Negotiating Inherent Asymmetries of Co-Design: A Case of Integrative Elementary Mathematics and Computer Science Instruction

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Abstract

Collaborative design, or “co-design”, is a term that has gained popularity in educational research and design communities, including those working with K-12 educators. While more groups are identifying with and pursuing co-design, much remains to be understood about how to structure the work within given different constraints, circumstances, and resources available to different parties. We propose understanding co-design as having inherent asymmetries and structuring co-design work patterns involves negotiation of those asymmetries. Through a case of an elementary computer science and math integration research-practice partnership, we share ways that those asymmetries are both intentionally softened and leveraged at different times.

Keywords: Co-design, collaborative design, research-practice partnerships, elementary school, computer science education, computer science integration

Introduction

Collaborative design, or "Co-design," is a term that is being enthusiastically embraced in educational research communities, as it signifies a commitment to pursue educational improvement in ways that bridge persistent gulfs between design-oriented researchers and K-12 educators (Penuel et al., 2020). It intentionally involves a mixing of people with very different roles in education (e.g., researchers, developers, and teachers) working together to design educational solutions (Roschelle et al., 2006). By having more direct engagements and collaboration from the start, the hope is that co-design mitigates inequities so that all parties benefit from a design arrangement. For instance, the real-world time and resource constraints faced by different educators would be factored into the design at the beginning so that what works effectively in one learning setting is also designed to work well in a setting a very different set of resources. Moreover, researchers will gain new knowledge for academic communities, developers will have a viable and desirable product for distribution, and educators will have useful and usable materials to positively impact their students.

Given that the goal is for co-design to benefit all parties involved, it may seem at first glance that co-design would be best implemented as a joint, synchronous endeavor from start to finish. Doing so could promote equal ownership and contribution to the work. However, those who are doing and reporting on educational co-design work are keenly aware that educational co-design is challenging work and more complicated than that (Dodero et al., 2014). Challenges to and strategies for productive co-design are still being actively identified and added to the research, design, and practitioner literatures (e.g., Matuk et al., 2016; Penuel et al., 2007; Severance et al., 2016). This article contributes to that emerging body of work.

The main arc of this article's argument is that educational co-design often has inherent asymmetries distributed among the collaborating members of a co-design team. These asymmetries may include differentials in power and influence, availability, and access to resources during the design process (including time), and specific bodies of prior knowledge. One assertion is that when starting from the position of co-design as involving inherent asymmetries, the organization and conduct of co-design work becomes a negotiation of work processes given those asymmetries. Sometimes those differentials are kept intact and leveraged, and sometimes they are deliberately softened. As we will illustrate with this case, both approaches can be used effectively to produce a product and have legitimate and distinct contributions from all.

Literature Review

Co-Design

Co-design is a type of 'participatory' approach for curriculum design rooted in an educational design research tradition (Couso, 2016). One of the earliest mentions of "co-design" in the educational design literature comes from Roschelle et al. (2006):

> *We define co-design to be a highly-facilitated, team-based process in which teachers, researchers, and developers work together in defined roles to design an educational innovation, realize the design in one or more prototypes, and evaluate each prototype's significance for addressing a concrete educational need (p. 606).*

In describing the motivation for articulating co-design, Roschelle et al. alluded to the influence of preceding design perspectives such as user-centered (Norman & Draper, 1986), learner-centered (Soloway et al., 1994), and participatory design (Couso, 2016). Co-design now appears in several design-oriented research-practice partnerships – which are frequently abbreviated as "RPPs" (Coburn & Penuel, 2016) – whereby researchers and practitioners examine and work together to gain better understandings of and devise possible solutions to persistent problems of practice. It is important to note that not all RPPs are design-focused, and even those that are oriented toward design may use different approaches than co-design (e.g., design-based implementation research; Fishman et al., 2013; Penuel et al., 2011). Moreover, not all co-design engagements unfold in the context of RPPs.

The co-design case discussed here, however, takes place within an RPP and reflects several of the challenges that are now appearing in the literature. For example, Farrell et al. (2023) discussed a study of multiple RPPs where equity was conceived and practiced in different ways that may have very different meanings to stakeholders. One distinction is between equity-in-mission – the focus on bringing about more equitable outcomes for learners – and equity-in-process – the focus on how the work within the RPP is coordinated and organized to strive toward equity in participation in the partnership work. While our examinations of the former appear in Robillard et al. (2023), the focus of this paper is on equity within the partnership work.

A typical co-design collaboration involves teachers and researchers, although different stakeholders may be involved including school district personnel, community members, or students. Gatherings are ideally more than a single meeting and instead are repeated and distributed over an extended period of time. However, there are no hard and fast rules for how long a co-design collaboration must last or be distributed. As a design endeavor, co-design does imply that some product for use in a learning setting will be a major end goal, such as new software tools, classroom routines, or curricula.

Inherent Asymmetries in Co-Design

Because educational co-design, specifically in an RPP, involves collaboration across members who operate primarily in research and practice organizations respectively, there are inherent differences in participants' perspectives and experiences. These differences exist along numerous dimensions, observed in early writings on the “work circle” antecedent of co-design. Reiser et al.’s (2000) analysis of work circle interactions explicitly called out tensions that emerged when classroom teachers and university researchers worked on curriculum creation together. These tensions include different opinions on how much time to spend on fine-tuning all the details in a lesson plan and how scalable the resulting materials needed to be.

Others have noted further differences with respect to how research and practice partners are accountable to different pressures. Penuel has described how different infrastructures underlie teachers' day-to-day work that may not align with what a codesign partnership is trying to accomplish (e.g., developing curriculum for ambitious new learning goals). For instance, Penuel (2019) described science curriculum co-design work in a RPP where the teachers were subject to evaluative observations that did not recognize the complex teaching work that they were enacting through newly designed curriculum. New infrastructuring work – in the form of new rubric and tool creation to crosswalk between existing evaluation protocols and the new practices – was necessary.

Farrell et al., (2023) offers institutional logics as one explanation for why these differences exist. Institutional logics are the "'belief systems and associated practices' that exist within a particular field, creating meaning systems for organizations, partnerships, and individual members." (p. 3). For instance, university-based academic researchers are often driven by institutional logics that value lengthy deliberations, specialized views on what constitutes sufficient evidence, and valuing theory and the building of generalizable knowledge for the purpose of generating academic publications. As such, researchers are often working on highly specialized topics and advancing knowledge on those topics in ways that are very time and resource intensive. However, there can be quite different institutional logics in K-12 participants that collaborate with researchers. Under intense time pressure and with many competing responsibilities, expediency in decision-making may be a key value that may conflict with the researchers' orientation towards the work. A researcher may wonder what works for different populations of students located across a country whereas a teacher may wonder what works for the specific students that are sitting in the same room with them. Neither the researcher nor practitioner perspective is more advantageous. Rather, they are tuned to work conditions and norms for professional communities.

That these differences exist is likely familiar for those who have conducted intensive research-practice collaborative work, such as co-design. However, one of our assertions is that these differences exist because of inherent asymmetries in resources and social positioning across members of a co-design team. Since researchers have different work demands than classroom teachers, there is a major difference in available time to do ‘prep’ work. On the other hand, because teachers are around a diverse set of students every day, their attunement to what is appealing and accessible for youth is likely more robust than those of university researchers.

These asymmetries can create power differentials because one party has access to resources or information that the other would like to have as well. Furthermore, other forces may be at work that widen power differentials. Varying degrees of formal training can lead to differences in who is seen as subject authority. In many respects, these differences set the backdrop and are preconditions for educational co-design. However, explicit acknowledgment of these differences can be used to organize partnerships in ways to strategically negotiate these asymmetries. In some situations, efforts will be made to flatten the asymmetries. In others, they will be intentionally leveraged.

Research and Design Context

The design case for this article comes from a research-practice partnership (RPP) that seeks to support and co-develop elementary school computer science (CS) instruction that involves paraprofessional educators (whose position title in the school district is “computer lab specialists”) and classroom teachers in a rural-serving U.S. school district. A key problem of practice addressed in this RPP is that very few elementary school teachers have backgrounds in or comfort with teaching CS. The computer lab specialists were newly being asked to provide CS instruction. The strategy being pursued by this RPP was to identify and highlight CS concepts in the mathematics curriculum and then structure the computer lab lessons as activities for exploring the related mathematical ideas through a computational medium (e.g., *Scratch*).

This RPP was born out of longstanding working relationships between a neighboring university and school district. As computer science standards were adopted statewide, conversations had taken place over multiple years with different university researchers and school district personnel exploring potential K-12 computer science education research and design activities for use in schools. In 2020, as some initial explorations concluded, members of the university research team and the district central office pursued and were awarded funding from the National Science Foundation (Grants no. 2031382 and 2031404) to further develop one of the approaches that had been explored for computer science integration in elementary school. This was in addition to some state-level funding that the district independently received to use for computer science integration that had its own obligations. A key question guiding this team and for this article was: through what decisions is co-design configured, enacted, and adjusted considering real constraints to support equitable contributions and participation between research and practice partners and still produce useful lesson adaptations?

Methods and Data Sources

This RPP project was initiated in the first year of the COVID-19 pandemic (2020) when social distancing and remote work measures were in place. As such, the vast majority of collaboration activities were virtual, and video recordings serve as the primary data source. Observations and artifacts are the primary focus for the current report.

Data included 49 recorded weekly meetings at the start of the RPP collaboration (each 1-1.5 hours) involving 7 university-affiliated researchers (Principal Investigators and Graduate Researchers) from two institutions and 2 school district-level Curriculum Leads. Those meetings involved much of the initial sense-making and planning for how to pursue co-design with classroom teacher and paraprofessional educator involvement. In addition, 18 co-design meetings involving university researchers, school district coordinators, teachers, and computer lab specialists were observed and recorded over a two-year period (2020-2022).

The research approach follows Severance et al (2014) in that it is ethnographic in nature; a project sub-team had been established to explicitly focus on documenting and studying the interactional dynamics of the RPP. To that end, at least one member of that sub-team was present and actively observing each meeting. Ethnographic research has historically involved field notes to document immersion in the activity or community that is being discussed (Emerson et al., 1995). However, given the timing of this work during the COVID-19 pandemic and that most co-design activities took place via online meetings, the decision was made to rely on videorecordings for online meetings and combinations of recordings and recordings and observational notes for in-person co-design meetings. Best practices for rigorously capturing and reviewing video records were followed (Derry et al, 2010). Regular debrief discussions among that sub-team took place weekly to note key observations and to launch new side analyses of these moments (e.g., Robillard et al., 2023; Tan & Lee, 2023). Particular meeting transcripts were coded to identify significant topics and focus areas for project team discussion (Lee et al., 2022). Additionally, consistent with ethnographic practice, artifacts in the form of digital files produced in preparation of and immediately after all co-design meetings were reviewed and analyzed. The goal of this paper is not to provide a systematic summary of all the interactions, but rather identify and report on some key activity structures that involve asymmetry negotiation that had been identified through review and coding of co-design records.

Results

Consistent with Penuel et al (2022), we observed that the work necessary for supporting co-design expands beyond a particular synchronous session. That is, there is a great deal of preparatory work that is done by team members and work that is also done outside of official co-design meetings, ranging from lesson materials revision to classroom teaching to analyzing information gathered from co-design sessions. The nature of the co-design work changes over time as project members shifted and interpersonal relationships developed.

Some constraints make some asymmetries more pronounced in the co-design relationships. For instance, this RPP and its co-design work were funded by a federal grant that was administered by a research agency and managed through the university partner and existed along other state-level funding commitments that the district had made. Additionally, there are practical limits in time availability. Practice partners contend with typical school day schedules that only make certain afterschool times available to meet, and while compensated for their time, there are limits beyond any party's easy control that established how often meetings can take place. Because of this, synchronous co-design meetings typically could occur no more than once a month. Eight of the 18 (44%) co-design meetings were during the school year, lasting one hour, five more school year sessions (28%) were more than one hour but less than 2 hours in length, and five sessions (28%) scheduled in the summers were two to three hours in length.

Reducing Asymmetries

While borne out of mutual interest and dialogue, some aspects of the project such as the finances and reporting accountabilities to funding agencies skewed influence toward the university partner. Also, that it was driven by district leaders and the university members without involving specific teachers or computer lab specialists presented an asymmetry of influence on the co-design work. The teachers and lab specialists who were going to be involved in co-design were invited to join the work after it had been awarded funding, giving them a 'newcomer' status. Still, their participation was critically important and highly valued and the team wanted to make that apparent in overt and in subtle ways. Therefore, several steps were intentionally taken by the project team to 'design for co-design', as described below.

Conscientious selection of technical systems

An early concern among partners was that technologies that were favored by one partnering organization, but not the other, could create barriers to participation. The university had contracts with various vendors including Box.com, and the university's institutional review board (IRB) required that Box be used for security purposes with human subjects data. This led to the university defaulting to Box for its online storage infrastructure. However, from transcripts of online meetings, we noted how a district team member expressed that Box was not familiar to district personnel: "*I just think it needs to be easy for teachers -- Box is not intuitive by any means.*

And I think it, you know -- teachers are used to Google drive." From recorded meetings and knowledge shared by lead researchers, we knew the university team was bound by IRB rules to use Box. Yet over the course of an early co-design planning meeting, the researchers opted to maintain both Box and Google-based volumes for the project, with Google Drive used exclusively for co-design so that district partners would not feel like they were encumbered with needing to learn to use 'the university's preferred tools'. While this is one decision, there were several others. For instance, in other project meeting transcripts, the project ultimately decided to create a design group email list through Google groups rather than a university listserv system so administrative control and email names did not have the university's address in them, further detaching those aspects of co-design communications from the university's tools. Elsewhere in early recorded co-design meetings, conscientious technical systems selection extended to questions about online calendaring systems for invitations and establishing dates and times and even which organization's Zoom accounts to use as those could represent influence in the partnership with one entity playing the persistent 'host' and having their system preferences dominate.

Flexibility in language use

Another instantiation of an asymmetry in the partnership regarded what language to use when referencing the work. While education researchers are currently enthusiastic about RPPs, it is unclear how widely known the term is among practitioners and how enthusiastically it is endorsed. To illustrate, district team member S, who had been part of writing the grant referred to the entire endeavor in a meeting as: "You know the design, you know the practice design practice partnership". While we were confident this person valued and enthusiastically supported the partnership, the RPP term itself was not one that seemed of great importance to S. The decision was made during a recorded co-design planning meeting in the team that while "research-practice partnership" would be mentioned, there would be no expectations for co-design team members to have familiarity with that as a term nor need to actively use it thus demonstrating that there are different language communities coming together where terms are bestowed different status. Forcing or policing these could inadvertently signal power or influence on the partnership and in designing the co-design, decisions were made to recognize and avoid giving those signals.

This question of terminology also even extended to the terms 'design' and 'co-design'. Educational researchers and designers value 'design' as an idea and treat it as a highly agentic and generative activity. However, a district partner commented that for teachers, "design" implied a lot of time and effort. For example, many teachers do not think of their work leading up to classroom instruction as "designing" their lessons but rather "planning" their lessons. This was illustrated by the following comment from the video record of an early meeting about what to call the team of (what we refer to in this article as[1]) curriculum co-designers.

> District Member B: I do think that, from the teacher's perspective -- going to the word adapting makes the challenge less overwhelming, because when you're talking to a

[1] While co-design was not a term that was aggressively enforced in this collaboration, we do ultimately decide to use the term 'co-design' for this article as it is reflective of the discourse among researchers and others in the field who look to publications such as this one for ideas and guidance.

teacher about designing units -- that's a long-term time-intensive process -- but adapting I think is a better word for that.

As we, the authors of this paper, are participants in and are through this article addressing a community where "design" is discussed (in the context of co-design), we comfortably use the term here. However, the RPP team that was designing the co-design elected to leave this determination to the co-design team. "Design" was offered as a descriptor, but the teachers and specialist viewed it as "integration". This became part of the collective identity that emerged, and that group even gave themselves the name "Code Math integration group" that did not use the "design" term and even designed a logo for that name[2].

Starting with outside examples

A common theme across the above examples is to reduce the sense that ownership was asymmetric at the onset of the co-design relationship. By seeking resources and language that felt equally accessible to all, we could diminish the sense that the university partners or the district central office were the main owners. Upon sequentially mapping of the scheduled activities for all co-design meetings (see figure 1), we observed that the decision was made to begin the three of the first five co-design meetings with teachers and computer lab specialists by jointly viewing and trying examples of integrated math and computer science instruction that existed outside of the partnership. These were presented as everyone trying and discussing some existing learning activities together during synchronous meeting time and react to them.

[2] The team name is slightly changed for this paper in the interest of de-identification of the practice partners.

For example, one activity was “Rain Cloud” coding task (Germia & Panorkou, 2020), which involved manipulating code in *Scratch* for a ”rain cloud”-shaped sprite to move to different locations. University researcher S introduced it in a co-deisgn meeting as an activity where “what we’ll do is we’ll just kind of go through like what the lesson says -- so Task A is just to see this, you know, to understand the sprite and sort of the space.” This was intended to put all co-design team members on equal footing in that no one had ownership or history with the existing lessons. By also working through other existing examples that introduced computer science ideas, the team could simultaneously address another asymmetry in the relationship: uneven prior content knowledge related to CS, as instantiated in the *Scratch* programming environment.

Minutes	Mtg 2: 3-17-21	Mtg 3: 4-14-21	Mtg 4: 5-19-21	Mtg 5a: 6-3-21	Mtg 5b: 6-4-21
5	Welcome	Welcome	Welcome	Welcome	Welcome
10	Rain Cloud Coding	Select Topics to Adapt	Animate name in Scratch		Exponents
15				Scratch Review + Activity	
20					
25	Discussion of Rain Cloud				
30		Planning - development			
35			Scratch Tutorial		
40	Brainstorm Topics or Units				
45					
50				Break	
55			Example - Action Fractions		Break
60	Logistic - Schedules	Logistic - Schedules		Exponents Lesson Adapt	
65			Adapt Exponents Lesson		Coordinate Grid Lesson
70					
75					
80					
85					
90			Logistics Schedules		

Figure 1: Tabular summary of several co-design meetings in 5-minute increments, with three meetings using pre-made examples that the co-design team explored togther – the Rain Cloud activity (Mtg 2), using *Scratch* (Mtg 4 and 5a), and Action Fractions (Mtg 4).

Once the group had worked through the task, it immediately led to conversations about how activities like this would work in the classroom or computer lab. In the recorded session after having time to explore the Rain Cloud activity, Computer Lab Specialist E offered as a reaction "So, but if I was to tell them to place a sprite -- the Rain Cloud in a certain spot -- they could do that with a little prompting…I'm teaching the fifth graders and especially the fourth graders this year different -- meaning I'm really focusing on the X and Y coordinates and what they do". Her comment about focusing on X and Y coordinates then created space for open discussion about what challenges anticipated students having with coordinate systems, to which the other district educators could contribute, and then some group synthesis for how new co-created instructional materials could address them.

Leveraging Asymmetries

In the interest of promoting agency and investment, it was important especially early in the co-design relationship to reduce asymmetries. However, because members of the co-design team brought different resources to the larger project by virtue of their jobs and institutional affiliation, it also makes sense to take advantage of those asymmetries. The contention here is that in co-design, while equitable processes and contributions from all persist as goals, their realization may come in the form of uneven distribution of specific activities to specifically leverage asymmetries.

Alternating synchronous and asynchronous work

One of the most pronounced asymmetries in the co-design work was in the available time to do preparatory work outside of scheduled synchronous co-design meetings. Preparing curricular materials, even when they are characterized as adaptations to existing materials, is a time-consuming process that can involve wrangling with software tools, cross-referencing information sources, and writing lessons. Classroom teachers had many subjects to teach and numerous responsibilities that lead many to work well beyond the regular workday hours. Computer lab specialists needed to provide instruction for the entire school as well as a range of other responsibilities. While the invitation to co-construct new support materials was open, the pattern that emerged was a continual back and forth of asynchronous development that extended across multiple co-design meetings (Figure 2).

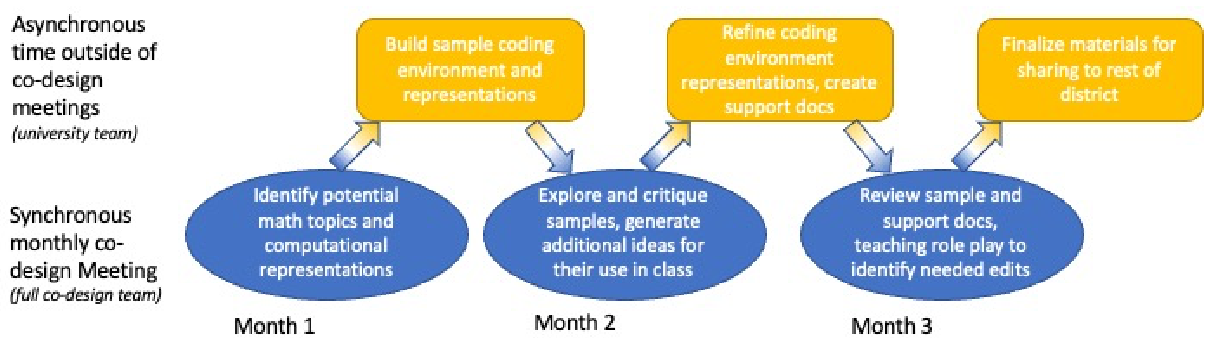

Figure 2. A depiction of the alternating synchronous and asynchronous development process to accommodate limited meeting times. At the end of this cycle, the materials and lesson adaptations were deployed and then subsequently evaluated.

The workflow operated in the following way and had been enacted across design meetings covering the co-design of two integrated math and CS units related to exponents and related to Cartesian coordinates. At the start of a cycle where some new materials and adaptations were to be created, a portion of a synchronous design meeting involved open solicitation of important CS concepts and challenging mathematics topics (see Figure 1, Mtg 3), based on teacher and computer lab specialist observations of students. For example, exponentiation as a form of repeated multiplication rather than repeated addition was an area where co-design teachers observed students having a narrow view of the concept (e.g., a conception aligned with a base-10-only view promoted in the textbook materials). When this was raised in the video recording, questions were asked by the group about the kinds of narrow conceptions and errors that students made and what teachers could see as helpful solutions. In this case, it was making visible that the operations and magnitude of repeated addition and repeated multiplication differed substantially and could easily be demonstrated through using visualizations in a coding environment. With that information, members of the university team prepared sample starter materials, in the form of a *Scratch* program, that could show this through cloning the same sprite and visualizing the different additive and multiplicative growth with “repeat” loops (see Robillard et al., 2023 for a detailed interaction analysis of this structure).

At a later co-design meeting, the materials were demonstrated as one possible resource, which then received feedback and discussion from the entire co-design team. The university-based team members then produced a more developed set of materials. In essence, the synchronous co-design meeting time became occasions for generating ideas, reacting to examples, and suggesting supports and activities. Outside of those meetings, one group that had time available for materials creation and edits took care of that so the focus during synchronous time could be more about trials and discussion. This cycle requires multiple months of co-design meetings given that only one meeting took place per month.

The alternating synchronous and asynchronous development cycle described above also has the advantage of accommodating asymmetries in computer science knowledge between co-design team members. Coding and debugging are things that can be delegated to university partners who are more comfortable with CS, but the challenge is to make sure that code is prepared in ways that are comprehensible to the practice partners in the co-design team who will teach those materials. This required careful annotation in support materials and intensive discussion about how the code worked and what could be made more comprehensible for teaching purposes and still support educator learning of computer science (Figure 3).

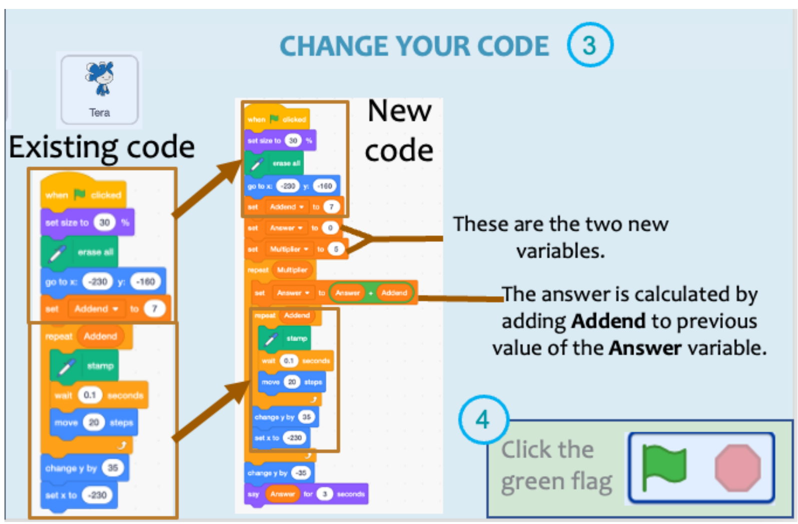

Figure 3. Example annotations to support code interpretation for use in classroom and computer lab teaching, refined after testing in teaching role plays.

Teaching role plays

Teaching role plays, or rehearsals, are another important part of our synchronous co-design experience and leverages two existing asymmetries. One is that the classroom educators are the experienced facilitators of classroom instruction and will have the most insight into what is useful. The other is the different teaching roles and unfamiliarity with one another's teaching context and content that can be leveraged through teacher role play with one another. Specifically, computer lab specialists can role play the teaching they are responsible for with the classroom teachers role playing as students. The classroom teachers can role play to the computer lab specialist. This is an opportunity to put on a 'student hat' to imagine what the experience is like for students (Biddy et al., 2021).

This role play is abbreviated but is an opportunity to find errors or needed improvements in the lesson materials and adaptations. Just as testing with actual users at various stages of the development process is critical to design, teacher role play is an important test scenario prior to use with actual students. This extends and concludes the alternating synchronous and asynchronous development process described above and identifies final modifications needing to be made before the lessons are taught. Through the role plays, a mix of concerns have surfaced by the classroom educators including typographical errors, the need for additional slides or examples to use during instruction, and conversations about cultural sensitivity and inclusivity (Robillard et al., 2023 provides transcript and in-depth interaction analysis that came about during a role-play).

These role plays also serve a purpose as new co-design team members join. We have invited classroom co-designers to lead the role plays of some existing units for the entire group when new co-design team members join at the start of a new academic year. For instance, in the 14th co-design meeting which took place in August before the start of the second school year for the project, the video record has the collaborating classroom teachers leading the designed instruction for the new teachers who had newly joined the project for that cycle. The benefit of this approach was that it positioned co-design team teachers and computer lab specialists as veterans who could model the designs they helped to create. It also demonstrated how the new instruction can be led, reduces concerns about what is expected of teachers, as well as helps identify any further fixes or adjustments that are needed.

Discussion

The described decisions above that have been identified through review of co-design team meeting video recordings and records and stabilized into the team's co-design routines demonstrate some ways in which inherent asymmetries can be navigated, especially in light of real constraints on time and resources in educational co-design. This report, while brief, shares how co-design was enacted and negotiated given real constraints in service of making more equitable contributions and participation possible between research and practice partners. Looking across the examples that had been identified from the co-design video records and other co-design meeting artifacts, we argue that in this case, co-design did not need to happen strictly during synchronous designated meetings, which were limited in time and number. Co-design structuring for equitable participation also took place explicitly when discussed by team members as part of preparatory work related to how the co-design relationship will operate. This was done to reduce some of the asymmetries so as to support entry and participation in actively reflecting on and imagining new directions for instruction.

While creating access and supporting affiliation is important, we also saw some decisions that relied on some differences in knowledge and circumstances and allowed the work to move efficiently (Figure 2). This configuration still preserved the synchronous time for joint reflection and appraisal that ultimately shapes what products get made and refined (see Figure 1). Portions of the materials creation and refinement take place outside of synchronous time, but that occurs in a way to produce stimulus to which the entire co-design team can respond. It is not intended to be final-form until multiple back-and-forth cycles occur, and it is rooted in jointly identified content targets. This configuration ultimately reflects that educational co-design work has intensive collaborative activity during synchronous sessions but is also distributed over time and across actors outside of the synchronous sessions.

Recognizing this is important to update our sense of what is involved in educational co-design. The literature on co-design activity structures is beginning to surface the idea that a co-design team working in lock step fashion through all stages of design is only one of many possible co-design models. There are additional valuable models of co-design that involve constrained tasks, idea generation, asynchronous work, and multiple cycles of testing. A key point of this article is that those are indeed educational co-design activities and may even be desirable given some of the inherent asymmetries that exist across co-design collaborators. Additionally, the collaboration approach described here that negotiates and navigates these asymmetries has successfully yielded the development of new materials, lesson adaptations, and given rise to new learnings for researchers, classroom teachers, and computer lab specialists (Goldman et al., 2022).

However, these outcomes are ones that we can only assert are tied to the constraints and circumstances of this project. If co-design meetings could have been more frequent or individually longer in duration, then the decisions made here may not have been necessary. Indeed, it is an open question about how co-design teams operate under a range of circumstances for different aims. The decisions made here that worked for this case might differ for educational co-design situations with educators working outside of school settings or with more intensive software design requirements. It may also have been very different in situations where other asymmetries are more prominent, such as those that involve issues of historical marginalization, or when they are more flat, such as when the content knowledge of the domain is more robust across all co-design partners. However, the contribution of this work is as its own design case (Boling, 2010) to illustrate how and when key decisions were made in the work of instructional design and also a contribution to our understanding of instructional design processes as they actually unfold over time (Edelson, 2002). This report adds to the efforts that are beginning to appear elsewhere (e.g., Matuk et al., 2016; Severance et al., 2016) that are helping us to gain a better understanding of effective educational co-design configurations and the types of decisions that must be made in service of more equitable participation in light of real constraints and limitations. In the future, more cases would be appropriate as well as more longitudinal research of how co-design relationships change over time, both when participants in the co-design process stay the same and when participants change, such as due to staff turnover or larger policy changes at an educational partner institution.

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