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# Teachers as Co-designers of a Knowledge Building Environment

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**Abstract:** While the value of teacher involvement in design-based research projects has been recognized in the Learning Sciences community, less is known about specific contributions teachers could make. The present study examined teachers' participation dynamics in a series of design workshops and types of knowledge they contributed as co-designers. Based on a qualitative analysis of workshops transcripts, we found teachers contributed various types of knowledge relevant to the specific design project. Teachers also demonstrated fruitful peer teaching/mentoring dynamics, which scaffolded a less experienced teacher to make increasingly sophisticated contributions. This study offers fresh insights into teacher as designers and encourages design teams to create effective contexts for teachers to contribute.

## Introduction

The value of involving teachers in the design of digital learning environments has been recognized in the Learning Sciences and Information Science communities. One notable line of work is focused on the application of "participatory design for learning" and has been featured in prior conferences (Bonsignore et al., 2013), Learning Sciences journals (Kali, McKenney, & Sagy, 2015), and edited volumes (Svihla & Reeve, 2016). This line of work has demonstrated that engaging teachers as designers can empower them to contribute to the design, elicit their beliefs that would impact technology integration, and lead to the co-development of pedagogical strategies (Kali, McKenney & Sagy, 2015). However, this work remains underdeveloped. More work is needed to answer several enduring questions: What types of knowledge do teachers bring to bear in design processes? To what extent are teacher contributions reflected in designed environments? To what extent are teacher knowledge and beliefs revised during design processes? How could we support more teachers to become designers?

In this paper, we report on a year-long journey of involving a group of teachers in an iterative process of designing a Knowledge Building environment for high school science. Informed by prior analysis of teachers' participation modes in design workshops (Cober et al., 2015), we attempted to delaminate types of knowledge teachers bring to bear during workshop participation. Building on earlier quest for productive environments for teachers to act as designers, we also examined dynamics among teachers in this particular context. Below, we first describe the design research project. We then introduce research methods, report findings, and discuss implications.

## The IdeaMagnets Project

Grounded in the long tradition of Knowledge Building pedagogy, design, and research (Scardamalia & Bereiter, 2014), the IdeaMagnets project aims to extend knowledge-building discourse in Knowledge Forum into broader cyber spaces via *web annotation* (Ciccarese et al., 2013). The IdeaMagnets project attempts to create a coupled digital system for idea development in knowledge-building communities. This project, contextualized within high school science, is motivated by a fact that high school students make frequent use of web and social media content but are rarely engage to build knowledge on the web. The project's high-level conjecture (Sandoval, 2014) is that we can potentially make knowledge-building discourse more pervasive and achievable by linking knowledge- building environments, such as Knowledge Forum, with broader web spaces which high school students already dwell in.

Following this high-level conjecture, the first year of the IdeaMagnets project centered on an iterative cycle of design workshops and software development participated by teachers, researchers, and engineers. The central focus in this phase was the embodiment of high-level conjecture in tools (Sandoval, 2014). In particular, we aimed to connect Hypothes.is—an open-source web annotation tool—with Knowledge Forum so that students can easily port ideas captured in annotations to their discourse in Knowledge Forum.

### Teachers as Co-designers in Design Workshops

Four in-service teachers, who have minimally five years of high-school teaching experience, were recruited to participate in a series of participatory design workshops. These teachers had varied levels of familiarity with the Knowledge Building pedagogy and technology. Among these teachers, two had used Knowledge Forum (Teacher A and Teacher B), whereas the other two (Teacher C and Teacher D) had minimal exposure to Knowledge Building and were contemplating using Knowledge Forum in their classes.

Briefly, these design workshops were semi-structured, featuring a combination of design thinking, sketching, paper prototyping, and open conversations. Each workshop was planned to be a 60 to 90-minute session facilitated by 2 researchers and 1-2 software engineers. A timeline of these design workshops, together with sketches generated from or prepared for these workshops, are illustrated in Figure 1.

Figure 1. A timeline of design workshops, with paper prototypes, low-fidelity mockups, and high-fidelity mockups produced during or prior to these workshops.

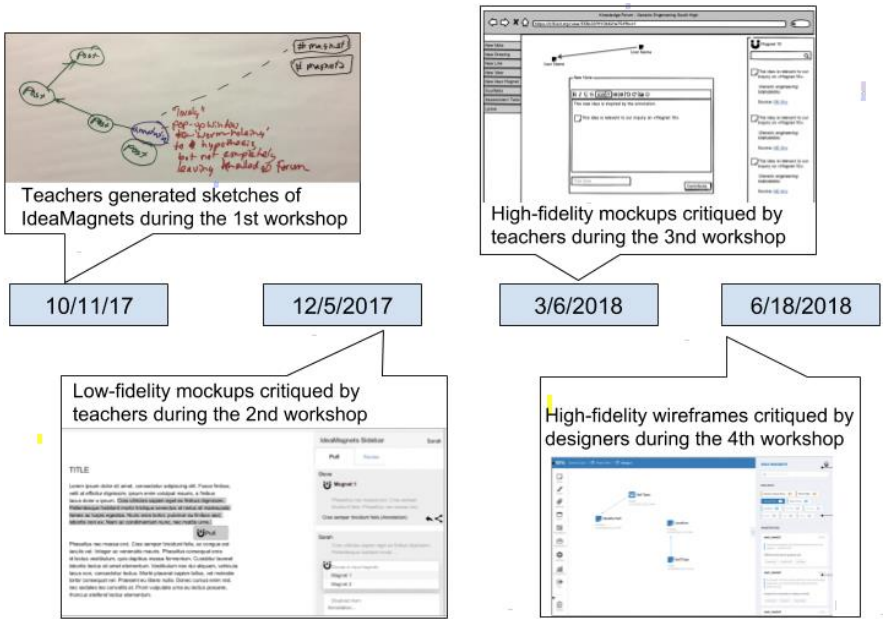


Figure 1. A timeline of design workshops, with paper prototypes, low-fidelity mockups, and high-fidelity mockups produced during or prior to these workshops.

## The Present Study

### Research Questions

To understand how teachers participated as co-designers in these design workshops, we pose the following research questions:

1. What knowledge did teachers bring to bear during the design workshops?
2. What participation dynamics did teachers demonstrate during the design workshops?

### Data and Analysis

The transcripts of two design workshops were the main data sources for this study. Each workshop contained a 90-minute conversation relevant to the project. To answer research questions, we qualitatively analyzed workshop transcripts using a two-cycle coding method (Saldaña, 2016). In the first cycle, two researchers conducted *open coding* separately and then used *axial coding* to organize the initial codes into categories. In the second cycle, based on patterns emerging from the axial coding, one researcher applied *selective coding* to identify core aspects of teacher knowledge and participation dynamics reflected in the design process.

## Findings

## Design Workshop 1

In the first workshop, teachers mostly contributed by discussing the initial tool design and its usability issues (see Table 1). They brainstormed new features, questioned design purposes, and critiqued usability. By doing so, they also developed technological knowledge important for their participation in the design process.

All teachers also drew from their pedagogical knowledge to elaborate possible scenarios of tool usage that could benefit students' individual or group inquiry. For example, one teacher appropriated the initial tool design to help students identify "ideas for solutions": "[Students] can click on that, and it would make available the magnets that have been associated with the solutions there." He further explained this idea was to "keep the problem [in the] front and center" by spotlighting "idea magnets" in the community (*Teacher A, Workshop 1*). All the teachers also recognized the value of IdeaMagnets for facilitate student awareness of community. For example, Teacher B contributed this scenario of engaging students to use this tool:

> "I mean having the magnet or the hashtag sitting right on the screen where they're having their discussion to say: 'Alright, you're having your discussion and then right here as you need to go outside of your personal understanding amongst the people in your group and gather information from outside of your group. Then you're going to click on this and then ... pull that annotation there into your conversation'." (*Teacher B, Workshop 1*).

Finally, teachers also contributed to the conversation by shedding light on practical barriers related to the shortage of devices in the school and possible challenges with introducing new tools to students.

Table 1: Knowledge contributed by teachers to two design workshops

| | **Workshop 1** | | **Workshop 2** | |
|---|---|---|---|---|
| | Technological | Pedagogical | Technological | Technological |
| IdeaMagnets design | • Propose a new feature<br>• Critique software usability | • Describe ways to deepen student discourse with the tool<br>• Imagine adapting the tool to support student inquiry | • Suggest and clarify a feature to improve its usefulness and usability | • Draft plans to prepare students for web annotation and idea tagging |
| Knowledge Forum | • Consider software utility | • Share pedagogical experiences of using KF | • Report prior experiences of technical problems<br>• Suggest making tutorial videos | • Recognize the importance of class norms and student roles<br>• Reflect on student use and provide ideas to encourage student usage |
| School context | • Raise concerns with limited school resources | • Imagine student pushback when using a new tool<br>• Discuss class management and student choices | • Raise concerns with limited devices and time constrains | --- |

## Design Workshop 2

In the second workshop, the teachers critiqued a low-fidelity mockup prepared based on the first workshop. Data analysis indicated that teachers mobilized their technological knowledge to understand particular user interfaces and critiqued the tool's usefulness and usability (see Table 1). For example, acknowledging the tool's value in connecting ideas, teachers continued to improve the design by suggesting "displaying relationship [among ideas]" or "having a few different levels of magnets" (*Teacher A, Workshop 2*).

Teachers also contributed their pedagogical knowledge to suggest ways to improve the tool to better support students-centered activities (see Table 1). As teachers continued to discuss how students could use this tool to connect ideas, they realized it would be "a very difficult skill" for students "to recognize the large idea;" they suggested students need to grasp basic domain knowledge before getting "any idea of what you're doing there" (*Teacher B, Workshop 2*). Teachers then brainstormed student-centered activities to scaffold student use of the tool, to make the tool's intension more apparent for students. For instance, teachers imagined how the design would work in their classrooms:

> "I was kind of visualizing how this might go in the classroom... so they say, what are some things we should consider when we are reading about genetic engineering and the students maybe create ... And then we can read the article and go back and say, hey, [we] should look at this interesting idea" (*Teacher A, Workshop 2*).

### Dynamics among teachers in two design workshops

Teachers in both workshops created a supportive and collaborative environment for everyone to contribute to the design activity. In both workshops, they worked together to consider the design's potential acceptance by their students, brainstormed feasible pedagogical strategies to scaffold student use, and contributed valuable contextual information about school resources and student dispositions.

Among four participating teachers, Teacher A acted as a leader and an experienced Knowledge Building teacher. Teacher B contributed perspectives as a novice Knowledge Building teacher hoping to adopt Knowledge Forum. Teacher C and Teacher D demonstrated less desire to adopt Knowledge Building, leading them to played a less active designer role; nonetheless, they contributed contextual information important for the project design.

We took a closer look at Teacher A and Teacher B's participation and found that Teacher A contributed the most in (a) technological knowledge relevant to the IdeaMagnet design and (b) pedagogical knowledge related to Knowledge Forum. As for Teacher B, she contributed the most in pedagogical knowledge for IdeaMagnet design and continued to develop her technological knowledge relevant to the tool design. We noticed interesting peer learning dynamics between them. In the first workshop, Teacher A was prompted by his colleagues to share his previous teaching experiences with Knowledge Forum. In the second workshop, Teacher B continued to pressed for a better way of using Knowledge Forum in her classroom. When she reflected on a dilemma of giving students the freedom to mess around the discussion board, Teacher A weighed in with his worked examples. With support from Teacher A, design ideas contributed by Teacher B became increasingly specific across two design workshops.

## Discussion and Implications

Design processes in design-based research projects are often left out in reports and seldom recognized as scholarship (Svihla & Reeve, 2016). Emerging work has started to highlight the value of teacher involvement in these projects (Cober et al., 2015; Kali, McKenney, Sagy, 2015). Building on this line of work, the present study examined teachers' participation dynamics in design workshops and types of knowledge they draw upon when acting as co-designers. Based on a qualitative analysis of workshops transcripts, we found teachers contributing a variety of knowledge relevant to the specific design project, its larger program of research, and contextual factors that would inform the tool design. Despite different levels of interests and prior knowledge, these teachers all contributed in meaningful ways. Two teachers in particular demonstrated a fruitful peer teaching relation, which scaffolded the less experienced teacher to make increasingly sophisticated contributions.

This study contributes fresh insights into teacher as designers. A key takeaway for design teams is to anticipate types of knowledge teachers could bring to design projects. The uncovered teacher interaction dynamics implies potential benefits of co-design workshops for teacher professional development.

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