International Society of the Learning Sciences

A Preliminary Model for Responsive Co-Design

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Abstract: Education reform is pushing teachers to teach in ways that are unfamiliar and which present challenges. One approach to helping teachers build comfort and capacity for implementing new and innovative teaching strategies is co-design. In this paper, we build on prior research to concretely articulate *how* researchers can partner with teachers to foster mutual learning, build capacity, and cultivate comfort through responsive practices. Towards this, we present a theoretical model of a vision of co-design, which we call *responsive co-design*. Our model borrows concepts from *responsive teaching*, which is a family of pedagogical approaches that seek to elicit and build on student ideas. Our vision of responsive co-design expands how co-design has been theorized to include the generative, asset-based, and inclusive practices of responsive teaching.

Introduction

Findings from education research are inspiring efforts to reform curriculum and instruction in classrooms across age levels and subject areas (Duschl, 2008; Ford & Foreman, 2006). These reforms often push teachers to teach in ways that are unfamiliar and which present challenges (Hammer, 1997; Prawat & Floden, 1994). Co-design is an approach through which teachers and researchers collaboratively develop innovative teaching practices, which addresses both practical and theoretical aspects of learning (Goldman et al., 2022; Roschelle et al., 2006). By collaboratively addressing the challenges faced by teachers when enacting new teaching strategies, researchers and teachers can ensure designs are usable, sustainable, and equitable (Fishman & Penuel, 2018; Gutiérrez & Jurow, 2016). Engaging in co-design has been shown to support learning for both teachers and researchers (Ko et al., 2020; Penuel et al., 2022). The mutuality and care between teachers and researchers help them to leverage and develop their unique expertise to create teaching strategies through iterative processes of eliciting and refining design ideas (Penuel et al., 2007). In this paper, we build on this prior research to concretely articulate *how* researchers can partner with teachers to foster mutual learning, build capacity, and cultivate comfort through responsive practices. Towards this, we present a theoretical model of a vision of co-design, which we call *responsive co-design*.

Theoretical foundations

We fashion our model of responsive co-design after our characterization of *responsive teaching in the context of theory-building activities* (Swanson & Lawrence, 2024). This characterization is informed by a constructivist theory of knowledge and learning called *knowledge in pieces* (KiP; diSessa, 1993). KiP views knowledge as a complex system of interconnected elements, which are activated in response to the sense-making demands of the context at hand. Learning is viewed as a process through which the knowledge system is reorganized and refined. As more expert knowledge is built from the same pieces of knowledge that comprise the novice system, novice knowledge is viewed as a *resource* for the construction of expert knowledge. KiP is an anti-deficit perspective (Adiredja, 2019), which sits in contrast with *misconceptions* perspectives that view novice knowledge as an obstacle to learning (Chi, 2008; McClosky, 1980). In light of its epistemological commitments, KiP pedagogy seeks to elicit and build on learners' intellectual resources. In this way, KiP pedagogy aligns with the general goals and methods of *responsive teaching*, a family of approaches that seek to elicit and build on student thinking (Robertson et al., 2015).

Based on the assumption that students have a wealth of productive prior knowledge resources (diSessa & Minstrell, 1998), responsive teaching strategies generally seek to 1) understand the substance of their students' ideas, 2) identify connections between students' ideas and the knowledge and practices of the discipline, and 3) adjust instruction to pursue students' ideas (Robertson et al., 2015). Research on responsive teaching has found that it can help students develop conceptual understanding (Carpenter et al., 1989), engage students in disciplinary practices (Hammer et al., 2012), and promote student agency (Lemke, 1990) and equitable participation (Warren et al., 2001).

Our characterization of responsive teaching focuses on how instructional design and teacher moves can elicit and build on student ideas in the context of theory-building activities, where students are guided to develop *theoretical knowledge artifacts*, such as models or explanations. When students generate their artifact, they are guided to articulate their thinking, as their artifact embodies their thinking. When they test their artifact, they are

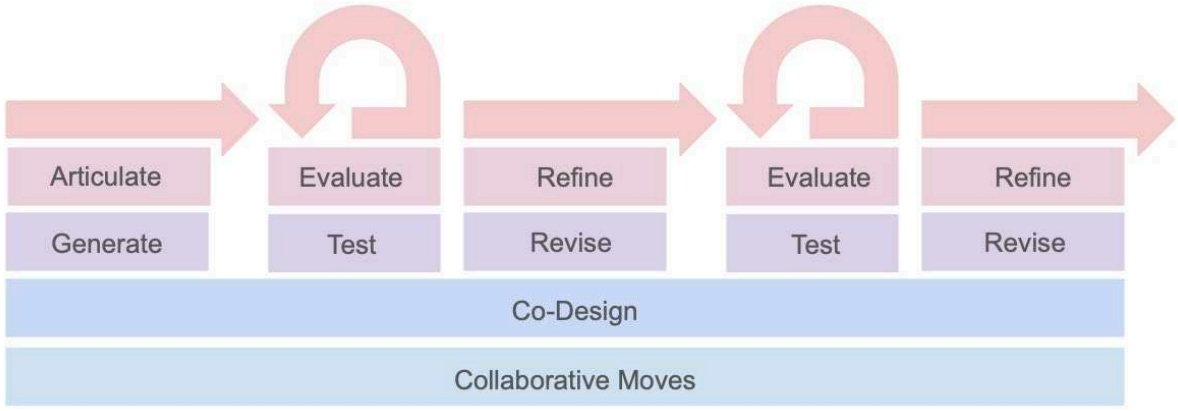
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guided to evaluate their thinking, as testing the artifact surfaces unexpected findings or reveals where their thinking may have been black-boxed. Their revised artifact embodies their refined thinking. In this way, theory building is a natural context for eliciting and building on student ideas – in other words – enacting responsive teaching.

Model of responsive co-design

Our vision of responsive co-design mirrors our characterization of responsive teaching, enabling us to expand how co-design has been theorized to include the generative, asset-based, and inclusive practices of responsive teaching. As researchers and teachers *generate*, *test*, and *revise* artifacts (in this case, their co-designed lessons), they are naturally guided to *articulate*, *evaluate*, and *refine* their thinking about the pedagogical ideas embodied in those lessons. We represent the core elements of our model in Figure 1. The goals at the heart of responsive co-design are to help both teachers and researchers *articulate*, *evaluate*, and *refine* their thinking about lesson design and pedagogy. The next layer represents the general lesson-construction actions (*generate*, *revise*, *test*) through which each of these goals is pursued. For example, when teachers and researchers collaboratively generate their lesson, they are guided to articulate their thinking about lesson design and pedagogy, as their lesson embodies their thinking. When they test their lesson (through classroom implementation) they are guided to evaluate their thinking, as testing the lesson surfaces unexpected findings or reveals where their thinking may have been left tacit. Their revised lesson embodies their refined thinking. These actions are scaffolded through the structure of the co-design process and collaborative moves made by teachers and researchers to achieve the goals of the co-design project.

Figure 1
Preliminary Model of Responsive Co-Design



The *co-design* layer is concerned with how the co-design process might be structured to engage both teachers and researchers in articulating, evaluating, and refining their thinking through generating, testing, and revising their lessons. For example, to help teachers and researchers *articulate* their initial ideas with regards to designing and teaching the lesson, the process of generating lessons begins with teachers sharing their goals and needs for the lesson design and with researchers sharing their research goals and needs for the lesson. The two groups then work together to co-construct goals for the lesson design based on the needs of both. The teachers then begin to generate the lessons, sharing drafts with the research team and then iteratively refining based on researcher feedback and decisions made jointly during the co-design workshops. Through these actions in the co-design process, collaborative moves are used to scaffold the process, including encouraging and negotiating goals, sharing ideas, providing feedback, evaluating designs, and revising joint understanding.

To *evaluate* their co-designed lessons, teachers test their lessons through classroom implementations and members of the research team observe, taking field notes and video and audio recording for later reference. Through implementation, teachers and researchers engage in collaborative moves, for instance revising and iterating in the moment to address new challenges in the classroom.

To *refine* teacher and researcher thinking, the team collaboratively reflects on the implementation. The teachers share their reflections and plans for revising their lessons and teaching, based on what they have learned from their implementation. Researchers share feedback from their observation of the implementation and preliminary research findings from the implementation. Collaboratively, the researchers and teachers make plans

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for revising the lessons and adjust the research focus if necessary. The team communicates and works through findings together, unpacking the successes and failures of the implementation to inform the next iteration.

To illustrate responsive co-design, we present a vignette, drawn from our Summer 2023 co-design with middle school science teachers, to illustrate how the structure of the co-design session and the collaborative moves help both teachers and researchers *articulate* their thinking.

> *It is the middle of the Summer 2023 co-design session and the team discusses Ms. K's unit on Energy Transformation, which features a "Can Crush" activity. Prior to the discussion, the researchers asked Ms. K to* articulate *her thinking about the energy lesson: what standards she wanted to teach, what the theory-building part of the activity might look like, and how it might elicit and respond to student ideas. During the co-design session, the team discusses Ms. K's initial design and thinks out loud about how she might best elicit and respond to student ideas. Ms. K documents her initial plan and the team's feedback, to help guide her revision of the lesson plan (Right, Figure 2). Her notes indicate her thinking about how to build on student ideas most effectively in the context of the lesson. She iterated on these ideas over the summer co-design session and tested them in the implementation, which occurred that Fall.*

Figure 2
Left: Summer 2023 Co-Design Session, Right: Ms. K's Notes During Co-Design Brainstorming



Discussion

In this paper, we presented a model for responsive co-design. The model shows how the basic goals of helping teachers and researchers articulate, evaluate, and refine their ideas about lesson design and pedagogy might be achieved through the co-design process by having them collaboratively generate, test, and revise lessons. The model further suggests structure for the design of the co-design activities and collaborative moves, which support both teachers' and researchers' articulation, evaluation, and refinement of thinking.

This paper makes a contribution to literature on responsive teaching (Hammer, 1997; Robertson et al., 2015), by expanding the context for responsive teaching to include teacher and researcher learning through processes of collaborative design. The paper makes a contribution to literature on co-design by providing a method through which the process can systematically attend to eliciting and building on both teacher and researcher ideas (Goldman et al., 2022; Roschelle et al., 2006). This, in turn, creates a natural dialogue between researchers and teachers, whereby promising research findings are translated into teaching practice and research products benefit from the experience and wisdom of practicing teachers.

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Acknowledgements

This project was supported by the National Science Foundation (1842375; 2235569).