Designing a Virtual Learning Community for Elementary Mathematics Teachers

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Abstract

Building on recent work in educational design, this paper describes the development of a National Science Foundation-funded virtual learning community (VLC) for elementary mathematics teachers. The VLC is currently in the second year of a three-year development process and has attracted 3000 members as of March 2012. This paper describes how the VLC team designed the web-based community around three research-based pillars of effective live professional development while also utilizing the unique affordances of an online environment. It also describes lessons learned from ongoing research about designing a virtual space for teachers, including data from live teacher focus groups and from active site users. It ends with implications for educational designers and professional developers.

Purpose

This paper describes the development of a National Science Foundation-funded virtual learning community (VLC) for elementary mathematics teachers (http://vlc.cemseprojects.org). The proposed goal of the VLC project is to create a prototype of a website that supports first- and fourth-grade teachers who use the elementary (pre-kindergarten through sixth-grade) mathematics curriculum *Everyday Mathematics*. *Everyday Mathematics* is the most widely-used elementary mathematics program in the country, reaching 4,300,000 students in over 220,000 classrooms, making it a fertile context for reaching teachers. The site's mission is thus to help these teachers improve their implementation of *Everyday Mathematics* specifically and their mathematics teaching more generally.

The development of the VLC was funded for three years, beginning in July 2010. The funding was awarded to the Center for Elementary Mathematics and Science Education (CEMSE) at the University of Chicago, which houses the authoring team of *Everyday Mathematics*. The authoring team is distinct from the publisher of *Everyday Mathematics*, and the project is firmly a research and development project, not a marketing one. The project aims both to create a supportive website for teachers and to contribute to broader knowledge about how to construct such a website to promote teacher learning and sustained engagement.

In the first year of the project (2010-2011), we identified some basic principles of site design (see Theoretical Framework), built the site architecture, and began developing high-quality content for the site (which we henceforth call the "resources" of the site). Following the principle that teachers must be integral to the construction of a professional development site designed for their use, we engaged 15 teacher partners who provided resources to the site and reviewed the site as it was designed. We videotaped these teachers as they taught their

mathematics lessons and asked them to participate in focus groups regarding the design and functionality of the site.

At the end of this first year (June 2011), we opened the site to anyone who wished to join, although we did not actively publicize the site beyond sending an initial email to a CEMSE-moderated listserv of *Everyday Mathematics* teachers. Membership of the site has grown steadily and quickly since that time. As of March 2012, the site boasts 3000 active users.

In the second year of the project (2011-present), we continued collecting and developing high-quality resources for the site with our teacher partners and began using feedback from the site's users to make revisions and improvements to the site. Although the site continues to serve largely a space for asynchronous activity, we began holding a small number of live events on the site in the second year, including a webinar on the Common Core State Standards and a recurring lesson video discussion club with a small group of teachers. We are currently planning the third year of the project (2012-2013), in which we will implement a research study on the site to measure the effects of the site on teacher's professional learning.

This paper shares information on the development of the VLC to date, including how we enacted our design principles in the development of the site and what we have learned from both our teacher partners, who have worked with us to provide lesson video for the site, and from the teachers who comprise the bulk of the site's 3000 users. This paper does not include any research findings on the effectiveness of the site, as that is the matter of future study in our third project year. Instead, we focus on what we have learned from the process of creating the site. We elaborate the implications of these findings for educational designers and professional developers.

Theoretical Framework

Teachers increasingly seek professional learning opportunities online, perhaps largely out of convenience. Online learning is generally cheaper and less time-consuming than live professional learning, and the bandwidth available to individuals has grown more ubiquitous and affordable. While one driver for online learning may be easy access, the use of web-based technologies also opens up opportunities for providers to improve professional learning, because web-based tools can personalize learning experiences for individual teachers and can sustain teachers' involvement beyond the typical time confines of a live course.

Recognizing the opportunity to design online professional learning tools responsibly, CEMSE began the three-year design and development of a virtual learning community (VLC) for elementary mathematics teachers. Our project design was three-fold. First, we aimed to translate what was known about effective live professional development into a web-based setting. Second, we sought to capitalize on the potential of web-based tools by incorporating components of effective online professional learning environments. Third, knowing that many similar sites exist with few active users, we decided to engage practicing teachers fully in the development process to ensure we could weave the site into the fabric of their professional lives.

After systematic review of the literature on effective live and online professional development, we determined three foundational pillars for our site. The first was to ground the VLC in **practical artifacts of teaching practice**, including lesson video clips, case studies, student work, instructional tools, and planning guides. A wealth of research (Ball & Cohen, 1999; Barab et al., 2001; Borko, 2004; Borko, Jacobs, Eiteljorg, & Pittman, 2008; Brophy, 2004; Crockett, 2002; Darling-Hammond & McLaughlin, 1995; Moore & Barab, 2002; Seago, 2004; Shulman, 2005) illustrated that teachers learn when they are engaged directly with practice. For instance, teachers have shown growth when they examine student work together or discuss what they notice about lesson video. While questions remain about how to design and frame these artifacts to enhance learning, it is clear that artifacts of practice are a central part of high-quality professional learning, be it live or online.

The second pillar was to build opportunities for **sustained teacher community** into the VLC infrastructure (Barab et al., 2001; Borko, 2004; Borko et al., 2008; Darling-Hammond & McLaughlin, 1995; Moore & Barab, 2002; Webster-Wright, 2009). Schools are currently adopting and maintaining professional learning communities amongst their staff, and with good reason: such communities provide an avenue for bridging the critical divide between teachers knowing what they should do and actually doing it. Professional learning communities allow teachers to discuss what changes need to be made in instruction, to make plans for enacting these changes, and to support each other in implementing them (see Wiliam & Thompson, 2008). In addition, these professional learning communities continue learning over time, which is crucial given research showing that professional development must be sustained over time to have an impact (Yoon et al., 2007). Given this striking evidence, we designed the site (including its name) to invoke the ideals of high-quality professional learning communities.

Finally, we determined that we should root the VLC in a **specific instructional system**, so that teachers have a shared, practical context for using the site (Ball & Cohen, 1996; Bryk, 2009). Because our center supports the most widely-used elementary mathematics curriculum in the country, we selected that particular curriculum as the instructional core of the site. This decision had obvious positive ramifications on our other two pillars of site design, including providing us a context in which to collect and curate artifacts of practice and providing us a potential user base that could support a large teacher community.

Methods, Data Sources, and Analysis

We approached this project with a design-based educational engineering method (Bryk, 2009; Burkhardt & Schoenfeld, 2003; Design-Based Research Collective, 2003), which involved engaging teachers in iterative cycles of site design, implementation, testing, and re-design. Previous research (e.g., Hur & Hara, 2007) has found teachers more willing to participate in professional learning sites when they feel a sense of ownership, so we worked to engage teachers as true partners in the site. After determining the pillars of site design and building initial site

architecture, we sought to involve teachers in the refinement and development of the design, and the feedback these teachers gave us became data for our project.

Teachers became involved in design work at two levels. First, a group of **teacher partners** provided us with artifacts of practice by allowing us to videotape their math lessons (using *Everyday Mathematics*), providing student work and instructional tools for the site, helping edit and frame selected lesson video clips, and communicating with us about the site design. These 15 teacher partners provided us with qualitative feedback data in the form of answers to focus group questions at two formal meetings, occasional email exchanges about site design, and informal interviews as we traveled to their classrooms to collect videotape and other artifacts. The demographics of the teacher partners were as follows: (a) all 15 were women, (b) 10 were white, 2 were Hispanic, and 3 were black, (c) 7 were first-grade teachers and 8 were fourth-grade teachers, and (d) 6 taught in urban schools and 9 taught in suburban schools, although the demographics of all of the schools varied widely and not predictably across the urban/suburban boundaries.

Second, 3000+ users of *Everyday Mathematics* across the nation joined the site and provided feedback through various site tools; we called these users the **teacher panel**. The teacher panel represents a diverse group of *Everyday Mathematics* users. According to March 2012 VLC user data, 69% of site users are classroom teachers, with the other members comprised of curriculum coordinators, specialists, math coaches, administrators, university professors, and a few others. The teachers are spread across the elementary grades; there are fewer fifth-grade, sixth-grade, and kindergarten teachers than there are first- through fourth-grade teachers, but the first- through fourth-grade teachers are evenly distributed. The site also includes a healthy mix of experience, with some rookie teachers and a variety of years on the job represented. The users are 90% female; they are also 88% white, 5% black, and 3% Hispanic, with the remaining percentage of users falling into other categories.

These teachers provided us with feedback data in several ways. First, we tracked their use of the site using web analytics tools. These tools included Google Analytics, which detailed what site pages within the site they visited, how long they visited, and how they entered and exited pages, and Vimeo, which provided statistics on whether teachers played videos we provided on the site and, more importantly, whether they *finished* the video-based resources on the site. Second, we analyzed the comments they made on the site, both on individual resources and community pages. The site provides comment forms on every site resource, which allows users to provide feedback on the technical and practical usefulness of the site's content. Since the launch of the site, we have received close to 300 comments on individual resources; for the purposes of this paper, we discuss our analysis of the first 162 comments that we conducted in December 2011. The site also includes discussion boards, which we regularly examine. Finally we examined emails users sent the project team. The site provides mechanisms for submitting feedback about the site design and functionality directly to the CEMSE development team, and we have received several emails from site users about the site overall.

Our own records of developing the site and responding to teacher feedback serve as a final data source for this paper. The VLC includes an extensive private database that stores written notes on selecting, editing, and framing resources used on the site. These notes document how our process of populating the site with content has evolved over the first two years of the project.

We analyzed these data sources for themes related to (a) site design and re-design and (b) emerging uses of the site by practicing teachers. In the section below, we describe the site design and present five key findings about use of the site, gathered from our teacher partners and panel.

Results

Site Design

The design of the site can best be understood by visiting the site itself at http://vlc.cemseprojects.org. The site is open to all members who register and have legitimate business on the site; users must register because the site contains video clips of students and teachers, and these students and teachers signed limited permissions allowing the use of images on a password-protected virtual learning community only. For this reason, we do not include screenshots of the VLC in this paper, but we encourage interested readers to join the website.

The site is built around five central pages: a home page with regular news updates about the site and links to key site content (HOME), a page explaining the background of the site (ABOUT), a page providing a searchable database of resources (RESOURCES), a page linking to discussion groups about various topics related to teaching mathematics (GROUPS), and a profile page allowing each user to bookmark useful resources and to review comments he or she made on the site (MYPAGE). We discuss three of these pages, HOME, RESOURCES, and GROUPS, here as they relate to the pillars of site design.

The HOME page was designed to introduce teachers to each component of the site and to provide regular updates on the site. We based this page on our research of social networks; we found that most successful social networks have some way of alerting users to new content, posts, and activity. Thus, this page provides us a means of announcing new additions to the site, upcoming live events, and other news. Realizing that users may also want to be alerted when more minor occurrences happen on the site, we created an email notification system that sends communication to users' inboxes whenever a new resource is added to the site or a user posts a comment on the site. Each user may opt in or out of this notification system and may determine the frequently of receipt of these notifications (once a day, every time a post occurs, etc.). These notifications allow users to see site activity and to follow ongoing conversations in which they are participants, without visiting the site every day. We believed these regular notifications were essential to maintaining community on the site, given the busy lives of teachers.

The RESOURCES page has thus far been the heart of the site. We spent a great deal of time thinking about and talking with teachers about how to organize the resource database in a teacher-friendly way. When a user lands on the RESOURCES page, he or she first sees titles and "thumbnails" (tiny pictures showing a bit of the content of a resource) for the three newest items on the site. The reasoning for listing the new arrivals first is the same as the driving force behind the HOME page: we wanted teachers to see that the site is a living, breathing community with new content and new comments coming in every day. Below these new arrivals, the user sees an option to upload his or her own resources to the site. This functionality was designed to promote teacher engagement in and ownership of the site. Indeed, user-created resources, such as books of prompts for students to write about math problems, are popular on the site and have received multiple comments from other users.

Finally, a visitor to the RESOURCES page would see lists of "tags" organized into various categories. We settled on "tagging," a web-based tool in which you can mark various items with a variety of search terms, as the best way to organize the resources in the database. These tags are organized into categories that we discussed and cultivated with feedback from teachers and research on *Everyday Mathematics* implementation; they include tags for (a) grade level, (b) type of resource, (c) pedagogical issue, (d) mathematical content, and (e) Common Core State Standards Mathematical Practices. If a teacher clicks on any of these tags, he or she can see thumbnails of all the resources marked with that tag. If this search proves too large, the teacher can also type key words into a search box to find exactly what he or she needs. Once the teacher finds a resource, he or she sees a page with the resource and all of the comments given by users about the resource. This flexible, user-friendly RESOURCES page is the direct portal to the artifacts of practice on the site, and teacher feedback has been critical in designing the page for maximum usability.

The GROUPS page is another page that promotes community on the site. The page allows users to join groups discussing various topics related to mathematics education. As of March 2012, there are 13 groups on the site, including a "gifted learners" group, a "management and differentiation" group, and an "instructional leaders" group. Many of these groups were created by CEMSE staff, but some were created by teachers. These groups have proven fruitful grounds for teachers to share ideas and comments with each other about teaching with *Everyday Mathematics*.

Key Findings on the Use of the Site

Now that we have explained the site design and its relationship to the three principles of professional learning we sought to enact, we can share some findings on teachers' reactions to the site, the site's design, and the site's content. Five themes have emerged from the data on our site development process, including the following: (a) the difficulty of selecting resources that are both practically useful and have the potential to promote broader reflection for teachers, (b) the challenge of framing resources in ways that can help teachers be reflective about their

practice, (c) the opportunity for organizing resources in ways that capitalize on technology's ability to personalize for the user, (d) the problem of weaving the VLC community into teachers' existing work lives, and (e) the imperative to use research on the curricular core of the site to predict needed resources and features. We discuss the first two in depth and touch on the last three briefly.

Selecting Resources. As we began videotaping our teacher partners, we met internally to determine a framework for selecting lesson clips and other resources to post on the VLC. We drew on research related to the implementation of reform-based mathematics curricular materials (CEMSE, 2011) to determine a focus on process-oriented instructional features, such as rich discussions, or transparent student thinking. We determined that non-video resources should be fairly practical, like assessment tools or handouts for students, but that they should be vetted carefully by our staff.

As we began collecting feedback from our various teacher groups, we quickly learned that we needed to (a) support a better balance between practical resources and resources designed to encourage deep reflection and (b) loosen the reins on vetting the resources. Analytics data on VLC usage through the first year of the site's public availability indicated that, although classroom videos drew some users' eyes (16 of our videos had more than 200 viewings on the site), users quickly migrated to downloading the more practical tools posted on the site. At this writing, the top 10 most-viewed resources on the site are an archive of a CEMSE webinar on the Common Core State Standards, "classroom tours" in which teachers share ideas and tips for organizing their classrooms, booklets of *Everyday Mathematics* assessments, and templates for organizing and planning differentiation activities. Save the webinar, these resources were all created solely by teachers or by teachers working with CEMSE, not by the VLC team. The popularity of these resources over the classroom videos, which CEMSE staff explicitly designed to promote teacher reflection on practice, suggests that most teachers are interested more in resources that support tomorrow's lesson than in resources that promote reflection.

Not only did users flock to practical resources, but teacher partners and panel members also routinely requested more practical resources and videos. Guided by research suggesting that useful video clips are only minutes long, we endeavored to create video clips that were 2 to 6 minutes in length. However, teachers routinely requested full lesson videos to see how a teacher conducts the various parts of an *Everyday Mathematics* lesson. They particularly wanted us to go beyond our project's focus on first and fourth grade to provide resources for all the grade levels. Other requests included photographs of how teachers organize mathematical tools in room, additional assessment tools for monitoring student progress, and teacher interviews about how they solve various curricular issues.

Based on these data, we determined that we should include more practical videos on the site, as well as more teacher-created, non-vetted instructional tools. We created the functionality for teachers to upload their own instructional tools. An invitation to use this function resides on the RESOURCES page. We also posted many more print resources related to grade levels outside of Grades 1 and 4, and we have begun collecting lesson video in classrooms beyond

these grades as well. Simultaneously, we are considering how we can use teachers' interest in these practical resources to engage them with some of the materials designed to promote more reflection. In year three of our project, we will study the effectiveness of the site, asking if the resources we intend to promote reflection actually produce better changes in teachers' thinking than the more practically-motivated ones.

Framing Resources. One of the goals of our site design was to promote teacher commentary on each resource. We were hopeful this commentary would show reflection and would encourage teachers to have reflective conversations with each other. We determined that we would need to provide some feedback mechanisms and guiding questions on resources to prompt conversations on the site. To develop these mechanisms and questions, we consulted our teacher partners.

In our first meeting with teacher partners, our partners were naturally sensitive about making their practice public, especially as our VLC interface already allowed users to comment on video clips (as well as other resources). We discussed how we might encourage users of the site to make constructive comments. Based on the results of this meeting, we designed a feedback mechanism that encouraged users to review the usefulness of a video for their practice, rather than the teaching in the video. We also included framing information on each video that was meant to provide context (e.g., what was being taught in the classroom that day) and guiding questions to focus the user's attention away from teacher criticism. We provided contextual information on non-video resources, but not framing questions, as many non-video resources are simply downloadable instructional tools.

Data from site usage indicate that these precautions were not enough. Many early comments on the site were overtly critical of teachers and avoided the guiding questions. Teacher partners raised concerns about the tenor of commentary on the site, and we immediately implemented a new feedback mechanism that even further discouraged disparaging commentary. We also theorized that the root of the problem was users needing guidance on their approach to the site.

At a second teacher partner meeting, we raised the question of providing this guidance by having the teachers write their own framing information for users of particular resources. In debriefing this activity, the teacher partners constructed a list of recommendations for visitors to the site, in order to move them, as one partner said, "from a place of judgment to a place of reflection." We implemented several of their recommendations, from encouraging users to watch video twice to focusing guiding questions more on student thinking and actions rather than teaching.

The results have been mixed. We conducted an analysis of user comments on the site resources in December 2011. At the time, there were 230 resources on the VLC and 162 substantive (i.e., non-technical, discernible) comments on the resources. These comments were spread across only 73 resources, and 36 of those resources had just a single comment. In other words, 78% of the total comments (126/162) were made on just 16% of the total VLC resources

(37 resources out of 230 resources on the VLC). The goal of rich, reflective conversations on site resources had simply not been reached, no matter the framing questions we provided.

However, there is reason to hope going forward. First, we are finding that videos (which provide framing questions) are promoting more commentary than the other resources (which generally do not provide framing questions). Of the 73 resources that had user comments in December 2011, 40 were videos and 33 were not videos. Although this may not seem like a huge discrepancy, closer analysis revealed that 62% of the videos on the site (40 out of 65 total) had comments, while only 20% of the non-video resources on the site (33 out of 165) had comments. Furthermore, 65% of the videos that had any comments at all garnered more than one comment (suggesting a conversation amongst users), while only 33% of the non-video resources received multiple comments. The fact that the videos (and potentially their framing questions) promote more user commentary is a reason to be cautiously optimistic about the framing of resources in general.

Second, the tone of the comments clearly improved over time. In the December 2011 analysis, we found that very few of the comments included the kinds of detailed discussion of student thinking and instructional practice we desired. Indeed, a number of the comments were simply generically positive (e.g., "Love it-thank you"). However, within many of these positive comments and praise, there were signs of reflection. Many commenters added information to their comments about how and when they would use a resource or what aspects of a video clip they particularly admired. For instance, one teacher reviewed a first-grade video in which students were sharing what they noticed about the number line, writing, "I loved how throughout this lesson this teacher took the opportunities to pause and repeat what the students said about the number line. The teacher's skill of summing up the children's answers was also a great repetition tool for those students who might not have gathered the information the first time it was said." While ostensibly acting as praise of the teacher, the comment also included reflective thinking about how the teacher re-voiced the children's commentary and how this re-voicing might have aided student understanding. We hope to continue to see such reflective commentary throughout the site, and we will study the effects of the site on teacher reflection next year.

Organizing Resources. Resources on the VLC are currently presented as standalone objects which are searchable by tags. We have received feedback from users requesting different ways of organizing content, including settings for customizing how resources are ordered and sequenced "courses" of resources that engage with common needs emerging from the curriculum. In response to these demands, we have enhanced the MYPAGE section of the site, so that teachers can more easily bookmark, organize, and annotate resources. In addition, we began a small, self-funded CEMSE initiative to test the potential of more formal "online professional development" for teachers that would utilize many of the resources on the site. We are currently working with a large urban school district to develop and pilot test a small number of online courses that will draw on VLC resources (and other resources) and provide sequenced learning opportunities for teachers. We hope to use the results of the pilot test to expand our work in this arena.

Incorporating the VLC into Teachers' Work. The VLC is related to teachers' work but is essentially an addition to their workday. Teachers are busy, and we have learned from our teacher partners that, despite the best intentions, they simply do not have time to engage in conversations on the site on a regular basis. Thus, we are experimenting with ways of integrating the site into teachers' daily work by encouraging school-based groups of teachers to use the site for live professional development discussions. We have begun a discussion group for instructional leaders to find out how they use the site for professional learning.

Using Curriculum Research. In building the content for the site, we drew on research conducted by our center on how teachers use *Everyday Mathematics*. The results of this research—which indicated which parts of the curriculum teachers struggle with—have closely mirrored the resources most requested and viewed by teachers. For instance, the previous research suggested teachers struggle most with pacing the lessons, and site users have routinely asked for full lesson videos just to show how long each part of the lesson is "supposed to be." We are considering expanding our curricular research to inform our professional development offerings on the site (see Beer, Schleppenbach, and Kim, 2011), but the realities of staffing and project scope have limited these efforts thus far.

Significance

This paper has implications for educational designers and professional developers. Designers may learn from the ways we engaged teachers as critical partners in the development process. At every turn, our commitment to including teachers in the design process has paid dividends, both in the number of site members we enroll every day and in the growing quality of commentary and interactions on the site. Including teachers in the design process can be exceedingly difficult; teachers are not often available when it is most convenient for designers, and teachers may focus on vastly different aspects of the design than the designers. However, we believe the work we did in developing easy ways for teachers to give feedback on the site itself and in recruiting and supporting a talented pool of teacher partners has paid important dividends.

Professional developers may learn from the ways teachers have suggested they would organize their own professional learning through an online interface. For one, we know that teachers are drawn to professional learning that is practical and can make their work lives easier. Although we reported that teachers are more drawn to the practical resources on the site than the ones designed to promote reflection, we believe that trend will ultimately help us reach our goals. Teachers are joining the site, perhaps largely due to word-of-mouth regarding the potential to find and download practical resources. However, once they are on the site, teachers may stay for some of the more reflective resources; indeed, we are finding that teachers view the practical resources, but they leave the best comments on the video clips designed to promote reflection. Indeed, this experience mirrors the findings of other staff in our center who conduct live professional development activities. These professional development providers have found

that they gain teacher trust and confidence by initially serving simply as an extra set of hands in a classroom; over time, this trust and confidence allows the providers to engage with teachers about their classroom practice. Professional developers, particularly those who work primarily in the research sector, can learn from this model by endeavoring to provide immediate, practical benefits to teachers as an initial, and integral, part of professional development.

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