go through an iterative design process to ultimately be shared with the broader community as an adaptable resource that can be used in classrooms to teach students with and without special learning needs about design thinking. In this paper, we present two case studies of student interactions from the first design thinking activity conducted with students, what we learned, and how we will apply what we learned moving forward.

Design Thinking Activity: The Co-Adapted 5 Chairs Challenge

The design thinking activity students participated in for this study was a modified version of the *5 Chairs Challenge* (https://dschool.stanford.edu/resources/the-5-chair-challenge). The goal of the original *5 Chairs Challenge* activity is "to encourage students to gain confidence iterating on designs based on human needs, while working with different materials." For this study, modifications were made to the original *5 Chairs Challenge* activity (http://bit.ly/Modified-5CC). The activity was lengthened to give students additional time for and support with reading and writing. A brainstorming step was added, and the proportion of time devoted to prototyping and materials available were expanded. Iterations were

Table 2: Transcript of interaction between students Kody and Evan.

Time	*Name*	*Utterance/action*
3:23	Kody	"What if we took this type of chair…" *[Gestures to his worksheet]*
3:25	Evan	*[Looks at Kody then at Kody's worksheet]* "Yeah?
	Kody	"And we had like a hook and a book bag and…so it could crank back and do everything else." *[Gesturing at his worksheet]* *[Looks at Evan's worksheet]*
3:31	Evan	*[Nods.]* "Ok." *[Looks at Kody's paper]*
3:32	Kody	"Like it has a tiny massage thing and memory foam." *[Points at paper, looks at Evan]*
3:35	Evan	*[Points to Kody's worksheet]* "Ok, then how about this right here…"
3:37	Kody	"No that…"
3:38	Evan	"Can go up and down?" *[Looks at Kody, moves hand]*
3:39	Kody	"No this is actually the, um, computer slash table." *[Makes eye contact with Evan, mimics pulling table up from side]*
3:41	Evan	"Oh, the computer, ok." *[Leans on elbow toward Kody looking at Kody's worksheet]*
3:42	Kody	"I'm just saying, 'cause it's in one of the armrests. Have you ever been in first class on a plane?"
3:47	Evan	*[Looks at Kody]* "No."
3:48	Kody	*[Elaborates on armrest table]*
3:58	Evan	"Yeah, yeah, no, I love that idea. And that's what this was supposed to be." *[Points to his paper, then Kody's]*

reduced from five to one to make up for the expanded prototyping step. Presentation time was added, and the discussion and reflection time at the end of the activity was lengthened to give teachers insight into the understandings gained by the students and to recap the entire design thinking process. Students were provided with a basic student worksheet with minimal text and plenty of space for writing and drawing. The purpose of these modifications was to 1) provide skill-level appropriate structure, scaffolding, and prompts for this unique group of students and the particular challenges they have with reading, writing, communication, and memorization, and 2) prepare students to apply the detailed design thinking methodology to more in-depth design challenges in the future. The actual *5 Chairs Challenge* activity that was conducted with students over the course of two days is summarized in Table 1. Components of the modified activity, such as the class discussion at the end, were cut due to time constraints.

DATA COLLECTION & ANALYSIS

Throughout the co-adapted *5 Chairs Challenge* activity, 4 video cameras were distributed around the classroom to capture teacher presentations, facilitation, student collaboration and group work, and student's final presentations. For each of the five student groups, an audio recorder was placed in a central location, for example, on a desk the students were gathered around.

The video data (synched with the audio recorded verbalizations) of the student groups was reviewed by the research team. Researchers reflected and discussed similarities and differences between the groups' responses to the activity prompts and facilitation, as well as how they engaged in collaboration with one another. The primary intent in this data analysis was to investigate ways to improve future co-development of design thinking activities, and opportunities to better support and scaffold learners in the significant weekly co-design and design thinking projects that will be engaged in by the team over the next three years of a grant funded collaboration.

During these reflections we noticed a particularly interesting contrasting case between two student groups. The video segments for these cases were transcribed, with additional descriptions included regarding physical actions and eye contact, for presentation of these segments below.

RESULTS AND DISCUSSION

Here we present two contrasting examples of student collaboration during the co-adapted design thinking activity. Students names have been replaced by pseudonyms.

Group 1: Kody and Evan

Kody and Evan are designing a chair for Martin, a young student. The interaction between Kody and Evan (transcript in Table 2, image in Fig. 1) occurs during a discussion of design ideas prior to prototyping.

Figure 1: Kody and Evan sharing space while they discuss ideas

Figure 2: Kody and Evan's final chair design, which included a fold-down table

There are several notable features of the interaction between Kody and Evan. When one student is talking, the other is typically quiet, and they frequently acknowledge that they are listening with brief verbal cues (3:25, 3:31). The dialogue remains respectful and their actions indicate they feel comfortable sharing a workspace (Fig. 1) and their worksheets (3:35, 3:58) and building on each other's ideas (3:35-3:38). The students ask questions to clarify ideas and check for understanding (3:42) and take time to explain their ideas fully (3:48-3:58). Their tone throughout the interaction remains calm, respectful, and encouraging.

After this interaction, Kody and Evan spend about seven more minutes refining their chair design idea, then 30 minutes building a prototype. Kody and Evan's final chair design (Fig. 2) was one of the more sophisticated designs of all the groups and did include a table that could fold up or down as they discussed in the transcribed interaction. However, there were key elements that they had planned on including in their design that were not implemented (e.g., a hook on the back of the chair to hang a backpack on).

Group 2: Hank and Gavin

Hank and Gavin are designing a chair for the Simpsons character Grandpa. The interaction between Hank and Gavin (transcript in Table 3, image in Figure 3) occurs during a discussion of design ideas prior to prototyping. Just prior to this interaction, Hank brings up the idea of including a hotline to *Door Dash*, a food delivery service, in the chair design. Hank and Gavin's actions and dialogue suggest they are unsure how to effectively collaborate together, specifically, how to effectively share ideas and give constructive feedback. They remain physically distant from each other in space (Fig. 3) and keep their work to themselves (0:45, 0:54, 1:07). Eye contact is brief and fleeting (1:17, 1:25). A significant portion of their interaction is either telling each other how they think the design should be, without opportunity for input or understanding (1:03), or disagreeing about superficial details (0:58, 1:20). Disagreements are addressed through raised voices. The tone of their dialogue is at times argumentative or dismissive.

After this interaction, Gavin spends a few minutes drawing out a design without much input from Hank, then the two students start building separate components of their chair out of clay. Hank and Gavin do not talk much for the rest of the prototyping session and maintain physical distance from one another. Their end design is a clay chair with a clay phone (Fig 4).

Table 3: Transcript of interaction between students Hank and Gavin.

Time	*Name*	*Utterance/action*
0:45	Gavin	"No, no. Door Dash, but you've got Grub Hub for the cooler. *[Picks up, points at worksheet, lays it down away from Hank]*
0:50	Hank	*[Mumbles something]*
0:52	Gavin	"You can get stuff from Grub Hub for the cooler too." *[Slides worksheet towards Hank and gestures at it]*
0:54		*[Moves worksheet away]*
0:55		"Same company."
0:58	Hank	*[Looks past Gavin]* "Grub Hub and Door Dash aren't the same company."
1:00	Gavin	*[Looks down, throws hands up, backs chair away from desk]*
1:03		"Let's do this one." *[Points to his worksheet]*
1:05	Hank	"Yeah…I agree." *[Glances at Gavin's worksheet]*
	Gavin	
1:07	Hank	"Alright, should we have like…" *[Looks at worksheet on his lap]*
1:11	Gavin	*[Moves in, leans towards Hank]* "Should we have a what?"
1:13	Hank	"We should have a little side table, or like a, a fridge. We should have a fridge." *[Looks up at Gavin]*
	Gavin	*[Picks up his worksheet]*
1:17		"Psh, fridge. Cooler!" *[Looks at his worksheet, then out at the room, then back at Hank]*
1:20	Hank	"Fridge! A cooler's something you put ice in." *[Looks at Gavin]*
1:25	Gavin	*[Looks past Hank]*

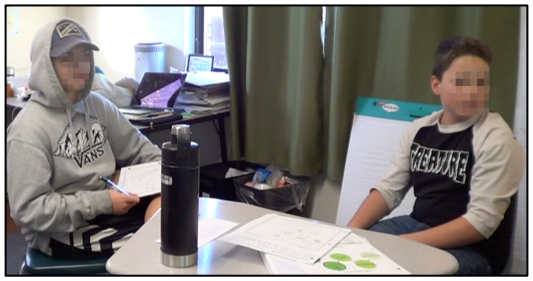

Figure 3: "Hank" and "Gavin" maintaining a separation of space between one another

Figure 4: Hank and Gavin's final clay chair design

Comparison of Interactions

We observed significant differences between groups in the ways in which the students collaborated, which we believe resulted in significant differences in the features and sophistication of their final designs. Group 1's design ideas not only remain relevant throughout their interaction, but evolve to become more sophisticated by the end of it. The students in Group 2 engaged in the design thinking activity, but struggled to constructively share ideas and debate differences in opinion, resulting in their design ideas not evolving significantly beyond refinement of relatively inconsequential details.

Some of the modifications made in the co-adapted *5 Chairs Challenge* were beneficial to students, including providing them with a worksheet to brainstorm ideas on and giving them additional time to think about and discuss their ideas. However, the differences in how these two groups of students engaged in the activity indicates that in its current form and with the facilitation as implemented, the activity did not successfully scaffold all learners in the classroom to productively engage in

collaboration during the design thinking experience. All students would likely have benefitted from a more structured discussion supported by question or idea prompts, examples or a protocol for how to constructively express ideas, and how to ask and answer questions amongst peers, and more effective teacher (and co-teaching researcher) facilitation. What we learned from this study will not only inform future iterations of this activity, but it will also inform how we co-design many other activities we will co-design and co-teach with this same student population and other populations.

CONCLUSIONS

Understanding how to effectively scaffold design thinking activities for students with learning disabilities will help us create more effective participatory design and learning experiences across many populations in the future. The purpose of this and future design thinking activities is to prepare this group of students to participate in a co-design process to improve the accessibility of online science and math simulations. Moving forward, we have already begun engaging students in more in-depth multi-week design challenges to give them extended and contextualized practice with design thinking. Ultimately, after several iterations, the activities designed for the students in this study will be generalized and made available to teachers wanting to teach design thinking to students with learning disabilities.

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SELECTION AND PARTICIPATION OF CHILDREN

The 10 child participants in this study are students at a school in Boulder County, Colorado serving students with learning disabilities that researchers from the University of Colorado Boulder established a partnership with. Children were selected based on which teachers at the school volunteered to participate. To obtain assent, a CU Boulder researcher explained the study and data collection methods (video and audio recording, artifact collection) to the children in a classroom at their school, answered their questions, and read through an age-appropriate assent form approved by the CU Boulder Internal Review Board (IRB) that the children voluntarily signed. Students were told that the data collected would only be shared for academic purposes, such as at professional conferences.

REFERENCES

[1] Nigel Cross. 2011. Design thinking: Understanding how designers think and work. Berg Publishing.

[2] Janet Kolodner. 2002. Facilitating the learning of design practices: Lessons learned from an Inquiry into Science Education. *Journal of Industrial Teacher Education* 39, 3, 9-40.

[3] Nathan W Moon, Robert L Todd, David L Morton, and Emily Ivey. 2012. Accommodating students with disabilities in science, technology, engineering, and mathematics (STEM). *Atlanta, GA: Center for Assistive Technology and Environmental Access, Georgia Institute of Technology.*

[4] Elizabeth B-N Sanders and Pieter Jan Stappers. 2008. Co-creation and the new landscapes of design. *International Journal of CoCreation in Design and the Arts* 4, 1, 5-18.

[5] Joseph J Stevens, Ann C Schulte, Stephen Elliott, Joseph F T Nese, and Gerald Tindal. 2015. Growth and gaps in mathematics achievement of students with and without disabilities on a statewide achievement test. *Journal of School Psychology* 18, 53, 45-62.