Three Cases of Teachers’ Collaborative Design: Perspectives From Those Involved

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Abstract: We present the perspectives of teachers and others involved in the collaborative design of teaching and learning artifacts across three cases: (a) an independent group participating in lesson study; (b) teachers participating in professional development programs; and (c) a district initiative for producing numeracy tasks. Among the results we found that (a) the role of the facilitator was crucial, (b) different forms of support were present, and (c) the impact extended beyond the involved participants. These cases represent an option for both the design of curricular material for classrooms and a curriculum for teachers’ continuous professional development.

Résumé: Nous présentons les points de vue d’enseignants et d’autres intervenants qui ont participé à la conception de matériel pédagogique dans trois contextes différents : un groupe indépendant participant à la mise au point de leçons, des enseignants participant à des programmes de développement professionnel et, enfin, une initiative régionale de production de tâches visant à améliorer les capacités au calcul. Nos résultats ont montré entre autres que : le rôle du facilitateur a été crucial, qu’il y a eu plusieurs formes de soutien et que leur impact allait bien au-delà des participants. Ces trois cas représentent une possibilité aussi bien pour la conception de matériel pédagogique à utiliser en classe que pour un curriculum de perfectionnement professionnel et de formation continue destiné aux enseignants.

INTRODUCTION

As new perspectives on mathematics education permeate the reformed curricula in many parts of the world, the professional development of prospective and practicing teachers oriented toward such perspectives requires new approaches. In many jurisdictions the mathematics curriculum calls for a focus on students’ experiences and thinking: “learning requires the active participation...
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Two and a half years of people learn in a variety of ways and at different rates... and learning is both individual and group process” (Ministry of Education–Province of British Columbia [MEPBC], 2007, p. 11). The needs of students for constructing their own meanings, exploring problem-solving situations, and developing positive attitudes toward mathematics learning are often stressed. Although textbooks and curriculum documents are important resources for the development of these capacities in students, these resources are often not enough for dealing with the professional development needs of teachers working to implement these desired changes inside their classrooms. What they need are resources that help them to deal not only with the content of the changing curriculum but also with the context in which this curriculum is to be delivered. The proper implementation of curriculum revisions and the incorporation of new research insights on mathematics learning into teaching practices require a perspective on the teacher as a lifelong learner. Professional development programs for practicing teachers must allow teachers to incorporate these changes and insight into their classrooms. Teachers need opportunities to think and to rethink what it means to teach and learn mathematics in the problem-rich and collaborative settings that the curriculum revisions are calling for.

One such opportunity comes in the form of teachers working together to co-construct teaching–learning artifacts such as lesson plans, assessment rubrics, or mathematical tasks. This approach forms the basis of a variety of high-profile models that have been successfully applied around the world, from lesson study (Fernandez & Yoshida, 2004), to learning study (Marton & Tsui, 2004), to collaborative teacher inquiry (Slavit, Nelson, & Kennedy, 2009). Each of these models is built on a platform of collaborative construction of an artifact, its implementation, analysis and discussion of results, and its refinement. The positive impact on teachers’ practices by means of such collaboration has been widely documented (Fernandez & Yoshida; Jaworsky, 2006; Lewis, Perry, & Hurd, 2009; Ling & Runesson, 2007; Marton & Tsui; Slavit & Nelson, 2010; Stigler & Hiebert, 1999). This type of collaborative work among teachers not only produces new teachers’ resources but also, and most important, affords teachers a context and a purpose to share, to reflect, and to explore the teaching and learning of mathematics and, as a result, to contribute to the improvement of students’ mathematics learning.

We have come to call the types of collaborative activities presented in these models, as well as the collaborative activities we discuss in this article, teachers’ collaborative design. A distinctive characteristic of teachers’ collaborative design is that the final product, the artifact, is something that teachers actually implement in their classrooms. We use the term artifact to describe teaching tools such as mathematical tasks, lesson plans, assessment rubrics, scripts for teaching, or any other construct that teachers use as resources for mathematics instruction. The following steps are part of the process involved in any case of collaborative design: (a) the design of an artifact to meet previously negotiated and agreed-upon goals; (b) the implementation of the artifact in at least one classroom; and (c) the debriefing of the implementation followed by any necessary refinement of the artifact. Once the artifact has been refined, other teachers can begin to use it, usually adapting it to fit their own classroom and students’ needs.

As such, teachers’ collaborative design provides two dimensions of impact. First, teachers participate in the development of tools that they will use for teaching mathematics. These tools are then made available for use to the larger community of practicing teachers for use in their own classrooms. Such teachers’ involvement is a common practice in Japan (Watanabe, 2007) and Finland (Pehkonen, Ahtee, & Lavonen, 2007), countries that have regularly shown high achievement in mathematics instruction at elementary and secondary levels (Martin, Mullis, & Foy,
2008; Organization for the Economic Co-Operation and Development [OECD], 2003). Second, in addition to the impact on what is taught in multiple classrooms, this type of collaborative work represents an option for the continuous professional development of teachers in ways already described.

We look at three different cases of collaborative design and from the voices of those involved we seek to answer the following two questions:

1. What are the elements that make these cases of collaborative design similar? What makes them different?
2. What are the central elements that contribute to the success of the collaborative design initiatives in terms of teachers’ practice? In terms to students’ experiences?

Having a comparison among different cases, including the elements that contribute to enrich teachers’ practices and students experiences, will inform teachers, educators, and educational stakeholders interested in the implementation of teachers’ collaborative design for developing both curricular material for elementary and secondary levels and a model for teacher professional development.

**METHODOLOGY**

The work presented here is a part of a larger study in which data were gathered from seven distinct sources, over a period of 3 years, for the purposes of elucidating and comparing the nature of teachers’ experiences across a number of different collaborative design settings:

1. a one-semester lesson study-inspired project developed at three different cities in Mexico (Preciado & Liljedahl, 2008);
2. an independent group of teachers and educators that started to meet in 2006 in order to conduct lesson study;
3. a project of collaborative design in a secondary school where three teachers and one of the authors participated over a period of 8 months;
4. a school district initiative running for 5 years in which several teachers have participated in the collaborative design of numeracy tasks;
5. a master’s graduate program in mathematics education that includes collaborative design as part of the course assignments;
6. a series of workshops for practicing mathematics teachers in which participants were engaged in collaborative design; and
7. pieces of literature that describe large scale cases of teachers’ collaborative design in Japan (Fernandez & Yoshida, 2004), Hong Kong (Elliot & Yu, 2008), and the United States (Slavit & Nelson, 2010).

The data from these sources include individual and group interviews, surveys, field notes, video and audio recordings, and e-mail exchanges.

We analyzed the data across the larger study using open and focused coding, theoretical sampling, and constant comparative analysis among emerging codes and categories, as described by Charmaz (2006). Emerging from this analysis was the prominence of the setting in which teachers’ collaborative design occurs as well as the roles of those involved. These emerging
categories informed the selection of data and formed the framework for analysis presented in this article. In particular, we looked at how the setting and roles differ across the different collaborative design contexts as well as how these aspects contribute (or not) to the success of collaborative design.

Due to space limitations, we do not present all of the data in this article. Rather we have selected a set of three cases that (a) took place within the same province in Canada and are immersed in the same curricular reform climate and (b) represent the broad spectrum of collaborative design activities existing within our data. The first case (called the independent group case) corresponds to data set 2 (above) and was selected partially because it is an example of lesson study, which is featured prominently in research literature in general and the larger study in particular. However, it was selected mostly because it is also an example of an independent professional development initiative that happens on participants’ own time. The second case (called the pro-d case) corresponds to some of the activities of teachers drawn from data sets 5 and 6 and were selected because they include collaborative design within structured professional development programs such as series of workshops, courses, or graduate programs. The final case (called the numeracy task case) is one of the initiatives we examined in data set 4 and was selected partially because it exemplifies collaborative design organized at a district level and partially because it is an example of activities organized for the express purpose of producing classroom resources. Some teachers had participated in both the second and third case. The professional development program had trained some of the teachers who participated in the school district initiative. Those teachers had a greater experience in collaborative design, and excerpts of the interviews with two of them are included in this article.

Both authors were involved in at least one of the three cases analyzed in this article. The first author, A. Paulino Preciado-Babb, conducted all of the interviews for these three cases and participated as a member of the independent group. The second author, Peter Liljedahl, a university professor, was the instructor in the pro-d case and participated as an expert guest in the numeracy task case.

The data generated for these three cases consisted of field notes and interviews, which were semi-open, allowing us to obtain both specific information about the process of collaborative design and emerging aspects not contemplated previously. Interviews were conducted both in person (30 to 45 minutes) and by e-mail when it was not possible to meet the interviewee. In some cases a second interview was conducted as a means to verify our interpretations and elaborate on emergent themes.

RESULTS

In what follows we present each of the aforementioned cases through the voices of those involved. Excerpts were chosen for their ability to not only exemplify the cases but also to provide insights into the research questions.

The Independent Case

The independent case was based on lesson study and was comprised of mathematics teachers—both practicing and prospective—and educators. Meetings were held at least four
times a year for 3 hours on Saturdays. The number of people attending the sessions of this inde-
pendent group varied, with about 15 participants who attend regularly. At each meeting an expert
in mathematics and an expert in mathematics education were present. Participants formed smaller
teams in order to design and implement lessons. The teams worked independently and reported
their results at the next general meeting. Teachers and educators came from a variety of schools
and postsecondary institutions, from which they might select a class for the implementation of
the lessons. The implementation of each lesson was observed by the members of the design team
and possibly by other members of the group. This was followed by a debriefing session and
refinements to the lesson were then made.

Interviewed participants in this case found collaborative design useful and interesting. They
appreciated the sharing of experiences and learning from the debriefing of the lessons. Even
ideas discussed during the design process but not used in the final lesson were often used by
some participants in their teaching. One of the interviewed participants, a university professor
involved in teacher education and a former teacher, mentioned her impressions regarding the
implementation of a lesson in which she participated as a designer and observer.

Professor: I found it quite interesting to watch someone else delivering the lesson that I helped plan,
to see if it will be the same as I would do it, and in there, there were places where I would step in
differently and do some things differently. And I also found new ways of looking at it and presenting
it . . . and I wish we had more chance to watch people delivering lessons, because it was a learning
experience for me as a teacher.

As can be seen in this excerpt, the professor reflected on their practice while observing another
teacher implementing the designed lesson. This same professor also acknowledged the challenges
of allowing time to meet for the design of the lessons and their implementations.

Professor: Unfortunately, we don’t have time and teachers from the same school at [this group].

This participant was alluding to the challenging setting created by working as part of an indepen-
dent group. It was difficult to find the time and place to design the lessons, and getting a class
for the implementations was problematic. Even if some participants’ schools allowed them to
conduct an observed lesson, observers might have to get permission in order to be absent from
their own classrooms.

Important to this case of collaborative design were the organizers, two people who have
managed to find support from an institution in order to have a location and refreshments for
the meetings. They also served as facilitators in leading the sessions, contacting special guests
for the general meetings, and coordinating the schedule and communication within the group.
One of these organizers is a secondary mathematics teacher who had participated as a designer,
implanter, and facilitator in this group. She explained some of the factors that have supported
and hindered the collaborative work in this case.

Teacher-organizer: What supports [the collaborative design] is the teachers’ desire to assist their
students . . . to learn well and to enjoy their learning, and to perform well and to succeed. I think
this is the common sense goal that teachers have. And so, this is kind of what binds these groups
together. . . . Depending on where this is held . . . the distance that these people have to travel . . .
hinders it. You know, if teachers cannot access each other’s classrooms, if they are living far apart or
working in different schools, that is also difficult: Schools would pay for subs. . . . But definitely the
time is always an issue for teachers; to find this common time and to meet. So there has to be a big commitment to this work. That’s the key.

Again, time and place for the collaborative design were mentioned as a limitation in this case. This teacher had also been involved in leading lesson study at her own school. In this context she had received support from her school, where several lesson study teams were working together.

Teacher-organizer: [We meet] about once every ten days, I would say, for let’s say four to five times for a lesson. And we ran two or three cycles in a year. And now we are fragmented actually, so we are having the after schools: three teachers run in one cycle and it doesn’t have to be in conjunction with the other part of the school.

In this particular school, the fragmentation is a strategy that allowed the implementation of more observed lessons. It also helped with disseminating the results of the designed and implemented lesson, an important part of the lesson study cycle. In contrast, the dissemination of results was in its beginning stages for the independent group.

Teacher-organizer: After the post-lesson discussion we are kind of done with it. Yeah, we don’t really have that one step further which is necessarily; you know, publish and share the experience. But we are now trying to make that alive at [this group] and this is why I meet with [another teacher] today, refining this lesson based from the feedback, from the post-lesson discussion and then we will put up and publish on [the group’s] website. . . . But I did get calls from a couple of schools to share those research lesson plans that I have. I sent e-mails of those.

That is, the dissemination of the lessons from this independent group represented an impact of teachers’ collaborative design on a broader audience than those who were involved in its creation.

The Pro-D Case

In the professional development case, participating teachers were enrolled in workshops or graduate courses where collaborative design was a requirement. Meetings were conducted periodically. In some courses teachers met every week, whereas in other workshops teachers met intermittently. The length of the sessions varied from a few hours to a full day. During the working sessions participants designed mathematical tasks or assessment rubrics that they implemented in their own classrooms and reported their results at the next sessions. In this way, a collective debrief and refinement of the artifacts was conducted. The instructor promoted discussions within the groups and, indirectly, provided a place and facilities for the sessions—the courses or workshops are officially organized by the university or a school district. In the following excerpt the instructor—one of the authors—described the process of collaborative design for this case.

(1) We begin with a common experience of doing a task like the kind we hope to eventually design. (2) We then clearly delineate what we are trying to design. This usually requires the definition of certain terms. (3) We set a timeline for design, field testing, refinement, more field testing, and implementation. (4) Then we begin to design. I allow very rudimentary things to get tested in the field. I find that the variety of such things brings back very good feedback to the group. (5) This feedback then allows the group to develop a clearer picture of what they are trying to do. (6) Once the field testing is done, I help the team to write what I call a “script.” This is a plan for implementation that helps to make concrete the details of enacting that which, until this point, has not been treated explicitly. (Instructor, December 2009)
Although not all of the teachers implemented the first version of the artifacts, most of them used the refined versions. According to the instructor collaborative design has a double effect: “(1) it contributes to the mathematical enrichment of students’ environment in the classroom, and (2) teachers change their perspectives toward teaching and learning mathematics.” (Instructor, December 2009)

Different forms of assessment were explored during the workshops, extending from typical quizzes and tests to other methods such as the use of rubrics. The following transcription from a participant teacher represents evidence of the impact on teacher change, as well as students’ performance, as a consequence of incorporating the mathematical tasks and assessment rubrics designed collaboratively in the workshops.

During our time together, I felt that my students really enjoyed their math class. I found the students to be focused, challenged, and motivated when they were working on the word problems. They would have a better understanding, overall, of what it takes to write a complete solution to a problem using the rubrics. I was able to see progress for the students who took the time to use the rubrics as a guide. After the collaboration, I’m trying to expand the samples that I’m using for assessment in class. I’m trying to go beyond the typical quizzes/tests, etc. I’m hoping to try and incorporate some of the observable behaviors to better understand the student I’m teaching in the classroom.

One of the questions asked of participant teachers, one year after being involved, in this case was “How did your participation in this collaboration affect you as a teacher during our time together and after?” The answers to this question involved more than implementing the designed artifacts in the classroom; teachers reported changes in their teaching approach and focus, as we can read in the following excerpt from an e-mail with another teacher:

My approach to teaching “math” has changed. I now look at the “big ideas” and do my best to engage students in the process of learning. The classroom focus is on the process and a student’s ability to represent and communicate their thinking, rather than the product (finding the “right answer”). I have tried and am very interested in continuing to do so. (January 2010)

Representation and the ability to communicate ideas, which is a significant part of the trends in the new curriculum, were fostered in this case of teachers’ collaborative design, which triggered a focus on students’ thinking.

One more participant teacher with 22 years of experience reported a renewed enthusiasm for teaching as a consequence of participating in these workshops, as we can read from the following excerpt of an interview conducted by e-mail:

[The] workshops have renewed my enthusiasm for teaching and have given me direction for professional development. . . . When all is boiled down, I truly value the time spent with colleagues and professors who have some common direction/thinking/enthusiasm around numeracy, . . . It is refreshing: 22 years of teaching and I was starting to feel stale. I think I’ve mentioned . . . before how [the instructor has] helped me get life back into my teaching. (January 2010)

The instructor had promoted independent collaboration among teachers. He had “tried very hard to promote capacities for teachers to work without him.” Initially, he brought a goal and coherence to the team. However, a network of shared artifacts and experiences has been formed as a consequence of the continuous implementation of this strategy in several professional
development programs. This network allows the teachers to continue to share their work in collaborative design of artifacts.

The Numeracy Task Case

The numeracy task case was a district initiative where teams of teachers worked to design mathematical tasks and assessment rubrics for use within that district. Teams of teachers from the district designed the artifacts that were implemented by these and other teachers who, thereafter, met in order to analyze students’ products and to debrief the implementations of the artifacts. Once an artifact was tested and refined it was distributed to other teachers within the district for use.

The collaborative work in this case was organized by a staff development coordinator for numeracy K to 12. Without being an expert in mathematics or mathematics education, he facilitated the collaborative work by (a) scheduling the meetings, (b) providing resources for teachers, (c) writing and doing the graphic design for the artifacts, (d) serving as a liaison between teachers and other experts and institutions, and (e) finding funds to support collaborative work. The place of the implementation was in the teachers’ classrooms and the meetings were held either in their schools or in a district office during their regular job schedule. The district-level teams met every 4 or 5 weeks in 3-hour morning sessions. The agenda for the collaborative work was determined by the district goals, which were related to the implementation of new strands in the curriculum.

Coordinator: One of [the goals] has been to create a district wide assessment in math for grades five and grade eight with a problems solving focus. . . . They come together to construct two problems that would be used to conduct district wide assessment and to get district wide data that uses the BC numeracy performance standards and focuses on the representations and communication strand. So, how students are communicating their thinking as they are solving the problems. (This is a transcript of the interview with the Coordinator.)

Additionally, the collaborative activities were a means of professional development for both designers and implementers. Moreover, there was another outcome for teachers: they value students’ thinking and communication.

Coordinator: It’s meant to be professional development for the teachers who create the problem, but also for the teachers who use it. . . . A third goal has been to help the teacher recognize that there is a value in what students can write about their thinking, and how they represent their thinking and communicate it. (This is a transcript of the interview with the Coordinator.)

According to the coordinator, an important factor that promoted a change in teachers’ practices was that they were required to try new strategies in their classrooms. Teachers were allowed to take risk in the design and use of their artifacts.

Coordinator: . . . So, then people are open to try things and risk. They have the permission to try and fail really. . . . I think that is what we found is driven more than any other thing. People have the permission to try new things. (This is a transcript of the interview with the Coordinator.)

In this case of collaborative design, teachers had changed toward a collective work in a lasting way. They keep doing collaborative design for the district or even initiated their own learning teams.
Coordinator: I find that most of the teachers who have been involved with this, if they have been involved with the learning teams they keep going. Usually the team runs for two or three years, and by then people have made them part of their practice. So it does, they have lasting impacts. (This is a transcript of the interview with the Coordinator.)

In addition, there was a measured improvement in students’ performance as a consequence of the collaborative design. In this case, improvement went well beyond expectation.

Coordinator: In five years, it [students’ representation and communication] has gone from fifty-six percent to eighty-four percent. So it has grown. And the grade fives were doing much better to begin with. They were about seventy and now they are about ninety percent. But what does speak to what teachers are teaching, is that they change their teaching practices. The kids have gotten better because they are incorporating teaching representation and communication into their math. So the kids are doing more writing in math. So again I would say this type of model, although they are not part of the team, the effects of the team are the changes in practice more widely than I think it was anticipated. (This is a transcript of the interview with the Coordinator.)

The mathematical task used for these artifacts had a focus on problem solving in a context familiar to students. Ambiguity and use of language are factors involved in some artifacts, as can be seen from the following excerpt of a teacher who participated in the design teams.

Teacher: We are looking at representation and communication and trying to come up with a variety of different tasks. So, tasks that ask them to do something different from what they have been presented with. So, trying to avoid tasks, in my opinion, which are strictly computational. We were trying to put in more language and a bit more ambiguity in there, and then some sort of context. The one we are working on right now... has to do with social responsibility. ... So, the [fictional] context of the problem or the situation we are setting up is that the school district has decided it’s part of the district wide initiative to be more socially responsible. ... And the grade eights are asked to make the decision of whether or not they will spend the money through this charity or this charity or combination and they have to justify and rationalize their choice.

One of the integral components of the nature of mathematics specified in the mathematics curriculum is uncertainty (MEPBC, 2007). This component was also integrated in the design of mathematical tasks by teachers in this school district. In the following excerpt another teacher explains the introduction on ambiguity as part of the designed tasks:

Teacher: I think that the harder part [students] have with it was the ambiguity. They want to know that there is a right way to do it, and when you are giving a certain constrain, but then give them freedom, I think it’s uncomfortable for them. Specially with math because I think they are very used to things being black or white, it’s right or it’s wrong. ... I found that, especially with the kids that I had in grade 4 and get in grade 5, it’s an insight being really liberating for them. I think that it opens their mind to a lot of different possibilities. And they are not so concerned about there’s a right or a wrong way of doing it. If it’s just a matter of “you can do it that way if like to, but you need to be able to justify and rationalize your thinking and make a strong point for it. Where is your evidence that this is a good solution?”

The previous transcription reflects not only ambiguity as a component that was deliberately included in the mathematical tasks but also students’ reactions to uncertainty as perceived by the teacher. This teacher mentioned that students had a hard time when coping with ambiguity but they also found liberating the possibility of having different answers to a mathematical problem.
An important factor that contributes to the collaborative design is the role of the facilitator. In this school district there were two types of collaborative work: the teams for task design described before and learning teams, which did not necessarily conduct collaborative design. The importance of having a facilitator was stressed by the coordinator.

Coordinator: An outside facilitator is vital. We have learned that when there are learning teams, if they are allowed to facilitate themselves it will not work. (This is a transcript of the interview with the Coordinator.)

Nevertheless, teacher commented in an interview that they can work well without the supervision of a facilitator. However, it is important to keep in mind that the role of the facilitator was not restricted to the participation in the designing process—for example, facilitating resources and organizing schedule for collaborative design.

Teacher: And I find, too, that it doesn’t make that much a difference to whether someone [a facilitator] is there. The group still seems to be able to manage themselves and stay on task.

This teacher had long experience in collaborative design. Having a clear expectation about the desired work and experience with the collaborative design may be factors that contribute to good performance of a team without a facilitator, as explained by the same teacher in the following excerpt.

Teacher: I think it’s because for the most part, we all are pretty seasoned as far as this goes, so we sort of know what the expectations are. We all seem to be pretty goal oriented; we don’t really want to waste our time together. We would like to get it done, so we stay on task.

The district-initiated case of collaborative design had a great advantage in terms of time and space, as well as resources for teachers. First, the work itself was valuable in that it provided teachers with time during their daily schedule to collaborate on the artifacts. Second, the artifacts themselves were valuable in that they were used by the whole district and, as such, they became a part of the curriculum. Additionally, this collaborative activity served as a means for professional development in a wider range because it had an impact on both designers and implementers.

**DISCUSSION**

Looking across the three aforementioned cases, similarities and differences begin to emerge. In this section we look more closely at these.

**Differences**

We have identified differences not only between the three cases of collaborative design but also among the roles that participants played within each case. We identified three different, possible overlapping roles: teachers, specialists, and facilitators. Teachers, including prospective teachers, were distinguished from the other two because they are susceptible to changing their teaching practice as a consequence of participating in collaborative design. Specialists were experts in mathematics or mathematics education and held official credentials such as a graduate degree. The instructor in the pro-d case was a specialist in mathematics education. External
specialists were sometimes invited to support the collaborative work among teachers, as in both the numeracy task case and the independent group. The role of the facilitator was basically to support the collaborative design teams. In contrast to teachers and specialists, facilitators varied in who they were and what they did. The coordinator in the numeracy task case was not an expert in mathematics or mathematics education; however, he was a facilitator for the teams in the school district. In contrast, the instructor in the pro-d case was also a specialist. Whereas some facilitators were fully engaged in the design process, as in the pro-d and the numeracy task cases, others provided resources for the collaborative work without actually participating in a team of collaborative design, such as one of the organizers in the independent group. Organizing and scheduling the collaborative work were tasks that facilitators often engaged in. In the cases of the independent group and the numeracy task, they served as a liaison with other institutions and as seekers of funding and other support.

In addition to roles, we differentiated between the forms of involvement that participants may have in collaborative design into three categories: designers, implementers, and observers. In the numeracy task case, some teachers just implemented the artifacts without participating in its design and reported the results and students’ products to the design team, contributing to the debriefing and refinement of the artifact. Though designers and implementers were present in the three cases, observers were only present in the independent group.

We identified different settings in each of the cases of collaborative design that included the place, time, and organization of the collaborative work, as well as other external factors that influenced the performance of the teams. The size of the teams varied from a couple of teachers to a whole cohort in a master course in mathematics education. Places for meetings varied from a university or school to an informal space such as a participant’s home. The time for the meetings and the periodicity also varied; whereas in some cases teachers met for 30 minutes once a week, in others they met for several hours once a month. The type of support for collaborative design also impacted the performance of the team. Economic incentives or grants made it possible for teachers to attend the courses and workshops in the pro-d case. In order to organize meetings with designers and implementers, substitute teachers were hired in the numeracy task case. Other types of support were also important; for instance, the meeting place and the refreshment provided to the independent group. Attachment of the design teams to an institution also provided support for the collaborative design in terms or resources and contact with educators and researchers.

Another difference was the original purpose of the collaborative design in each case. In both the independent group and the pro-d cases the primary purpose was teacher professional development, whereas in the numeracy task case the primary goal was to create specific artifacts. In the former scenario, professional development activities resulted in the construction of artifacts, whereas in the latter the design of artifacts brought about teachers’ professional development.

Similarities

We also found several similarities among the three cases of collaborative design. First, each case was predicated on an explicit effort to foster a problem-solving–based approach to teaching with special attention to students’ thinking. The designed artifacts were either mathematical tasks or rubrics to assess students’ processes during the resolution of a problem. This is in line with the curriculum changes being implemented within this jurisdiction.
Another similarity was the voluntary nature of participation in these cases of collaborative design. The fact that each case was well subscribed by participants attending regularly shows the high motivation that teachers bring to such endeavors. In the independent group teachers even used their own time for collaborative design. Additionally, in the numeracy task case teachers tended to continue with collaboration long after their formal involvement had concluded.

The designed artifacts for each case, once tested and refined, were shared with a larger community. In the independent group and the pro-d cases the artifacts were published on a website, allowing other teachers to use them. In the case of the numeracy task case the artifacts were designed with the original purpose of their use throughout the school district. This resulted in broad dissemination of tasks across many hundred teachers for use with many thousands of students.

Also evident in each case was the fact that, although serving different purposes for each group, there was always someone in charge of facilitating the group. In the independent group two persons played this role, in the pro-d case it was an instructor, and in the numeracy task case it was played by a district staff development coordinator. In addition to the facilitator, each group had a specialist. In the general meetings, the independent group included specialists in both mathematics and mathematics education. In the pro-d case the instructor played a double role of facilitator and specialist. Specialists were also invited to support the teams of collaborative design for the numeracy task case.

Contributions to Success

We summarized the elements that contribute to the success of teachers’ collaborative design, in terms of both teaching practice and teachers’ attention to students’ experiences, in four categories. Firstly, in the three cases the teachers focused on students’ thinking in the context of problem solving. Having an opportunity to reflect on and change their practice in this context was facilitated through the implementation of the designed artifacts. In the independent group the professor mentioned that she reflected on her own practice while watching others teaching the lesson they had planned together. In the pro-d case, teachers also reflected after the field testing—in particular, they reported a change in their perspectives on representation and communication. These perspectives were shared by the school district’s interests from the numeracy task case, where teachers had permission to try and fail in designing and testing the mathematical tasks. Secondly, the dissemination of the resulted artifacts in the three cases was a factor that extended the impact of teachers’ collaborative design. This effect contrasts strongly with regular professional development programs that impact only the teachers involved. Thirdly, the support that each of these cases received for the collaborative design was an important element that contributed to its success. In particular, the diverse support of the facilitators proved to be pivotal in the ongoing success of the different groups. Finally, the improvement in the district results claimed by the coordinator in the numeracy task case, as well as the students’ performance described by the teachers, is evidence of the downstream success of implementing teachers’ collaborative design.

CONCLUSION

In this article we have presented three different cases of teachers’ collaborative design, including participants’ perceptions of the impact on teachers’ practices. We identified similarities and
differences across these cases as well as elements that contributed to the success of teachers’ collaborative design.

Facilitators and different forms of support played a relevant role in the three cases. The role of the facilitator as a funds seeker, liaison with other institutions, organizer, and writer and graphic designer supported the collaborative design activity. Economic support was provided to the pro-d and numeracy task cases. The independent group received other types of support from an institution: a place for meetings and refreshments.

We also found that collaborative design had a potential to impact beyond the participants involved in all three cases. In the independent case other teachers had access to the lessons designed either through direct contact with a participant or through the group’s website. Similarly, teachers in the pro-d case shared experiences and artifact designs through the networks formed. The influence in the numeracy task case was even broader—not only did designers and implementers have access to the artifacts but other teachers in the district used the artifacts once they were tested and refined. Thus, the impact on changing teacher practices extended to other teachers in the district.

The three cases of collaborative design presented here shared an additional relevant attribute: the artifacts designed had a focus on problem solving—a clear trend in curriculum revisions. As such, the optimization of the setting and maximization of the roles and involvement of the participants allowed for collaborative design to meet the curricular needs of both students and teachers. We therefore advocate teachers’ collaborative design as a form of continuous professional development for mathematics teachers as a process that allows the time to think and rethink what it means to teach and learn mathematics as they work to implement curriculum revisions as well as changes to their practice. We have shown that this form of professional development has an impact on participating teachers, teachers who implement in their classrooms the designed artifacts, and students.

Finally, the description of the settings and participants’ roles presented in this article are consistent with our data in the larger study. The variety of settings represented in the data, including the large-scale projects reported in the literature that were used as second-hand data, suggests a level of generality in the descriptions of the roles used in this article. Such settings and roles vary from case to case. However, the role of a facilitator/organizer, as well as the local support from a school, school district, or educational institution are factors that contribute to the implementation of collaborative design in order to develop both curricular material and a model for professional development. In particular, allowing the time and place for collaborative design may be challenging without such support, as was the case for the independent group described in this article. Dissemination of the artifacts designed is another factor to consider for such implementation. In order to establish this method of teacher professional development, which entails teaching as a career of lifelong learning, collaborative design must be included as a teachers’ duty not as additional task but as part of their job, with its corresponding timetable within their working hours.

REFERENCES


